Skills Development Guide
INTRODUCTION

Students and client organizations together will find Penn Foster, the new brand name for the premier distance learning provider, better positioned to satisfy your requirements for lifelong learning, personal enrichment, and career advancement.

Penn Foster delivers state-of-the-art, tailored learning solutions for individuals, businesses, and institutions across educational and training markets. Specialized content, applications, and services are utilized to foster academic excellence, professional development, and measurable competitive advantage. Penn Foster uses the full depth and breadth of their products and services to assist customers in managing the complete learning process: developing courseware solutions to meet needs, the actual instructional process, and measuring success toward desired goals and results.

The Workforce Development Division of Penn Foster implements the direction set forth by Penn Foster. Customers access our learning library that consists of 3,000 courses covering multiple delivery options: online, print-based study units; video; and CDs. Workforce Development Consultants design the training curricula that augments the learning style and resources of both the individual and the organization. We support independent study, at home or on the job. We also support blended learning that integrates study units with computer-based or video courses, to deliver an enhanced skills development environment.

The Skills Development Guide, your source for course descriptions and curriculum recommendations, also addresses the assessment and administrative services that comprise the complete learning process. Workforce Development custom-assessment tools identify the appropriate courseware for each trainee. An ever-growing number of Penn Foster’s 300,000 active students are proactively receiving these services immediately through the Internet.

The traditional Workforce Development student works in manufacturing or at an electric utility. For many years, Workforce Development has developed apprenticeships, maintenance trades training, and skills upgrade programs for experienced workers. Recent times have seen the expansion of cross-training and multi-craft skilled workers in the core industrial disciplines – Electrical, Electronics Technology, Mechanical Maintenance, and the Machine Trades. Workforce Development continues to invest in new product development that reflects the impact of technology utilized in plants. Equipment operations, maintenance, and troubleshooting applications are emphasized.

To achieve our goal of assisting customers in developing a high-quality work force, Workforce Development continually expands our library of training solutions.

Our knowledgeable team of Training Consultants, Customer Service, and Educational Specialists look forward to helping our customers and students become a successful part of the new millennium of learning and accomplishment.
THE PENN FOSTER SKILLS DEVELOPMENT GUIDE

Resource 1: CD-ROM, DVD, and Video Learning Supplements

A broad library of media-based courses addresses both individual and group workplace knowledge and disciplines. Administrative services capability that assists customers with their corporate university or lifelong educational programs is described. New subject areas include electrical and mechanical maintenance, basic skills, machine technology, welding, PLCs, and much more.

Resource 2: Foundation Skills

A prerequisite for achieving success is having the essential math, reading, and communications skills. Our self-paced programs are ideal for addressing these critical, yet personally sensitive, topics. Pre-technical industrial skills such as measurements, blueprint reading, using tools, and quality principles are covered.

Resource 3: Health and Safety

A working understanding of industrial safety standards, laws, and practices helps you and your employees develop and maintain a healthy and safe working environment. Our Safety Meeting Kits — everything you’ll need to run professional safety meetings — offer an ideal approach for the part-time safety administrator.

Resource 4: Electrical and Electronics

Maintenance organizations are faced with the challenge of upgrading the skills of experienced technicians to deal with new technology. And the hiring of new employees has generated renewed interest in the apprenticeship training concept. This Resource provides complete curricula from basic electricity to microprocessors.

Resource 5: Mechanical Maintenance

The need for mechanical maintenance skills is increasing due to new maintenance strategies such as TPM and preventative maintenance, and the cross-training of work teams. Key subjects include: bearings, seals, and lubrication; hydraulics and pneumatics; mechanical power transmission systems; and robotics.

Resource 6: Machine Technologies

Our curricula and topical programs can provide employees with the training they need to operate metalworking machinery and related equipment. Apprentice and career trades topics include: machine shop introduction, tool and die making, lathes, milling, grinding, NC/CNC, and welding.
Penn Foster offers comprehensive curricula addressing a wide variety of apprenticeship and career trades in construction and facilities maintenance, air conditioning and refrigeration, carpentry, masonry, plumbing, and pipe fitting.

In addition to the courses and subjects contained in the electrical and mechanical maintenance resources, utilities require specialized training in power generation, transmission, and distribution. This Resource presents several curricula which integrate utility-specific programs with the related industrial skills and trades courseware.

Engineering programs address chemical, electrical, mechanical, civil, industrial, pulp and paper, surveying, and water/wastewater plant technologies.

The vehicle maintenance curricula progresses from entry-level basics to advanced topics, covering both automotive and diesel engine maintenance. Service industries, public transportation, and company-owned fleets employ workers who can benefit from our training.

Provide your people with the essential business skills they’ll need, from supervisory management skills to accounting, personal computing, and marketing.

“With Penn Foster’s help, we have re-engineered our schooling process for employees. Penn Foster is very flexible and willing to accommodate design changes. Our Penn Foster Rep is honest, cordial, and innovative. With his consultation and Penn Foster’s streamlined approach, we’ve cut our administrative costs in half!” — Bob Dischner, Manager of Career Development Niagara Mohawk Power Corporation Syracuse, New York
COMPREHENSIVE TRAINING, TAILORED TO YOUR REQUIREMENTS

Entry-Level Employees

Foundation Skills
- Math, Measurements, Reading

Pre-Technical Skills
- Hand Tools, Industrial Safety, Print Reading

Basic Functional Training
- Principles and Concepts, Manufacturing Equipment, Basic Skills

Computer Literacy
- Concepts and Applications Software

Experienced Employees

Apprentice Programs
- Skilled Trades and Crafts

Functional Skills
- Systems and Processes, Personal Computing

Diagnostic Skills
- Schematics, Troubleshooting, Advanced Math and Measurements

New Technology Training
- Automation, Robotics, New Equipment

Tenured Employees

Advanced Functional Skills
- Systems Troubleshooting

Journeyman Programs
- Subject Mastery, Topical Programs

Cross-Training
- Principles and Concepts, Functional Skills

Supervisory Skills
- Leadership, Communications, Business Management
PRINT-BASED COURSES

Penn Foster study units thoroughly immerse the learner in the important concepts and applications of each topic. These stand-alone study units are written by subject matter experts and are well illustrated to reinforce major points. Most study units require 5-10 hours to complete, allowing for individual learning styles and the content of each topic. Check Your Learning practice exercises, and final progress examinations provide ongoing feedback on how the learner is progressing.

NOTE: The content of some courses is more comprehensive, directed toward a specialized skill, job function, or knowledge requirement. These courses are identified by a statement found in the special notes of the course description: covers subject at an advanced, in-depth level.
Penn Foster offers several training aids to enhance learning, particularly in the electrical, electronics, and drafting curricula. Training aids are integrated with the courseware, and are often accompanied by student workbooks and parts kits. The popular PC-based Electronics Workbench® program lets students test their skills in a variety of electrical and electronics areas. They can troubleshoot faulty circuits, and even design their own. Our Drafting with AutoCAD® program is an innovative combination of the AutoCAD® software, video instruction, and print-based lessons for fully integrated learning. Other training aids include equipment for experimentation, simulators, fiber optic splicing, and soldering kits.

**Industrial Skills** — Penn Foster video courses and supplements combine sight, sound, and motion to further engage learners in specific subjects. 800+ videos are available to supplement many of the industrial topics. Students see how to accomplish specific tasks, and receive reinforcement of prior print-based instruction.

**Health and Safety** — Our 49 Safety Meeting Kits include VHS tapes or DVDs, leader guides, student handouts, and tests covering essential knowledge elements. These affordable, easy-to-use meeting kits allow you to build a library of up-to-date programs to meet your legal requirements and, more importantly, to avoid accidents and lost productivity. The regulatory compliance programs are available with “how to,” fill-in-the-blank templates for developing your own in-house procedure manuals.
Penn Foster has been the leader in guided, independent study since 1890. Today, Penn Foster has a worldwide student body of 500,000 men and women. Over 2,500 corporations use Penn Foster training and support services, including such giants as Ford, Nestle, Sprint, and British Petroleum. Penn Foster training materials meet the demanding instructional accreditation standards established by the Distance Education and Training Council, the governing body recognized by the U.S. Department of Education.

Some corporations are establishing their own distance-learning universities, and major colleges and universities are implementing distance-education programs too, to address the time, travel, and cost problems which confront many would-be students. There are many benefits and reasons why this proven approach will work for you, too:

**Targeted, Performance-Based Training**  Employees take the necessary training and complete training at their own pace. An *individualized* curricula for the *individual*.

**Flexible Program Design**  We custom assemble programs, tailored to the unique needs of the individual. Needs vary by organization and by individual, so we build a plan which meets your specific requirements - basic skill remediation, topical programs, apprenticeships, cross-training, and career curricula.

**Individualized Learning**  Instructional materials are designed to ensure that *every* trainee learns the material, not just the top 50-80%. It’s a known fact that many adults perform better with distance education than traditional classroom programs. Materials are easy to understand, yet are engaging in order to maintain interest. There’s no classroom competition. Your “on-call instructor,” progress checks, and learner support are built into the courses.

**Proven Learning Methods**  Courses are developed by teams of subject matter experts and instructional designers, satisfying both the educational and content objectives.

**Mastery Oriented**  The training is consistent, measurable, and accountable for each participant. Students must demonstrate mastery in order to complete a course.

**No Scheduling Problems**  Courses are designed for self-directed study. Employees can study when it’s convenient for them, on their own time. Training is portable, flexible, and cost-effective. Distance learning is ideal for shift workers, single parents, and handicapped employees.

**At Work or At Home**  Our programs can be used either way. The expense of travel, and employee time off the job are eliminated.

**Multiple Applications**  Course materials can be used later as an on-the-job reference library. The coursework can also be used to enhance classroom training, or as a prerequisite to classroom instruction and vendor seminars.

**Reinforcement Options**  Our Training Aids provide learners with powerful, hands-on reinforcement. Typical work situations are simulated. Exercises help students apply newly learned concepts and skills on the job. Videos enhance learning and improve retention.

**Centralized Control**  Individualized study programs can be implemented at multiple locations with the assurance that all employees will receive the same quality instruction. Yet, you maintain centralized administrative control. We summarize employee progress for management on a monthly basis.

“Penn Foster courses provide the certified training for apprenticeship trades and are the basis for our pay-for-knowledge program. We like the content of the courses offered as well as the convenience afforded by the independent study approach. Since ours is a ‘shift’ operation, our apprentices are able to study during non-work hours. This training approach is very flexible. HG&S employees are more productive and the company stays competitive by keeping pace with technological changes that can help improve the operation.”

Jozette A. Montalvo
Human Resources Manager
Hawaiian Commercial & Sugar Company
Puunene, HI
Each of the 11 Resources begins with its own Subject Index which lists the major subjects, course titles and numbers, and the pages where the course descriptions are located. The second part of a Resource provides recommended Curricula for planning and discussion purposes. The remainder of the Resource provides the complete Course Descriptions, in numerical sequence.

APPRENTICE PROGRAMS for many of the trades recognized by the U.S. Department of Labor’s Bureau of Apprenticeship and Training (B.A.T.). These curricula meet their requirement for a minimum of 144 hours per year, of job-related instruction. These curricula provide the foundation, knowledge, and basic skills which, when combined with practical on-the-job experience, develop tomorrow’s journey people. Typical Penn Foster apprenticeship programs take 3-5 years to complete.

TOPICAL PROGRAMS teach a specific set of targeted skills. These are shorter than the other curricula, and can be used to enhance a worker’s current skills, or to pursue a new area of interest.

COURSE DURATION — how long, on average, it takes a student to complete the course. Most courses include mastery tests, and the number of tests in the course is also indicated. Video courses are listed by their actual running time.

PREREQUISITE(S) — which courses or subject matter the student should master prior to taking a course. By reviewing the descriptions of prerequisite courses, you may determine that the employee has satisfied the necessary prerequisite by completing a non-Penn Foster course, or through on-the-job experience.

WHAT STUDENTS LEARN/COURSE OBJECTIVES — information, concepts, and skills which the course will teach. These descriptions provide specific insight into the course, and serve as your primary selection criteria.

COURSE COMPONENTS — Course components list the related study units in a print “block” or individual video tape courses in a video “series.”

SPECIAL NOTES — other information, such as whether the course replaces an older course and the minimum hardware required to take the course.

Three indexes are included at the back of the Skills Development Guide to help you locate specific courses and plan your training:

THE ALPHABETICAL INDEX — by course title and key subject area
THE NUMERICAL INDEX — by course number
THE CURRICULA INDEX — alphabetic by title

CUSTOMER SERVICE
1-800-233-0259
### The Training Program Life Cycle

#### Needs Assessment
- The initial step is to determine job requirements and assess individual needs.
- How do you identify training requirements? Are you satisfied with your present methods?

#### Program/Course Selection
- After needs are determined, the most effective method of satisfying the training requirements is selected.
- How do you identify training alternatives? Do you have access to the programs you need? What is the process used to develop a training curricula?

#### Training Administration
- Planning, enrollments, and reporting are important management activities.
- How is your program administered? Do employees and management find this method satisfactory?

#### Training Evaluation
- Training should be evaluated periodically to determine whether objectives are being reached.
- How do you evaluate training? Do some areas need further evaluation?
Three essential components:

Consultative educational representatives assisting clients in determining skill and knowledge requirements, conducting the needs assessments, and designing individualized training curricula.

“Custom-assembling” our courseware. Designing apprentice, career, and topical programs, to meet organizational and individual needs.

Administrative services help you to manage the program - evaluating trainee progress, complete record keeping and documentation, and educational assistance for trainees.

Training Needs Analysis

By conducting a Training Needs Analysis with you, a Penn Foster Training Consultant can help you identify your training and educational requirements and design the most effective program for your needs. The TNA will identify:

Skill and knowledge areas by job title, including anticipation of future requirements.

Individual requirements by job title, requiring training, and a logical sequence for addressing the deficiencies.

Your Training Consultant will gather and report this information by surveying your managers, supervisors, and key employees. The TNA will also provide a wealth of important data for cost-justifying your training investment.

Important input for the TNA can include your job descriptions, performance standards, and documentation which addresses any known deficiencies and future plans, such as automation, team implementation, and quality improvement programs.
PHASE ONE:
NEEDS ASSESSMENT
(cont’d)

PHASE TWO:
PROGRAM SELECTION

Individual Training Needs

Programs can be developed for specific individuals based on their job responsibilities, knowledge, and skill deficiencies. The most effective training occurs immediately prior to the time when the employee must apply new skills on the job.

Skills Development Guide

The sample curricula included in this guide are a useful starting point for identifying major topic requirements. These suggestions reflect client programs which have been successful in the past. Detailed course descriptions allow you to precisely select the right courseware for your needs.

Curriculum Development

Based on the TNA and organizational requirements, curricula can be established for the major job titles. We will also ensure that courses are selected and completed in a logical learning sequence, particularly when a set of interrelated skills are being taught.

Skills Inventory/Pretesting for Program Placement

Evaluate the skill and knowledge level of your employees in relation to the new curricula for their respective positions. A customized test can be produced using questions selected from our computerized item bank. A diagnostic test scoring service summarizes individual results by subject area.

“Custom-Assembled” Training Programs

Only Penn Foster can develop and deliver a 100% “custom-assembled” training program to meet your specific needs, at a surprisingly affordable price.

We match our highly modular courses to your operational skills and task requirements, defined by the TNA. A “draft” curriculum is produced including the pre-technical, foundation skills courses that are prerequisites for the technical skills courses. Further discussion refines the plan until you’re completely satisfied.

Individual Training Plans

A knowledge and skills pretest identifies deficiencies by topic for each worker. Working with your Penn Foster consultant, individualized curricula can then be developed. This process insures cost-effective training by placing each person at the appropriate point in the curriculum suited to his/her needs and matched to your organization’s budget and time constraints.
Penn Foster Administration:
With Penn Foster as your partner, we:

- Correct your trainees’ tests and score all progress examinations (via toll-free Tel-Test®, the Internet, or paper and pencil).
- Maintain complete training records for each program participant. Progress reports are sent to you every month during which a test has been scored. In addition, you can view student progress through our administration website.
- Distribute courses directly to your employees or to your designated location(s) for training. Courses can be shipped on an automatic basis, corresponding to student study progress. Many courses can be viewed online.
- Issue completion documents: Diplomas, Certificates of Apprenticeship, Certificates of Completion. These documents are inscribed with the name of each trainee and the organization’s training program.
- Provide trainees with an individualized website on which they can view their lessons, take exams, review their grades, access the Penn Foster library, or contact their instructor.
- Penn Foster will also provide trainees with a toll-free telephone number for course assistance from an educational instructor (DIAL-A-QUESTION®).
- Provide a toll-free telephone number for responsive service regarding all aspects of your company’s programs and individual student records. Our Customer Service Managers are ready and anxious to take your call. You will also have access to your students’ records through our online administrator’s website.

If you choose to administer your own program, we can, for convenience, or if required by local or union regulations, provide computerized test correction services. Blank completion documents are also available.

Supporting Materials and Reports
The following are included with every Penn Foster-Administered Training Program:

- *Program Administrators’ Guide* — provides useful information describing how to implement and facilitate your training program.
- *Student Welcome Package and the Trainee Handbook* — a handy reference covering the Penn Foster services and educational procedures for students, and how to develop good study habits.
- *Program Outlines* — a Program Coordinator, designated by you receives curriculum outlines for each trainee. Progress reports and student transcripts are issued regularly, providing current information regarding test results and measurement toward completion.
THE CLIENT SERVICE SYSTEM

PHASE THREE:
TRAINING
ADMINISTRATION (cont’d)

Program Implementation and Student Orientation
Based on the training plan, you will order initial courseware. A brief Kick-Off meeting is recommended to build enthusiasm, communicate the importance of training, and establish a partnership of shared investment between the employee and the organization. As students receive their initial courses, the Student Welcome Package and the Trainee Handbook should be reviewed, along with the procedure you selected for submitting Progress Tests.

Educational Assistance for Students

**DIAL-A-QUESTION**® Educational Instructors for each major subject are as close as your phone or the Internet. Students can call or write to discuss a lesson, have a particular concept explained, or get help with any question. This popular service is available Monday through Friday, using our toll-free telephone number on the Internet.

**Penn Foster on the Internet**
Whether you are a human resources or technical professional, or a new student, discover more Penn Foster capabilities, courses, and services through our Internet address of [http://www.PennFoster.edu](http://www.PennFoster.edu), and click on Industrial Training and Workforce Development, or you may go directly to our B2B website at [www.WorkforceDevelopment.com](http://www.WorkforceDevelopment.com).

Email: Contact our Customer Service Department using INDUST@PennFoster.edu, with your questions or requests for information and literature.

**Personalized Client Support**

*Customer Service.* A team of dedicated, experienced professionals make sure that your training proceeds smoothly. From order processing to billing; assistance in selecting courses; handling student status requests and monitoring courseware shipments; your total support resource is available, toll free: 1-800-233-0259, Canada 1-800-637-1506.

*Customized Services.* If you have a unique requirement, think of Penn Foster. You might be considering an in-house course catalog to support a career development, continuing education, or tuition reimbursement program. Would personalizing your program documents, management reports, assessment needs, course packaging and distribution, or student motivation letters enhance the value of your training?
Comprehensive Testing Capabilities

A well-orchestrated testing and placement approach enhances the value of any employee development program, making it more efficient and cost-effective. We offer comprehensive testing capabilities that meet the training and administrative requirements of clients and trainees alike.

Testing should be an essential component of training, providing:

- **Verification.** To ensure that training is meeting your needs.
- **Targeted Training.** Learners should be enrolled at the appropriate level within a curriculum, where training will result in the greatest performance improvement. Targeted training eliminates wasted time in the study of unnecessary courses.
- **Evaluation.** A systematic evaluation of each learner’s progress throughout a program and a basis for measuring the overall effectiveness of your training program.

Customized Tests

Our comprehensive, computerized testing system can be used to meet your particular requirements. You determine the purpose of the test - prerequisite evaluation, placement, mastery, or certification using a proctored examination. You can review and select the questions that appear in each test, the test length, and the type of correction service. Tests are developed from our computerized item-bank, which includes more than 55,000 questions cross-referenced to Penn Foster courseware.

- **Prerequisite Evaluations** are pretests which measure general skills and background knowledge to determine readiness for curriculum enrollment.
- **Diagnostic Placement Tests** which determine where individuals should enter an established curriculum, indicating current strengths, thereby avoiding unnecessary retraining.
- **Progress/Mastery Tests** which measure trainees’ success in meeting the learning objectives of courses and curricula. Alternate progress/mastery tests can be used after remediation training.
- **Proctored Examinations** for blocks of instruction, pay increases, and credentials certification.

Testing Flexibility

Tests can be scored two different ways:

- Percentage correct score
- Diagnostic prescriptions which determine prior knowledge and standard/remediation needs

Multiple choice test questions are normally used and can be produced as:

- Identical tests
- Scrambled question tests — the same questions, generated in different sequences
- Variable tests — questions selected randomly, by topic, from our test item-bank
There are three ways to take a Mastery Test:

- **Internet.** Through the Penn Foster website, exam answers can be entered. Results are seen immediately, and your student record is updated.

- **Tel-Test.** A toll-free call, using a Touch-Tone telephone to enter information directly into the Penn Foster computer testing system. Results are provided immediately, so trainees receive immediate feedback. Tel-Test also has voice recognition capability for hands-free input.

- **Paper-based testing.** Tests are sent to our Customer Service Department for scoring and updating student records. Using the Penn Foster Exam Express Method, electronic grading of special answer cards accelerates scoring and student record updates.

For further information regarding how our testing capabilities can assist in the development of your training program, contact your Workforce Development Consultant, or our Customer Service Department, at 1-800-233-0259, Canada 1-800-637-1506.

**Client Progress Reports**

These reports provide continuing updates on student progress. They include grades for the progress exams submitted by each student monthly. In conjunction with student transcripts which monitor program progress, your Program Coordinator has the key information to evaluate the status of individual trainees and the training program as a whole at any time. You can also view employee progress utilizing the website.

**Client Training Program Reviews**

Penn Foster is ready to work with your organization during each phase of the training process to accomplish your objectives. Our Training Consultants will want to meet with you periodically to discuss and evaluate your training program effectiveness. We will also identify potential program enhancements and identify new areas for training. A successful training program is a process of continuous improvement.
HOW TO PLACE AN ORDER

You may place an order by contacting your Training Consultant or our Customer Service Department.

Our Customer Service staff will welcome your calls Monday through Friday, between 8:00 a.m. and 5:00 p.m., E.T.

Organizations may order by telephone, mail, fax, or telex. Please have an authorized Purchase Order number ready. For federal government clients, GSA discount terms are applied. NOTE: When you or your Purchasing Department send the paper confirmation document, please identify it clearly as a “Confirmation Order - Do Not Duplicate.” We also accept orders with MasterCard, VISA, American Express, or Discover credit cards.

Orders received from individuals will require payment at the time of processing, by check, money order, or credit card. The Order Form, including instructions for completion and the terms and conditions, appears on the following pages.

A complete price list is available from your Training Consultant or Customer Service (1-800-233-0259, Canada 1-800-637-1506).

SHIPPING METHODS AND CHARGES

A 5% shipping and handling charge is added to all purchases. Unless the shipping method is specified in your order, shipment will be by best direct method, as determined by Penn Foster. We offer express shipments by next-day or two-day air and will bill you for the actual cost of this service.

Program Outlines are provided for each student enrolled using the Penn Foster Administration option at the start of the training. This, along with a packing list, itemizes each shipment of courseware and materials.

Send your orders to your Training Consultant, or to the following address:

Penn Foster
Workforce Development
925 Oak Street
Scranton, PA 18515

Customer Service:
1-800-233-0259 (In Canada: 1-800-637-1506)
Fax: 570-343-3620
Email inquiries: INDUST@PennFoster.edu
• Applied DC Fundamentals
• AC Motors
• DC Motor Series
• DC Motor Controllers Series
• Motor Controls Series
• Motor Drives Series
• Industrial Electricity Series
• Using RSLOGIX Series
• Programmable Logic Controllers Series
• Basic Electronic Components and their Measurement Series
• Electronic Circuits Series
• Mechanical Electrical Control Systems Series
• AC/DC Theory Series
• Basic Process Control Series
• Continuous Process Control Series
• Calibration and Test Equipment Series
• Electronic Maintenance Series
• Smart Digital Instrumentation
• Process Measurement Series
• Control Valves and Actuators Series
• Industrial Drives Series
• Clutches and Brakes Series
• Industrial Seals Series
• Industrial Bearings Series
• Boiler Operation and Control Series
• Steam Traps Series
• Machinery Lubrication Series
• Centrifugal Pumps Series
• Hydraulics Series
• Industrial Hydraulics Series
• Hydraulic Power Systems and Troubleshooting Series
# APPLIED DC FUNDAMENTALS

Designed specifically for technicians and maintenance personnel, this important two-volume series covers virtually all aspects of applied DC fundamentals including voltage, resistance and current. The series also covers basic rules for DC circuits including how Kirchoff’s Laws are applied to circuit analysis.

## Voltage, Resistance and Current

<table>
<thead>
<tr>
<th>Media Type</th>
<th>Item Code</th>
<th>Duration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD-ROM</td>
<td>ADC001-NDO</td>
<td>16 min.</td>
<td>What is electricity, Charge and potential, Voltage, EMF, current and resistance, Complete circuits and resistor types</td>
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## Ohm’s Law and DC Circuits

<table>
<thead>
<tr>
<th>Media Type</th>
<th>Item Code</th>
<th>Duration</th>
<th>Description</th>
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<tbody>
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<td>CD-ROM</td>
<td>ADC002-NDO</td>
<td>24 min.</td>
<td>Ohm’s Law, Series circuits: equal and unequal resistances, Parallel circuits: equal and unequal resistances, Power in series and parallel DC circuits</td>
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</table>

## Electronic Components and Magnetism

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<th>Duration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD-ROM</td>
<td>ADC003-NDO</td>
<td>16 min.</td>
<td>Conductors, insulators, semiconductors and diodes, Magnetic fields, Electronic indicators, Electric motors</td>
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</tbody>
</table>

## Electronic Schematics and Circuit Analysis

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<tr>
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<th>Item Code</th>
<th>Duration</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>CD-ROM</td>
<td>ADC004-NDO</td>
<td>24 min.</td>
<td>Basic component symbols, Circuit tracing, Voltage dividers, Applied circuit analysis, Kirchoff’s Laws</td>
</tr>
</tbody>
</table>

Series Workbook: ADC001-WKB 200 pages

**Save when you buy the complete series.**

## AC MOTORS

This new video familiarizes students with the basic parts of an AC motor and how it operates.

Video — item #ACM001-VHS
Workbook — item #ACM001-WKB
• Principles of AC motor action
• Polyphase, synchronous and induction motor operation
• Features of repulsion-type motors that use commutators
• Stator and rotor function and construction
• Split-phase AC motor operation

**DC MOTORS SERIES**
This important two part series familiarizes students with the internal parts of the DC motor and how they fit together, and the applications for these motors. The course covers field construction of the DC motor, the armature and commutator. Fundamentals of DC motor maintenance, including proper lubrication, brush replacement, inspection and troubleshooting are also explained.

**Basics and Internal Parts**
CD-ROM — item #DCM001-NDO Video (19 min.) — item #DCM001-VHS

- Motor basics
- Field, armature and commutator construction
- Motor applications
- Motor principles and types

**Maintenance and Troubleshooting**
CD-ROM — item #DCM002-NDO Video (19 min.) — item #DCM002-VHS

- Motor wiring
- Maintenance
- Troubleshooting measurements and procedures

Series Workbook: item #DCM001-STW 88 pages

*Save when you buy the complete series.*

**DC MOTOR CONTROLLERS SERIES**
Designed with manufacturing engineers in mind, this two-part series focuses on typical applications for DC motor speed control systems. Important terms are defined and explained. The operation of single and three-phase motor controllers, as well as of a Ward/Leonard motor controller, are also described.

**Controller Function and Operation**
CD-ROM — item #DCC001-NDO Video (18 min.) — item #DCC001-VHS

- Controller basics
- Types of controllers
- AC source controllers
- DC source controllers

**Maintenance Procedures and Applications**
CD-ROM — item #DCC002-NDO Video (14 min.) — item #DCC002-VHS

- Maintenance, types, inspection and testing
- Troubleshooting measurements
- Cleansing, repair and replacement

Series Workbook: item #DCC001-STW 76 pages

*Save when you buy the complete series.*
### MOTOR CONTROLS SERIES (videos also available in Spanish)

Help your employees master the fundamentals of motor controls with this eight-part series. It covers overload and time delay relays, schematic symbols, wiring diagrams, and installing and troubleshooting control systems.

### Basic Motor Controls and Relays

<table>
<thead>
<tr>
<th>CD-ROM</th>
<th>Video (17 min.)</th>
<th>Workbook:</th>
</tr>
</thead>
<tbody>
<tr>
<td>item #MTR001-NDO</td>
<td>item #MTR001-VHS-ENG</td>
<td>item #MTR001-STW</td>
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- Types of control systems  
- Magnetic relays  
- Schematic symbols  
- Solid state relays

### Overload Relays

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<tr>
<th>CD-ROM</th>
<th>Video (17 min.)</th>
<th>Workbook:</th>
</tr>
</thead>
<tbody>
<tr>
<td>item #MTR002-NDO</td>
<td>item #MTR002-VHS-ENG</td>
<td>item #MTR002-STW</td>
</tr>
</tbody>
</table>

- Overloads and fuses – what’s the difference?  
- Thermal overloads  
- Dashpot timer

### Time Delay Relays

<table>
<thead>
<tr>
<th>CD-ROM</th>
<th>Video (18 min.)</th>
<th>Workbook:</th>
</tr>
</thead>
<tbody>
<tr>
<td>item #MTR003-NDO</td>
<td>item #MTR003-VHS-ENG</td>
<td>item #MTR003-STW</td>
</tr>
</tbody>
</table>

- How timers operate  
- On and off delay timers  
- Pneumatic timers  
- Solid state electronic timers  
- NEMA schematic symbols

### Schematic Symbols

<table>
<thead>
<tr>
<th>CD-ROM</th>
<th>Video (18 min.)</th>
<th>Workbook:</th>
</tr>
</thead>
<tbody>
<tr>
<td>item #MTR004-NDO</td>
<td>item #MTR004-VHS-ENG</td>
<td>item #MTR004-STW</td>
</tr>
</tbody>
</table>

- Resistors, capacitators and transformers  
- Coil, wire and ground systems  
- Relay contacts and push buttons  
- Standard switches

### Schematics and Wiring Diagrams

<table>
<thead>
<tr>
<th>CD-ROM</th>
<th>Video (25 min.)</th>
<th>Workbook:</th>
</tr>
</thead>
<tbody>
<tr>
<td>item #MTR005-NDO</td>
<td>item #MTR005-VHS-ENG</td>
<td>item #MTR005-STW</td>
</tr>
</tbody>
</table>

- Recognizing schematic diagrams  
- Recognizing wiring diagrams  
- Developing a wiring diagram  
- Interpreting control circuit logic

### Starting Methods for Squirrel Cage Motors

<table>
<thead>
<tr>
<th>CD-ROM</th>
<th>Video (18 min.)</th>
<th>Workbook:</th>
</tr>
</thead>
<tbody>
<tr>
<td>item #MTR006-NDO</td>
<td>item #MTR006-VHS-ENG</td>
<td>item #MTR006-STW</td>
</tr>
</tbody>
</table>

- Across the line starting  
- Resistor starting  
- Reactor starting  
- Auto-transformer starting
**Wye-Delta, Synchronous and Wound Rotor Controls**

CD-ROM — item #MTR007-NDO  Video (18 min.) — item #MTR007-VHS-ENG

- Wye-delta connected motor  
- Synchronous motors  
- Wound rotor motors

Workbook:  item #MTR007-STW

**Installing and Troubleshooting Control Systems**

CD-ROM — item #MTR008-NDO  Video (14 min.) — item #MTR008-VHS-ENG

- Installation methods  
- Using terminal strips  
- Identifying wires  
- Troubleshooting functions

Workbook:  item #MTR008-STW

*Save when you buy the complete series.*

---

**MOTOR DRIVES SERIES**

This series will enable students to understand the fundamentals of motor drives. This six part series is designed to familiarize the student with the fundamentals of motor drive operation and setup.

**Motor Drive Identification**

CD-ROM — item #MTD001-NDO  Video (19 min.) — item #MTD001-VHS

- Identify regenerative and non regenerative DC drives
- Identify voltage source and current source inverters  
- Identify vector control drives

Workbook:  item #MTD001-STW

**Open and Closed Loop Systems**

CD-ROM — item #MTD002-NDO  Video (19 min.) — item #MTD002-VHS

- Open and Closed loop systems  
- Direct and inverse feedback  
- Tachometers  
- Encoders

Workbook:  item #MTD002-STW

**Variable Speed AC Drives**

CD-ROM — item #MTD003-NDO  Video (19 min.) — item #MTD003-VHS

- Understand voltage rectification, operation of the DC bus and the Inverter section
- Identify controlled and uncontrolled rectifiers and silicon controlled rectifiers
- Describe operation of the pulse width
- Modulated drives and vector control in AC drives

Workbook:  item #MTD003-STW
Servo and Stepper Motors
CD-ROM — item #MTD004-NDO  Video (19 min.) — item #MTD004-VHS

- Identifying the motors
- Types and uses of servo and stepper motors
- How they operate

Workbook: item #MTD004-STW

AC Motor Operation
CD-ROM — item #MTD005-NDO  Video (19 min.) — item #MTD005-VHS

- How a rotating magnetic field is created
- Slip and How to calculate it
- How voltage is induced in a rotor
- Torque and horsepower

Workbook: item #MTD005-STW

AC Drive Selection and Setup
CD-ROM — item #MTD006-NDO  Video (19 min.) — item #MTD006-VHS

- Determine drive requirements
- Set up a drive for basic control requirements
- Determine run, protection and stop parameters

Workbook: item #MTD006-STW

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INDUSTRIAL ELECTRICITY SERIES ( videos also available in Spanish)
This seven part series discusses the elements and applications of electricity that are common to any industrial facility. This series was designed in strict accordance with the current National Electrical Code.

Basic Principles
CD-ROM — item #ELS001-NDO  Video (22 min.) — item #ELS001-VHS-ENG

- Electrical theory
- Basic electrical circuits
- Shorts and grounding

Workbook: item #ELS001-WKB

Alternating Current
CD-ROM — item #ELS002-NDO  Video (17 min.) — item #ELS002-VHS-ENG

- Alternating current circuits
- AC generators
- Inductance and capacitance
- Transformers

Workbook: item #ELS002-WKB

Conductors
CD-ROM — item #ELS003-NDO  Video (15 min.) — item #ELS003-VHS-ENG

- Conductor properties
- Circuit protectors
- Grounding and bonding

Workbook: item #ELS003-WKB
Wiring
CD-ROM — item #ELS004-NDO Video (15 min.) — item #ELS004-VHS-ENG

- Wiring methods and techniques
- Soldering
- Insulator spikes
- Wiring Diagrams

Workbook: item #ELS004-WKB

Installation, Distribution and Lighting
CD-ROM — item #ELS005-NDO Video (16 min.) — item #ELS005-VHS-ENG

- Introduction to installation, distribution and lighting
- Power transformation and routing
- Distribution systems

Workbook: item #ELS005-WKB

Generators and Motors
CD-ROM — item #ELS006-NDO Video (16 min.) — item #ELS006-VHS-ENG

- Objectives
- Generators
- Motors

Workbook: item #ELS006-WKB

AC Motor Control and Current Measurement
CD-ROM — item #ELS007-NDO Video (14 min.) — item #ELS007-VHS-ENG

- AC motor controls
- Basic operation
- Electrical measurement devices

Workbook: item #ELS007-WKB

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USING RSLOGIX™ SERIES
This best selling three part series enables students to grasp the fundamentals of the Rockwell Software program, RSLogix™. It is designed specifically to provide a working knowledge of the Windows based software, and to familiarize the student with setting up software drivers, logging onto networks, uploading and downloading projects, searching, documentation, histograms and, trending, forcing and editing basic programs.

Configuring Hardware and Software
CD-ROM — item #RSX001-NDO

- Identify hardware necessary for communicating with PLC
- Create and configure drivers
- Access software and select drivers
- Go online to the PLC and access essential help functions

Programming and Editing
CD-ROM — item #RSX002-NDO

- Open a new file, add rungs and instructions, edit and address and, add comments and symbols
- Verify, save and download files, edit online and access program files
Testing and Troubleshooting
CD-ROM — item #RSX003-NDO

- Apply and understand forcing
- Understand data monitors and searches
- Discuss advanced tools such as configuring intelligent modules and trending

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PROGRAMMABLE LOGIC CONTROLLERS SERIES (videos also available in Spanish)
This popular series approaches PLC technique from a fundamental perspective and has been designed as an educational tool at a foundation level – or to be utilized as a refresher course for the complete PLC team. The five part series is presented generically so that its contents will be applicable to all PLC manufacturers’ systems. It covers such tasks as programming, wiring, troubleshooting, communications and advanced programming.

**Fundamentals**
CD-ROM — item #PLC001-NDO Video (22 min.) — item #PLC001-VHS-ENG

- PLC components
- Ladder diagrams
- Logic functions
- Number systems

Workbook: item #PLC001-WKB

**Programming**
CD-ROM — item #PLC002-NDO Video (20 min.) — item #PLC002-VHS-ENG

- Ladder diagrams
- Programming codes
- Memory
- Program documentation

Workbook: item #PLC002-WKB

**Inputs and Outputs**
CD-ROM — item #PLC003-NDO Video (16 min.) — item #PLC003-VHS-ENG

- Inputs
- Outputs
- Wiring
- Connecting multiplex systems

Workbook: item #PLC003-WKB

**Troubleshooting**
CD-ROM — item #PLC004-NDO Video (12 min.) — item #PLC004-VHS-ENG

- Troubleshooting process
- Software functions
- Common failure modes
- Safety

Workbook: item #PLC004-WKB

**Communications and Advanced Programming**
CD-ROM — item #PLC005-NDO Video (19 min.) — item #PLC005-VHS-ENG
• Types of communication devices • Programming math functions • Advanced logic functions
• Using advanced programming commands

Workbook: item #PLC005-WKB

**Save when you buy the complete series.**

**BASIC ELECTRONIC COMPONENTS AND THEIR MEASUREMENT SERIES**
This three part series familiarizes students with basic electronic components and their functions within a circuit as well as teaching the methods and tools used in testing and measuring the components.

<table>
<thead>
<tr>
<th>Types and Diagrams</th>
<th>CD-ROM — item #BEC001-NDO</th>
<th>Video (21 min.) — item #BEC001-VHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interconnection diagrams</td>
<td>• Read linear and nonlinear scale meters</td>
<td>• Calculate circuit values</td>
</tr>
<tr>
<td>Analog and digital multimeters</td>
<td>• List sources of measurement error with VOMs</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Controls and Applications</th>
<th>CD-ROM — item #BEC002-NDO</th>
<th>Video (21 min.) — item #BEC002-VHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical and Horizontal deflection</td>
<td>• Triggering controls</td>
<td>• Vertical and horizontal calibration</td>
</tr>
<tr>
<td>The steps necessary to align and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>measure square and sine wave voltages</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operation and Troubleshooting</th>
<th>CD-ROM — item #BEC003-NDO</th>
<th>Video (21 min.) — item #BEC003VHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test the functioning of capacitors and inductors</td>
<td>• Using ohmmeters</td>
<td></td>
</tr>
<tr>
<td>Test a transformer and calculate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>transformer power losses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Series Workbook: item #BEC001-STW 130 pages

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**ELECTRONIC CIRCUITS SERIES**
This three part series teaches students the fundamentals of electronic circuits and some common applications, as well as introduces students to the principles and functioning of many common electronic circuits.

<table>
<thead>
<tr>
<th>Basic Principles</th>
<th>CD-ROM — item #ECI001-NDO</th>
<th>Video (11 min.) — item #ECI001-VHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic quantities in electrical</td>
<td>• Series and parallel</td>
<td></td>
</tr>
<tr>
<td>circuits</td>
<td>circuits</td>
<td></td>
</tr>
<tr>
<td>Capacitance, electromagnetism &amp;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>inductance</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics and Operation</th>
<th>CD-ROM — item #ECI002-NDO</th>
<th>Video (23 min.) — item #ECI002-VHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectifiers</td>
<td>• Amplifiers and pulse</td>
<td></td>
</tr>
<tr>
<td>Power supplies</td>
<td>generating devices</td>
<td></td>
</tr>
</tbody>
</table>
### Logic Fundamentals, Types and Application

CD-ROM — item #ECI003-NDO  
Video (30 min.) — item #ECI003-VHS

- Basic Logical circuits  
- Number systems  
- Sequential logic and circuit applications  
- Boolean and arithmetic logic concepts

Series Workbook:  
item #ECI001-STW  
208 pages

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### MECHANICAL ELECTRICAL CONTROL SYSTEMS SERIES (videos also available in Spanish)

Use this seven part series to help technicians gain a detailed understanding and diagnosing ability of any electrical system problems.

#### Introduction to control Schematics

CD-ROM — item #MEC001-NDO  
Video (15 min.) — item #MEC001-VHS-ENG

- Understanding schematics  
- Symbols used in schematics  
- Advanced schematics-manual/auto

Workbook:  
item #MEC001-WKB

#### Creating Schematics

CD-ROM — item #MEC002-NDO  
Video (17 min.) — item #MEC002-VHS-ENG

- Creating a schematic  
- Reading the schematics  
- Advanced schematics-Manual/auto  
- Cooling systems

Workbook:  
item #MEC002-WKB

#### Electrical Lockout

CD-ROM — item #MEC003-NDO  
Video (12 min.) — item #MEC003-VHS-ENG

- Electrical and manual lockouts  
- Short cycle delay  
- Holding and reset relays

Workbook:  
item #MEC003-WKB

#### Design and Troubleshooting

CD-ROM — item #MEC004-NDO  
Video (16 min.) — item #MEC004-VHS-ENG

- Controls design  
- Safety requirements  
- Troubleshooting

Workbook:  
item #MEC004-WKB

#### Energy Management

CD-ROM — item #MEC005-NDO  
Video (15 min.) — item #MEC005-VHS-ENG

- Energy Efficiency  
- Timer Control  
- De-energized circuits

Workbook:  
item #MEC006-WKB
### Electronic Controls
CD-ROM — item #MEC006-NDO  
Video (16 min.) — item #MEC006-VHS-ENG

- Startup and safety controls  
- Heating control settings  
- Troubleshooting

Workbook:  item #MEC006-WKB

### Responsive Systems
CD-ROM — item #MEC007-NDO  
Video (17 min.) — items #MEC007-VHS-ENG

- Multiple switch controls  
- Time delay devices  
- Time delay relays

Workbook:  Item #MEC007-WKB

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### AC/DC THEORY SERIES (videos also available in Spanish)
This 14 part series is designed to provide a fundamental understanding of AC/DC circuitry. Upon completion of this series, students will have a solid foundation in electrical/electronic theory.

### Current
CD-ROM — item #ACD001-ASF  
Video (18 min.) — item #ACD001-VHS-ENG

- Identify the electronic charge of the atom, electron, proton, neutron, nucleus and ion  
- Describe Coulomb’s Law  
- Define terms associated with current  
- Measure current with an ammeter

### Voltage
CD-ROM — item #ACD002-ASF  
Video (18 min.) — item #ACD002-VHS-ENG

- Explain how connecting batteries in series or in parallel will affect voltage & current capability  
- Differentiate between voltage drop and rise  
- Explain ground, negative and positive voltage  
- Measure voltage with a voltmeter

### Resistance
CD-ROM — item #ACD003-ASF  
Video (15 min.) — item #ACD003-VHS-ENG

- Differentiate between conductors and insulators and describe the characteristics that affect them  
- Interpret resistor color codes  
- Describe various types of resistors  
- Describe how resistors can be connected to achieve different amounts of total resistance

### Ohm's Law
CD-ROM — item #ACD004-ASF  
Video (21 min.) — item #ACD004-VHS-ENG

- Write Ohm’s Law in three different forms  
- Select the proper equation to calculate current, voltage or resistance  
- Calculate the amount of power in a circuit
### Magnetism

CD-ROM — item #ACD005-ASF  
Video (18 min.) — item #ACD005-VHS-ENG

- Define electromagnetic terms
- Explain basic electromagnetic rules & principles
- Describe the operation of generators & motors

### Electrical Measurement

CD-ROM — item #ACD006-ASF  
Video (18 min.) — item #ACD006-VHS-ENG

- Explain how the VOM works and should be connected to a circuit
- Calculate the value of shunt required to increase the current capability
- Calculate the series dropping resistance to increase the voltage capability
- Define voltmeter loading

### DC Circuits

CD-ROM — item #ACD007-ASF  
Video (19 min.) — item #ACD007-VHS-ENG

- Explain how a voltage divider works
- Describe Kirchhoff’s Law
- Explain the superposition theorem, Thevenin’s Theorem and Norton’s Theorem

### Inductance and Capacitance

CD-ROM — item #ACD008-ASF  
Video (19 min.) — item #ACD008-VHS-ENG

- Define the terms, units and symbols related to inductance and capacitance
- Explain inductance and capacitance
- Calculate total capacitance and solve Time constant problems

### Alternating Current

CD-ROM — item #ACD009-ASF  
Video (18 min.) — item #ACD009-VHS-ENG

- Describe the advantages and applications of AC electronics
- Explain electromagnetic induction
- Describe the components of a sine wave

### AC Measurement

CD-ROM — item #ACD010-ASF  
Video (17 min.) — item #ACD010-VHS-ENG

- Explain the operation of AC meters and The oscilloscope
- Measure alternating current, AC voltage, Amplitude, period and frequency
- Analyze phase relationships of AC waveform

### Capacitive Circuits

CD-ROM — item #ACD011-ASF  
Video (21 min.) — item #ACD011-VHS-ENG

- Describe commonly used capacitors
- Calculate total capacitance for capacitors in series and parallel
- Describe the phase relationships between current And voltage in different types of capacitor circuits
- Calculate impedance in series and parallel RC circuits
### Inductive Circuits

CD-ROM — item #ACD012-ASF  
Video (21 min.) — item #ACD012-VHS-ENG  

- Explain how inductors operate and which Features affect them  
- Describe the phase relationship between current and voltage  
- Explain mutual inductance  
- Compute inductive reactance

### Transformers

CD-ROM — item #ACD013-ASF  
Video (22 min.) — item #ACD013-VHS-ENG  

- Describe the construction and operation of transformers  
- Describe sources of loss in transformers  
- Solve problems dealing with turns ratio, voltage, ratio, current ratio and impedance  
- Describe how the autotransformer and isolation transformer work

### Tuned Circuits

CD-ROM — item #ACD014-ASF  
Video (20 min.) — item #ACD014-VHS-ENG  

- Calculate impedance, current, voltage, power  
- Calculate resonant frequency, capacitance  
- Describe series and parallel resonant circuits  
- Describe four basic types of filters  
- Factor and phase angle in RLC circuits  
- Value or inductance value in RLC circuits  
- Explain the relationship between bandwidth and Q

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  #S20020; 30 min.  
- The Zener Diode  
  #S20030; 27 min.  
- Special Diodes  
  #S20040; 28 min.  
- Bipolar Transistor Operations  
  #S20050; 25 min.  
- Bipolar Transistor Circuits & Testing  
  #S20060; 24 min.  
- Bipolar Transistor Characteristics  
  #S20080; 21 min.  
- Bipolar Transistor Testing  
  #S20090; 21 min.  
- Field Effect Transistors  
  #S21000; 19 min.  
- Insulated Gate FETS  
  #S21010; 28 min.  
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  #S21020; 27 min.  
- Thyristors-DIACs & UJTs  
  #S21030; 29 min.  
- Integrated Circuits  
  #S21040; 23 min.  
- Integrated Circuits, packages & Applications  
  #S21050; 18 min.  
- Optoelectronic Devices, Pt. 1  
  #S21060; 25 min.  
- Optoelectronic Devices, Pt. 2  
  #S21070; 27 min.

### Fundamentals of Circuits

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- Filters  
  #E80020; 19 min.  
- Voltage Multipliers & Regulators  
  #E80030; 23 min.
**Series Voltage Regulation** #E80040; 25 min.
**Power Supply Circuits** #E80050; 27 min.
**Transformer Oscillators** #E80060; 21 min.
**LC & Crystal Controlled Oscillators** #E80070; 22 min.
**RC Oscillators 7 Nonsinusoidal Oscillators** #E80080; 24 min.

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- Inspection Boards, Tracks & Connections #I10010; 21 min.
- Inspecting Components & Leads #I10020; 11 min.

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- Number Systems Codes #P10010; 28 min.
- Microcomputer Basics #P10020; 27 min.
- Computer Math #P10030; 29 min.
- Digital Logic Circuits #D10040; 25 min.
- Introduction to Programming Branching #P10040; 22 min.
- Introduction to Programming/Algorithms #P10050; 21 min.
- 6800 Microprocessor #P10060; 33 min.
- 6800 MPU Stack Operation/Subroutines #P10070; 16 min.
- 6800 MPU I/O Operations/Interrupts #P10080; 19 min.
- Interfacing Basics #P10090; 22 min.
- Interfacing RAMs/Displays #P11000; 24 min.
- Interfacing Switches #P11010; 18 min.
- Interfacing Peripheral Adapters #P11020; 19 min.

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- Introduction to 6800 Microprocessor Concepts #P20010; 16 min.
- Programming Model #P20020; 21 min.
- Hardware Overview #P20030; 19 min.
- Addressing Modes #P20040; 27 min.
- Basic Instructions #P20050; 24 min.
- Program Problems #P20060; 24 min.
- System Control Pins #P20070; 17 min.
- Exception Concepts #P20080; 19 min.
- External Exceptions #P20090; 23 min.
- Internal Exceptions #P21000; 32 min.
- Intermediate Instructions #P21010; 32 min.
- Example Programs #P21020; 20 min.
- DMA Control and Synchronous Bus Control Pins #P21030; 19 min.
- Advanced Addressing Modes #P21040; 29 min.
- Advanced Instructions #P21050; 25 min.
- Advanced Example Programs #P21060; 17 min.
- Review #P21070; 26 min.
- MC68000 Educational Computer Board Lab #P21080; 23 min.

**Digital Techniques**
- Introduction to Digital Techniques #D10010; 21 min.
- Transistor Operations  #D10020; 21 min.
- Bipolar Switch/MOSFET  #D10030; 25 min.
- Digital Logic Circuits  #D10040; 25 min.
- Logic Circuit Characteristics  #D10050; 23 min.
- TTL/ECL Logic Circuits  #D10060; 22 min.
- MOS/I2L Logic Circuits  #D10070; 19 min.
- Boolean Algebra Basics  #D10080; 26 min.
- Boolean Rules  #D10090; 29
- Latch/D-Type Flip-Flops & Registers  #D11000; 27 min.
- JK Flip-Flops  #D11010; 15 min.
- Sequential Logic Circuits “Binary Counters”  #D11020; 30 min.
- Sequential Logic Circuits “BCD & Special Counters”  #D11030; 16 min.
- Sequential Logic Circuits “Shift Registers”  #D11040; 28 min.
- Sequential Logic Circuits “Clocks”  #D11010; 21 min.
- Combinational Logic Circuits “Decoders/Encoders/Multiplexers”  #D11060; 31 min.
- Combinational Logic Circuits “Exclusive OR/Code Converters”  #D11070; 21 min.
- Combinational Logic Circuits “ROMs & PLAs”  #D11080; 24 min.
- Semiconductor Memories “Memory Basics”  #D11090; 19 min.
- Semiconductor Memories “Read/Write Memories”  #D12000; 24 min.
- Semiconductor Memories “Dynamic/PROM Memories”  #D12010; 34 min.
- Data Conversion “Digital-to-Analog”  #D12020; 38 min.
- Data Conversion “Analog-to-Digital”  #D12030; 43 min.
- Digital Test Instruments  #D12040; 26 min.
- Digital Troubleshooting  #D12050; 29 min.

### Amplifiers

- Introduction to Amplifiers  #E60010; 26 min.
- Amplifier Biasing & Coupling  #E60020; 22 min.
- Direct Current & Audio Amplifiers  #E60030; 20 min.
- Video Amplifiers  #E60040; 20 min.
- RF & IF Amplifiers  #E60050; 15 min.
- Differential & Operational Amplifiers  #E60060; 11 min.
- Closed-Loop Amplifiers & Operational Amplifier Applications  #E60070; 12 min.

### BASIC PROCESS CONTROL SERIES

This intensive none part series covers every aspect of instrumentation and its many applications. Beginning with the principles and concepts of process control – with a special emphasis on maintenance skills – the series covers calibration, replacement, repair adjustment and troubleshooting in great detail. Produced in conjunction with ISA.

### Feedback Control

CD-ROM — item #BPR001-ASF

- Manual and automatic control
- Variables used in process control
- Components and functions of a feedback control loop
- Common types of control elements
**Process Control Modes**

CD-ROM — item #BPR002-ASF

- Two position control
- Proportional control
- Integral control
- Derivative control

**Process Characteristics**

CD-ROM — item #BPR003-ASF

- Characteristics of open and closed systems
- Fahrenheit and Celsius temperature scales
- Heat and heat transfer
- Heat, mass and pressure
- Rankine and Kelvin temperature scales

**Process Variables**

CD-ROM — item #BPR004-ASF

- Converting between gage pressure and Absolute pressure
- Pressure measurement and height of liquid
- Converting between psi, inches of water and inches of mercury, volume, density, and specific gravity
- Flow rate mass flow rate, volumetric flow rate

**Instrumentation Symbols**

CD-ROM — item #BPR005-ASF

- Balloon symbols
- Line Symbols
- Loop identification numbers and loop indicator suffixes
- Valve and actuator symbols
- Reading a simple loop

**Instrument Loop Diagrams**

CD-ROM — item #BPR006-ASF

- Instrument ports and connections
- Operating range and set point for an instrument
- Electronic and pneumatic loops
- Junction boxes and identifier
- Symbols and reference

**Piping Instrumentation Drawings**

CD-ROM — item #BPR007-ASF

- ISA Standard 5.1
- Control concepts
- Interpreting diagrams
- Symbols and identifiers

**Mechanical Connections**

CD-ROM — item #BPR008-ASF

- Tubing materials and applications
- Calculating tubing gain
- Fittings and plastic tubing
- Cleaning, tubing and fittings for silver soldering

**Electrical Connections**

CD-ROM — item #BPR009-ASF

- Coaxial cable connections and conductors to terminal
- Grounds and shields
- Electrical noise and signal distortion
- Signal tracing in an electrical circuit
- General Safety and intrinsic safety

**Save when you buy the complete series.**

### CONTINUOUS PROCESS CONTROL SERIES
This new four part series explains in detail the principles of continuous process control. Produced in conjunction with ISA.

#### Principles of Continuous Control
CD-ROM — item #CPC001-ASF

- Characteristics of continuous processes
- Importance of signal transmission
- Control of continuous processes
- Control strategies for continuous processes

#### Applications of Heat Exchanger Control
CD-ROM — item #CPC002-ASF

- Basic operation of heat exchanger system
- Cascade and feedforward control system
- Basic functions and types of variables
- Modified heat exchanger system

#### Applications of Distillation Control
CD-ROM — item #CPC003-ASF

- Basic Distillation operation
- Controlling pressure and temperature
- Features and control of reflux streams
- Condensate transport control

#### Applications of pH Control
CD-ROM — item #CPC004-ASF

- Importance of pH control
- Hardware selection in a pH system
- Factors affecting pH control
- PH control strategies

**Save when you buy the complete series.**

### CALIBRATION AND TEST EQUIPMENT SERIES
This six part series covers the calibration and use of process control test equipment. Produced in conjunction with ISA.

#### Primary Calibration Standards
CD-ROM — item #CTE001-ASF

- Manometers
- Hydraulic deadweight testers
- Pneumatic deadweight testers

#### Pneumatic Test Equipment
CD-ROM — item #CTE002-ASF

- Test gages
- Digital display pneumatic instruments
- Deadweight testers as calibration pressure sources
<table>
<thead>
<tr>
<th>Media Training</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electronic Test Equipment</strong></td>
<td>CD-ROM — item #CTE003-ASF</td>
</tr>
<tr>
<td>• Multimeters</td>
<td>• Multifunction calibrators, parts I and II</td>
</tr>
<tr>
<td>• Function generators and frequency counters</td>
<td></td>
</tr>
<tr>
<td><strong>Oscilloscopes</strong></td>
<td>CD-ROM — item #CTE004-ASF</td>
</tr>
<tr>
<td>• Introduction to functions and features</td>
<td>• Using the oscilloscope</td>
</tr>
<tr>
<td>• Advanced measurements and applications</td>
<td></td>
</tr>
<tr>
<td><strong>Instrumentation Calibration</strong></td>
<td>CD-ROM — item #CTE005-ASF</td>
</tr>
<tr>
<td>• Introduction to instrument calibration</td>
<td></td>
</tr>
<tr>
<td>• Calibration preparation and pneumatic instrument calibration</td>
<td></td>
</tr>
<tr>
<td>• Electronic instrument calibration</td>
<td></td>
</tr>
<tr>
<td><strong>Instrumentation Errors</strong></td>
<td>CD-ROM — item #CTE006-ASF</td>
</tr>
<tr>
<td>• Characteristics of measuring instruments</td>
<td>• Analysis of instrumentation errors</td>
</tr>
<tr>
<td>• Installation and interpretive errors</td>
<td></td>
</tr>
</tbody>
</table>

**Save when you buy the complete series.**

**ELECTRONIC MAINTENANCE SERIES**

Use this twelve part series to form a learning resource which will provide students with an introduction to concepts and devices associated with solid state electronic circuitry as well as an understanding of the components associated with process control and integrated circuitry. Produced in conjunction with ISA.

<table>
<thead>
<tr>
<th>Solid State Devices</th>
<th>CD-ROM — item #EMS001-ASF</th>
</tr>
</thead>
<tbody>
<tr>
<td>• PN junction transistors</td>
<td></td>
</tr>
<tr>
<td>• Bipolar junction transistors</td>
<td></td>
</tr>
<tr>
<td>• Amplifiers</td>
<td>• Semiconductor devices</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Integrated Circuits and Op Amps</th>
<th>CD-ROM — item #EMS002-ASF</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Integrated circuits and operational amplifiers</td>
<td>• Negative feedback</td>
</tr>
<tr>
<td>• Amplifying circuits</td>
<td>• Op amp configurations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sensor and Transducer Principles</th>
<th>CD-ROM — item #EMS003-ASF</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Temperature, pressure, level, flow and weight sensors</td>
<td>• Current-to-pneumatic (I/P) transducer</td>
</tr>
<tr>
<td>• Electronic transducers</td>
<td>• A/D and D/A converter</td>
</tr>
<tr>
<td>• Fiber optics</td>
<td></td>
</tr>
<tr>
<td>Transmitters</td>
<td>CD-ROM — item #EMS004-ASF</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>• Transmitter operation</td>
<td>• Pressure transmitter troubleshooting</td>
</tr>
<tr>
<td>• RTD transmitter operation and calibration</td>
<td>• Vortex shedding flow meter operation</td>
</tr>
<tr>
<td>• Capacitance level transmitter</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transducers</th>
<th>CD-ROM — item #EMS005-ASF</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Transducer operation and maintenance</td>
<td>• I/P transducer operation, maintenance and calibration</td>
</tr>
<tr>
<td>• Pneumatics and electronic troubleshooting and maintenance</td>
<td>• Pressure transmitter calibration</td>
</tr>
<tr>
<td>• Fiber optic circuit operation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Controllers, Indicators and Recorders</th>
<th>CD-ROM — item #EMS005-ASF</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Analog controller types and function</td>
<td>• Controller calibration and troubleshooting</td>
</tr>
<tr>
<td>• Indicators and annunciators</td>
<td>• Types and functions of recorders</td>
</tr>
<tr>
<td>• Troubleshooting recorders</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tuning</th>
<th>CD-ROM — item #EMS007-ASF</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Analog controller types and function</td>
<td>• Controller calibration and troubleshooting</td>
</tr>
<tr>
<td>• Indicators and annihilators</td>
<td>• Types and functions of recorders</td>
</tr>
<tr>
<td>• Troubleshooting recorders</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sampling Systems and Gas Chromatograph Valves</th>
<th>CD-ROM — item #EMS008-ASF</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Operating principles of a single and multi-stream sampling system</td>
<td>• Troubleshoot components</td>
</tr>
<tr>
<td>• Interpretation of a chromatograph</td>
<td></td>
</tr>
<tr>
<td>• Learn to disassemble, repair and reassemble</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gas Chromatograph Ovens and Controllers</th>
<th>CD-ROM — item #EMS009-ASF</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Troubleshoot and maintain</td>
<td>• Disassemble, repair and reassemble thermal conductivity detectors</td>
</tr>
<tr>
<td>• Disassemble, repair and reassemble flame ionization detectors</td>
<td></td>
</tr>
<tr>
<td>• Calibrate gas chromatograph controllers</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spectroscopic Analyzers</th>
<th>CD-ROM — item #EMS010-ASF</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Operating principles and configurations</td>
<td>• Cleaning</td>
</tr>
<tr>
<td>• Disassemble, repair and reassemble ultraviolet, visible, and infrared analyzers</td>
<td>• Source replacement</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Electrochemical Analyzers**
CD-ROM — item #EMS011-ASF
- Function of pH sensor components
- Maintenance
- Function of conductivity sensors
- Calibration

**Instrument Loop Troubleshooting**
CD-ROM — item #EMS012-ASF
- Designing a troubleshooting plan
- Application of techniques in a temperature and flow control system
- Using a distributed control system

Save when you buy the complete series.

**SMART DIGITAL INSTRUMENTATION**
This 4 part series provides forced mastery of HART Protocol and an understanding of HART Technology. The student will gain an understanding of the applications of HART Smart Field Devices, including installation, maintenance, calibration, and troubleshooting.

**Understanding HART Protocol**
CD-ROM — item #SMI001-ASF
- Overview and objectives
- HART Technology
- HART-Compatible field devices

**Applications of HART Smart Field Devices**
CD-ROM — item #SMI002-ASF
- Overview and objectives
- Central host system and interfaces
- Installing HART field devices
- Industrial application examples

**Commission, Configure, Maintain, Calibrate, and Troubleshoot HART Smart Field Devices**
CD-ROM — item #SMI003-ASF
- HART-Compatible communicator/calibrators
- Configuration
- Troubleshooting
- Commissioning
- Maintenance and calibration

**Foundation Fieldbus (FF)**
CD-ROM — item #SMI004-ASF
- Foundation Fieldbus Communication Model
- Blocks
- Function block applications

Save when you buy the complete series.
PROCESS MEASUREMENT SERIES
This eight part series explains in detail the principles of temperature pressure, level and flow, and identifies the equipment for measuring each. Produced in conjunction with ISA.

Temperature: Thermometers and Thermocouplers
CD-ROM — item #PME001-ASF
- Temperature scales
- Types of thermometers
- Pneumatic deadweight testers
- Factors affecting accuracy of measurement
- Thermocouples

Temperature: Resistance and Radiation
CD-ROM — item #PME002-ASF
- Resistance temperature detectors
- Radiation pyrometers

Pressure: Manometers and Gages
CD-ROM — item #PME003-ASF
- Manometers
- Mechanical pressure transducers

Pressure: Indicators and Transmitters
CD-ROM — item #PME004-ASF
- Electrical/electronic pressure elements
- Installation considerations

Level: Level Measurement and Gages
CD-ROM — item #PME005-ASF
- Visual level sensors
- Variable displacement devices

Level: Level Indicators and Transmitters
CD-ROM — item #PME006-ASF
- Electrical level sensors
- Ultrasonic and sonic sensors

Flow: Flow Measurement
CD-ROM — item #PME007-ASF
- Fluid properties
- Measuring flow

Flow: Flow Sensors
CD-ROM — item #PME008-ASF
- Mass Flow meters
- Rotameters
- Positive displacement and axial turbine flow meters
- Vortex shredders

Save when you buy the complete series.
## CONTROL VALVES AND ACTUATORS SERIES
This four part series is designed to provide general instruction on the subject of control valves and actuators. Produced in conjunction with ISA.

### Basics and Function
CD-ROM — item #CVA001-ASF
- Basic tasks of a control valve
- Importance of proper valve selection
- Dispensing, dissipating and distributing
- Functions of control valves

### Types and Design
CD-ROM — item #CVA002-ASF
- Linear motion control valves
- Types of control valve actuators
- Control valve safety
- Rotary motion control valves
- Primary and secondary valve trim

### Fundamentals and Selection
CD-ROM — item CVA003-ASF
- Fluid flow fundamentals
- Steps for selecting a control valve
- Control valve selection
- Criterion for proper actuator selection

### Sizing and Installation
CD-ROM — item CVA004-ASF
- Steps for determining valve sizing
- Valve sizing for liquid, gas and vapor applications
- Factors involved in actuator sizing
- Valve installation and maintenance

Save when you buy the complete series.

## INDUSTRIAL DRIVES SERIES
Industrial drive systems are used to transmit mechanical power from its source to move machinery. Almost every type of machine has a drive system. This six part series will introduce workers to industrial drives in the workplace.

### Chain Drives
CD-ROM — item #MDR001-NDO
Video (20 min.) — item #MDR001-VHS
- Chain tension, take up devices and Sprockets
- Troubleshooting
- Installation and maintenance

Workbook: item #MDR001-STW

### Belt Drives
CD-ROM — item #MDR002-NDO
Video (20 min.) — item #MDR002-VHS
- Safety
- Installation and maintenance

Troubleshooting Workbook: item #MDR002-STW
**Enclosed Drive Systems**
CD-ROM — item #EDS001-NDO Video (21 min.) — item #EDS001-VHS

- Fundamentals of enclosed gear drives
- Types of gears and adjustable speed drive

Workbook: item #EDS001-STW

**Complete Drive Packages**
CD-ROM — item #CDP001-NDO Video (27 min.) — item #CDP001-VHS

- Coupled drive systems
- Drive system efficiency and protection

Workbook: item #CDP001-STW

**Gears and Gear Systems**
CD-ROM — item #GGS001-NDO Video (33 min.) — item #GGS001-VHS

- Parallel and perpendicular shaft configurations
- Calculating critical dimensions of gears
- Installation and inspection of spur, Helical, bevel, miter and worm gearing

Workbook: item #GGS001-STW

**Shaft Joining and Coupling Devices**
CD-ROM — item #SJC001-NDO Video (32 min.) — item #SJC001-VHS

- Principles, types and applications

Workbook: item #SJC001-STW

**CLUTCHES AND BRAKES SERIES**

Power transmission components are critical to the success of industrial machinery. This two part series focuses on clutches and brakes and their purpose and applications. This course is essential for those needing a strong foundation in all aspects of industrial clutches and brakes.

**Types and Applications**
CD-ROM — item #CBR001-NDO Video (33 min.) — item #CBR001-VHS

- Mechanical clutches and brakes
- Pneumatic and hydraulic systems
- Electrical control systems
Troubleshooting

CD-ROM — item #CBR002-NDO Video (14 min.) — item #CBR002-VHS

• Troubleshooting mechanical clutches and brakes
• Troubleshooting pneumatic and hydraulic systems
• Troubleshooting electric clutches and brakes

Series Workbook: item #CBR001-STW 78 pages

Save when you buy the complete series.

INDUSTRIAL SEALS SERIES

This three part series is designed to familiarize the student with the basics of various types of gaskets, packing and seals. It includes all types and properties, inspection, installation and troubleshooting.

Types, Materials and Properties

CD-ROM — item #MPS001-NDO Video (20 min.) — item #MPS001-VHS

• Rotating and reciprocating machinery
• Different types of seals and gaskets
• Ensure compatibility

Workbook: item #MPS001-STW

Gasket and Packings: Inspection and Installation

CD-ROM — item #MPS002-NDO Video (20 min.) — item #MPS002-VHS

• Removal, inspection and installation of gaskets
• Removal, inspection and installation of packings
• Removal, inspection and installation of lip packings

Workbook: item #MPS002-STW

Mechanical Face Seals: Troubleshooting and Installation

CD-ROM — item #MPS003-NDO Video (20 min.) — item #MPS003-VHS

• Identify
• Perform removal and inspection
• Troubleshooting

Workbook: item #MPS003-STW

Save when you buy the complete series.

INDUSTRIAL BEARINGS SERIES

This 3 part series is designed to train new students in the field of bearings – and to offer in service maintenance personnel the opportunity to review the basics of bearing technology. It provides instruction on the application of bearings and stresses the importance of accurate bearing troubleshooting for maximum efficiency and life expectancy of rotating equipment.
### Application and Technology

CD-ROM — item #BRG001-NDO Video (14 min.) — item #BRG001-VHS

- What is a bearing?
- Types of rolling element bearings
- Protective housings for bearings
- Different types of loads
- Bearing wear and life expectancy

Workbook: item #BRG001-WKB

### Maintenance and Installation

CD-ROM — item #BRG002-NDO Video (14 min.) — item #BRG002-VHS

- Installation and alignment
- Checking operating clearances
- Bearing lubrication and removal
- Special alignment applications

Workbook: item #BRG002-WKB

### Troubleshooting

CD-ROM — item #BRG003-NDO Video (14 min.) — item #BRG003-VHS

- The four indicators for determining Bearing condition
- Causes of premature failure
- Removing and inspecting failed bearing
- Equipment adjustment

Workbook: item #BRG003-WKB

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**Save when you buy the complete series.**

### BOILER OPERATION AND CONTROL SERIES

This 5 part series covers boiler control and operations. Produced in conjunction with ISA.

#### Introduction to Boilers: An Overview

CD-ROM — item #BOI001-ASF

- Principles of steam production
- Applications of steam energy
- Functions of boiler systems

#### Boiler Design and Construction

CD-ROM — item #BOI002-ASF

- Firetube and watertube boilers
- Functions of watertube boiler components
- Steam and water side of the boiler
- Fuel and air side of the boiler

#### Boiler Feedwater and Steam

CD-ROM — item #BOI003-ASF

- Corrosion and scale on boiler component
- Boiler’s response to steam demand
- Single element control systems
- Two element control systems
- Three element control systems
Boiler Fuel and Air
CD-ROM — item #BOI004-ASF
• Three types of boiler fuels
• Fuel and air systems, and equipment
• Factors needed to control combustion
• Combustion control systems

Boiler Operation
CD-ROM — item #BOI005-ASF
• Boiler startup procedures
• Boiler shutdown procedures
• Boiler operator’s responsibilities
• Abnormal and emergency conditions

Save when you buy the complete series.

STEAM TRAPS SERIES
This vital three part general maintenance series is designed to familiarize the student with steam, steam trapping and the different types of steam traps. Additionally, methods to test for steam trap operation during monitoring and troubleshooting are presented.

Types, Principles and Functions
CD-ROM — item #MSM001-NDO Video (30 min.) — item #MSM001-VHS
• Identify steam states including steam Quality
• Describe the effects of condensation and Entrained water in a steam system
• List the primary function of the steam trap
• Explain orifices in a steam trapping system

Workbook: item #MSM001-STW

Sizing, Installation and Monitoring
CD-ROM — item #MSM002-NDO Video (33 min.) — item #MSM002-VHS
• Define live, dry, quality, wet and Flash steam
• List conditions for each of the factors
• Affecting trap size and identify how to determine each of the factors
• Describe causes of water hammer and ways to eliminate it

Workbook: item #MSM002-STW

Diagnostics and Troubleshooting
CD-ROM — item #MSM003-NDO Video (30 min.) — item #MSM003-VHS
• Identify steam trap areas that are Responsible for significant energy loss in steam systems
• Identify how losses occur, and ways to avoid loss
• Describe what components and areas of the steam system are affected by corrosion, erosion, and water hammer and identify ways to combat
• Recognize and describe the function of a steam trap testing station
• Recognize components to check when diagnosing failed steam traps

Workbook: item #MSM003-STW

Save when you buy the complete series.
MACHINERY LUBRICATION SERIES

This three part series will introduce workers to machinery lubrication. It covers oil types, applications, handling and storage, equipment, maintenance and greases.

Lubricating Oil: Types, Properties and Handling

CD-ROM — item #MLU001-NDO  Video (20 min.) — item #MLU001-VHS

- Friction and wear
- Applications
- Different types of lubrication
- Handling, dispensing and storage
- Types of oils

Workbook:  item #MLU001-STW

Lubricating Oil: Equipment and Procedures

CD-ROM — item #MLU002-NDO  Video (20 min.) — item #MLU002-VHS

- Lubricating equipment
- Maintaining a splash system
- Maintaining a circulating or pressure system

Workbook:  item #MLU002-STW

Lubricating Greases: Types, Applications and Equipment

CD-ROM — item #MLU003-NDO  Video (20 min.) — item #MLU003-VHS

- Lubricating greases/applications
- Handling, storage and equipment
- Lubricating bearings, journals and anti-friction bearings
- Lubricating wire ropes, chains, rails and slides

Workbook:  item #MLU003-STW

Save when you buy the complete series.

CENTRIFUGAL PUMPS SERIES

This five part series will teach your employees the proper procedures for installing, maintaining and troubleshooting centrifugal pumps. It discusses pump basics and terminology, mechanical seals, bearing failure, cavitation, entrainment and, disassembly and repair. A specific course has been created explaining the theoretical principles of interpreting pump performance curves, Affinity Laws, and matching specifications of a system to its application.

Design and Function

CD-ROM — item #PUM001-ndo  Video (20 min.) — item #PUM001-VHS

- Pump differences, design and classification
- Compression packing, mechanical seals, lantern rings and external lubrication
- Purpose of pumps in a fluid system
- Centrifugal pump components, parts, functions

Workbook:  item #PUM001-STW
System Characteristics and Selection

- Normal system parameters
- Terminology
- Concepts such as interpreting pump performance curves, understanding Affinity Laws and matching specifications of a system

Workbook: item #PUM002-STW

Operation and Maintenance

- Basic start up, operation, shutdown and maintenance of pumps
- System components requiring monitoring and adjusting
- Abnormal operating conditions

Workbook: item #PUM003-STW

Troubleshooting and Disassembly

- Possible causes of high motor temperature, overheated packing and bearings
- Signs of and causes for cavitation, vibration and air entrainment
- Causes of low flow rate and low discharge pressure
- Procedures for isolating a pump, depressurizing a system, draining and inspecting pump fluids
- Location and consequences of pitting, erosion and scoring in a pump

Workbook: item #PUM004-STW

Reassembly and Installation

- Precautions during reassembly, installation, and start up, including rigging
- Proper inspection and installation of components
- Soft foot and start up valve alignment, post start up checks, and compression packing adjustments

Workbook: item #PUM005-STW

Save when you buy the complete series.

HYDRAULICS SERIES (videos also available in Spanish)

This series will help your employees gain knowledge of fluid characteristics and understand how fluids exert pressure to support loads and flow to move loads. The seven part series contains an overview of hydraulics including hydraulic circuits, pumps and actuators, valves, fluid, safety and maintenance troubleshooting.

Harnessing Hydraulic Power

- Discovering hydraulic power
- Hydraulic fluid flow
- Simple hydraulic circuit

Workbook: item #HDL001-WKB
### The Hydraulic Circuit

**CD-ROM — item #HDL002-NDO**  
**Video (33 min.) — item #HDL002-VHS-ENG**

- Hydraulic uses
- Fluid control components
- The safe hydraulic circuit
- Hydraulic symbols
- Energy transferring components

**Workbook:** item #HDL002-WKB

### Pumps and Actuators

**CD-ROM — item #HDL003-NDO**  
**Video (37 min.) — item #HDL003-VHS-ENG**

- Non positive displacement pumps
- Reciprocating positive displacement pumps
- Actuators
- Rotary positive displacement pumps
- Delivery rates

**Workbook:** item #HDL003-WKB

### Control Valves

**CD-ROM — item #HDL004-NDO**  
**Video (36 min.) — item #HDL004-VHS-ENG**

- Pressure control valves
- Methods of spool positioning valves
- Flow and directional control valves
- Modes of failure

**Workbook:** item #HDL004-WKB

### Hydraulic Fluid

**CD-ROM — item #HDL005-NDO**  
**Video (34 min.) — item #HDL005-VHS-ENG**

- Hydraulic fluids
- Storing hydraulic fluid
- Fluid conditioning

**Workbook:** item #HDL005-WKB

### Hydraulic Systems Safety & Maintenance

**CD-ROM — item #HDL006-NDO**  
**Video (25 min.) — item #HDL006-VHS-ENG**

- System safety
- Maintenance Practices
- Fluid and pump maintenance

**Workbook:** item #HDL006-WKB

### Hydraulic System Troubleshooting

**CD-ROM — item #HDL007-NDO**  
**Video (20 min.) — item #HDL007-VHS-ENG**

- Troubleshooting procedures
- Inspecting the system
- Troubleshooting scenario

**Workbook:** item #HDL007-WKB

**Save when you buy the complete series.**
INDUSTRIAL HYDRAULICS SERIES

This four part series provides students with an understanding of hydraulic power concepts and circuits. Students receive instruction in hydraulic pumps, conductors, accessories and valves, and are introduced to procedures for maintenance and safety, and troubleshooting industrial hydraulic systems.

**Basic Principles and Applications**

CD-ROM — item #IDH001-NDO  
Video (22 min.) — item #IDH001-VHS

- Principles of hydraulics
- Hydraulic power systems
- Storage, handling and maintenance

**Types and Concepts**

CD-ROM — item #IDH002-NDO  
Video (23 min.) — item #IDH002-VHS

- Hydraulic piping, fittings and connections
- Hydraulic pumps

**Function and Operating Principles**

CD-ROM — item #IDH003-NDO  
Video (26 min.) — item #IDH003-VHS

- Control valves and accumulators
- Actuators
- Hydraulic cylinders and motors

**Maintenance and Troubleshooting**

CD-ROM — item #IDH004-NDO

- Maintenance of hydraulic systems
- Troubleshooting hydraulic systems
- Safety of hydraulic systems

Series Workbook: item #IDH001-STW 162 pages

Save when you buy the complete series.

HYDRAULIC POWER SYSTEMS AND TROUBLESHOOTING SERIES

This two part series is ideal for engineers and others who require an advanced understanding of hydraulic systems operation and maintenance. From examining basic to complex circuitry, students will learn to troubleshoot and repair hydraulic systems.

**Identification and Operation**

CD-ROM — item #HPS001-NDO  
Video (24 min.) — item #HPS001-VHS

- Open, closed and series circuits
- Intensification circuits
- Hydrostatic drive systems

**Troubleshooting Techniques**

CD-ROM — item #HPS002-NDO  
Video (20 min.) — item #HPS002-VHS

- Troubleshooting basics
- Testing tools and repair procedures
- Troubleshooting problems

Save when you buy the complete series. INDUSTRIAL HYDRAULICS SERIES
## SECTION 1 – INTRODUCTION TO PLCS

Section 1 includes three video modules. Module 1 provides a basic understanding of PLCs and shows typical applications. The second module explains the different number systems used in PLCs and shows how ASCII and BCD codes are stored in internal registers. The final module of this section thoroughly explains the logic functions and shows how they are used to implement PLC output circuits and sequences.

All of the information is related to actual applications you are likely to see in your plant.

### Module 1: Introduction to Programmable Controllers (27:55 minutes) 486E11

- Definition
- Background
- Areas of Application
- Benefits of PLC Usage
- Principles of Operations
- Scan
- Relay Logic and the PLC
- Addressing

### Module 2: Number Systems and Codes – Their Uses and Applications in PLCs (25:15 minutes) 486E12

- Number Systems
  - Decimals
  - Binary
  - Octal
  - Hexadecimal
- Number System Conversion
- Binary Codes
  - ASCII
  - BCD
  - Binary Code Extended
- Binary Concepts used in PLC Systems
- Registers

### Module 3: Logic Functions and Their Relationship with PLC Systems (20:56 minutes) 486E13

- Basic Logic Functions
  - AND
  - OR
  - NOT
  - Truth Tables
- Logic Function Applications & Examples as Used in PLC Systems
- PLC Circuits and Logic Contact Symbology

## Section 2 – Hardware

Section 2 includes three video modules and thoroughly explains the hardware section of the controller. The first module describes the CPU, I/O scan, mapping, and sequencing. The second module explains discrete (ON/OFF) I/O and the wiring and programming of these devices. The third module covers, in great detail, analog I/O including signal understanding, data representation and handling, as well as I/O interfacing and connection.

Throughout the modules, real-life control examples are presented to prepare you for proper application and troubleshooting.

- CPU Operation
Module 4: General CPU Operation, Memory System and PLC I/O Addressing (47:20 minutes) 486E14
- Scan • Memory System • Memory Types • Memory Structure • Application Memory
- I/O Mapping and Addressing • I/O and Memory Interaction
- Configuring Your PLC System

Module 5: Discrete Input/Output System (45:15 minutes) 486E15
- I/O System Basics
  — Description
  — Uses and Applications
  — Connections
  — Multiplexing
- Remote I/O Interfaces
  — Description
  — Uses and Applications
  — Connections
  — Multiplexing

Module 6: Analog Input/Output System (49:32 minutes) 486E16
- Analog Inputs
  — Signal Understanding
  — Data Representation
  — Data Handling
- Analog Output
  — Connections
  — Signal Understanding
  — Data Representation
  — Data Handling
  — Connections

SECTION 3 – SOFTWARE/PROGRAMMING

Section 3 includes three video modules that explain all the aspects of PLC programming. The first module covers the basic instructions as well as ladder format, logic continuity, and scan order evaluation. The next module progresses into how to use and apply the many different types of timers and counters. In addition, instructions that apply to PLC program flow control – GOTO, GOSUB, and MCR – are also explained. Finally, the last module wraps up programming by covering advanced functions, such as how to handle I/O data, block transfers, Boolean Mnemonics, and much more.

In order to learn how to program any PLC, the programming instructions throughout this section relate to real-life situations.

Module 7: PLC Instructions and Control Software Programming, Part 1 (49:59) 486E17
- Types of PLC Instructions • Ladder Format • Block Format • Logic Continuity
- Basic Relay Instructions • Ladder Scan Evaluation
- Special Input Programming • Output Programming • Latch/Unlatch
- Creating Control Output Sequences

Module 8: PLC Instructions and Control Software Programming, Part 2 (42:33 minutes) 486E18
- Timer Instructions, Uses, and Applications • Counter Instructions
- Program/Flow Control Functions and Examples • MCR (Master Control Relay)
- Jump • GOTO Subroutine • Register Usage
- Arithmetic: Add, Subtract, Multiply, Divide, and Square Root • Double precision arithmetic
### Module 9: PLC Instructions and Control Software Programming, Part 3 (43:40 minutes) 486E19

- Data Manipulation and Handling Instructions
  - Data Comparison
  - Absolute
  - Logic Matrix
  - Data Conversion
  - Set Constant
  - Logic Shift
  - Rotate
  - Examine Bit

- Data Transfer Instructions
  - Move Data
  - Table to Register
  - Register to Table
  - Block Transfer In and Out
  - ASCII Transfer
  - FIFO Transfer Sequencers

- Boolean Mnemonics, Boolean Programming

### SECTION 4 – SYSTEM IMPLEMENTATION

Section 4 puts all the concepts learned throughout the training program into action. This module explains how to implement a PLC-based system and provides guidelines to ensure a safe installation. We use real life examples to illustrate both the implementation and programming steps so that you can relate to actual situations seen on the shop floor.

### MODULE 10: PLC CONTROL SYSTEM IMPLEMENTATION AND PROGRAMMING (51:20 MINUTES) 486E20

- Control Definition
- Control Strategy
- Program Organization/Implementation
- Real and Internal I/O Assignment
- Program Coding/Translation
- Implementation Guidelines
- Flowcharting
- Register Assignment
- Configuration
- Portions to Leave Hardwired
- Control Program Examples and Implementation

The PLC Video Training Series
- VHS Video #500-VH5
- DVD #500-DV5

Testing, Practice, and Assessment Software – CD-Rom – a great companion for the video program #500-SW5
ELECTRICAL TRAINING PROGRAM
(DVDs)

UNDERSTANDING 3Ø POWER AND PLANT DISTRIBUTION 486E01

Learn about 3Ø power and its distribution in the plant. Master the Wye and Delta power system as well as switchgears and busways. Cover details of the important topic of power factor and power factor correction and where to place power factor correction capacitors for proper corrections.

Part 1:
- Bringing power inside the plant
- Power generation
- Wye & delta power systems
- Balanced power circuits
- Phase to neutral & phase to phase voltages and currents in wye and delta systems
- Transformer troubleshooting

Part 2:
- Wye & delta transformers and connections
- Plant power distribution
- Switchgear, busways, motor control centers
- Rectification of 3Ø power into DC power
- Power factor and correction
- Areas of proper power factor correction in a motor circuit

Part 1 24:47 minutes
Part 2 26:29 minutes

ELECTRICAL SWITCHING, TIMING AND CONTROL DEVICES 486E02

Study the use, application and troubleshooting of basic field devices (switches, selectors, drum switches, relays, etc.) used in electrical control circuits. You’ll also thoroughly cover the use, application and the different types of on-delay and off-delay timers in control circuits.

Part 1:
- Basic ladder diagrams
- Information provider switches
- SPST, SPDT, DPST, and DPDT switches
- Proper component wiring connections
- Control device troubleshooting: static & dynamic checks

Part 2:
- Understanding drum switch operation & its use in the reversal of motors
- Use and application of control relays (standard & latching)
- Troubleshooting delay circuits
- ON-delay & OFF-delay timer action, timing control & troubleshooting

Part 1 26:48 minutes
Part 2 24:26 minutes

INSTRUMENTATION: DISCRETE AND SENSORY 486E03

Learn the use, application and troubleshooting of field devices used in the sensing of position in discrete instrumentation (Limit, Proximity, Photoelectric) and in the sensing of discrete process information (Pressure, Flow, Level, Temperature). Covers a thorough explanation of discrete solenoid operated valves generally used in the control of fluid flow.
Part 1:
- Discrete instrumentation sensing and position devices
- Limit switches: use, application, installation, ad wiring
- Proximity sensors: operation and use, inductive and capacitive
- Photoelectric sensors: selection, installation, wiring, and troubleshooting
- Proper component wiring connections

Part 2:
- Discrete process-sensing control devices: pressure, flow, level & temperature sensors: wiring connections, setup (bench test), installation, circuit troubleshooting
- Discrete solenoid-operated control valve operation & application: 2-way, 3-way, & 4-way – 4 and 5 ports
- How to properly read solenoid valve schematics
- Troubleshooting solenoid control valves

**UNDERSTANDING ELECTRICAL DIAGRAMS AND CONTROL CIRCUITS 486E04**

Master ladder, wiring and layout diagrams and the interaction of the many control devices found in these circuits. Program also covers topics of adding memory to a control circuit, interlocking, and interpreting more complex control circuits.

Part 1:
- Control circuit components & representation
- AND-OR-NOT circuit logic: understanding & application
- Electrical diagrams: ladder, wiring (motor circuits) & layout
- Proper reading, referencing, interpretation, design & implementation of electrical control diagrams
- Control circuit examples & implementation

Part 2:
- Adding interlocking memory to a control circuit
- Types of control circuit interlocking: mechanical, push button & electrical
- Magnetic starter wiring diagrams
- Layout & connection diagrams
- Interpretation of more complex ladder diagrams
- Component placement & wiring

Part 1 26:10 minutes
Part 2 26:02 minutes

**PREVENTIVE MAINTENANCE AND TROUBLESHOOTING CONTROL CIRCUITS 486E05**

Study the many ways to “engineer” Preventive Maintenance into control circuits and the plant’s electrical power distribution network. Examine three troubleshooting approaches which include the power source, the control circuit and the power circuit.
- Preventive maintenance: approaches, guidelines & scheduling
- Preventive maintenance checks: dynamic & static inspections
- Engineering preventive maintenance into control circuits & into the plant’s electrical power distribution with power & phase monitors
- Preventing & detecting phase imbalance, phase loss & phase reversal
- Troubleshooting electrical systems at the power source & at the control circuit
- Troubleshooting using ladder diagrams & wiring diagrams (motor circuits)
- Troubleshooting the logic section & the power section of the control circuit
- Finding faulty components
- Finding a short circuit
34:52 minutes
This introduction covers magnetic starters, the different types, uses & symbols in wiring diagrams. It details motor protection provided by fuses, breakers, and overload heaters (Eutectic and Bimetal) and the application and operation of zero speed switching used in motor plugging circuits. Also learn the 2-wire and 3-wire control used in motor operations and review causes of motor failures in the field and ways to prevent potential problems.

Part 1:
- Understanding, application, installation & wiring of contactors, and manual & magnetic motor starters
- Types of motor starters: full-voltage, combination, reversing, two-speed & reduced-voltage
- Arc suppression & protection in contactors & starters
- Motor & circuit protection: fuses (single & double element), circuit breakers (magnetic & thermal), & overloads (eutectic, bimetal & solid-state)

Part 2:
- Understanding motor protection curves, over-load conditions & proper sizing of heater elements
- Use of double-element fuses as motor backup protection
- Controlling motor operations & plugging
- 2-wire & 3-wire control: application & uses
- Causes of motor failure: symptoms & prevention and correction in a motor circuit

Part 1 31:21 minutes
Part 2 33:11 minutes

Learn Article 430 of the National Electrical Code, dealing with motor, motor controller and motor circuit protection. Follow a systematic method for selecting the proper protection for feeders and branch circuits according to the number and type of motor loads present in the circuit. Learn how to properly read the important information presented in the motor’s nameplate so that proper motor protection can be achieved according to code.

- Introduction to the National Electrical Code (NEC)
- Article 430 of the NEC: motor, motor controller and motor circuit protection
- Safety & Article 430
- Sizing the proper protection for feeder & branch circuits
- Choosing proper conductors for feeder & branch circuits
- Understanding & protection of locked rotor amperage in motor circuits & overload situations
- Understanding motor nameplate information according to code

1 tape 22:02 minutes

Learn about 1Ø and 3Ø AC motor controls. Cover the different methods and circuits to reduced-voltage start AC motors. Also cover acceleration and deceleration circuits, along with different available braking techniques. Explore the operation and control of motors using AC drives, trouble-shooting methods and procedures used with AC motors, and symptoms to look for to avoid motor failures.
**Media Training**

**Part 1:**
- 1Ø & 3Ø AC motor components & operation
- Types of 1Ø motors: split-phase & capacitor motors
- Starting and accelerating 1Ø & 3Ø motors
- Selecting motor starters: across the line & reduced voltage
- Types of reduced voltage starts: primary resistor, auto-transformer, part winding, wye-delta & solid state
- Operation of all reduced voltage starts, wiring & connections

**Part 2:**
- Reversing circuits for 1Ø & 3Ø AC motors
- Speed control: multi-speed motors & variable frequency
- Introduction to AC drive speed control (inverters)
- Deceleration of AC motors: methods and circuits
- Braking circuits using plugging (zero-speed) switches
- Troubleshooting at the power section (branch circuit) & wiring circuit
- Finding open & short circuits
- Detection of serious AC motor symptoms and corrections

Part 1  31:44 minutes  
Part 2  32:27 minutes

**DC MOTOR CONTROLS & TROUBLESHOOTING 486E09**

Learn to apply and control the Series, Shunt, and Compound DC motors. Covers different mechanisms and ways to reduced voltage start DC motors. Study the methods and circuits used to accelerate and decelerate DC motors and the different braking options and techniques. Study speed control using DC drives. Cover troubleshooting the Series, Shunt, and Compound DC motors and their electrical control circuits.

**Part 1:**
- Acceleration of DC motors using variable resistance & solid state controls
- SCR operation & basic troubleshooting
- Deceleration circuits & methods used with DC motors: plugging, regenerative braking & friction brakes
- Troubleshooting the series, shunt & compound DC motors
- Checking for open & short circuits in DC motors

**Part 2:**
- Components & operation of DC motor types: series, shunt & compound
- Application, characteristics & uses of series, shunt & compound DC motors & their wiring connections
- Field winding & armature winding circuit representation
- Starting DC motors: across the line & reduced voltage
- Reversing DC motors using drum switches & manual and magnetic starters
- Speed control of DC motors

Part 1  17:10 minutes  
Part 2  21:03 minutes
Explore from programming and I/O scanning to implementation of discrete PLC electrical and motor control applications. Cover the number systems used with PLCs, I/O addressing and field device references, PLC memory system, discrete input and output interfaces and their connections to field devices, programming languages and instructions used in discrete control applications, PLC control implementation, and troubleshooting of the CPU and discrete I/O.

Part 1:
- PLC principles of operation
- Ladder Symbology & power flow: continuity & logic
- Binary concepts & number systems used in PLCs
- Input and output (I/O) system addressing & structure
- Discrete I/O modules: interface installation & wiring
- Ladder diagrams and the PLC
- Basic relay instructions

Part 2:
- Timer control: ON-delay and OFF-delay timers
- PLC control circuit examples & implementations: start/stop motor circuit (2 wire & 3 wire control), wiring & interfacing to magnetic starters, reversing motor control & interlocking
- Troubleshooting the CPU & I/O system
- Sections to leave hardwired for safety reasons
- Isolating faults
- PLC preventive maintenance

Part 1 31:33 minutes
Part 2 33:20 minutes
Basic Industrial Skills
Blueprint Reading
Mathematics
Measurements
Quality Concepts
Reading, Writing, and Verbal Communications
Troubleshooting
## Foundation Skills

### Subject Index

#### Basic Industrial Skills
- **Bench Work (5004A-C)** ................................................................. 241
- **Common Hand Tools, Part 1 (186052)** .................................................. 58
- **Common Hand Tools, Part 2 (186053)** .................................................. 58
- **Effective Training (8932T)** ................................................................. 53
- **Electric Drilling and Grinding Tools (186054)** ...................................... 58
- **Electrician’s Tools (006026)** ................................................................. 58
- **Fundamental Principles of Rigging Technology (286016)** ................... 200
- **Hand and Power Tools (Block X24)** ...................................................... 57
- **Introduction to ISO9000: ISO for the Supervisor (186038)** .............. 45
- **Introduction to ISO9000: ISO for the Technician (186037)** .............. 45
- **Jacks, Hoists, and Pullers (186060)** ......................................................... 59
- **Jobs, Companies, and the Economy: Basic Concepts for Employees (186034)** ................................................................. 45
- **Learning Strategies (147008)** ................................................................. 45
- **Manufacturing Processes, Parts 1-4 (186075, 186076, 186077, 186078)** .... 46
- **Planning the Rigging Operation (286017)** ........................................ 200
- **Plumbing and Pipefitting Tools (286042)** .............................................. 58
- **Pneumatic Hand Tools (186056)** ............................................................. 58
- **Power Cutting Tools (186055)** ............................................................... 58
- **Quality Concepts: Terminology for Management (186035)** ............. 45
- **Quality Concepts: Tools and Applications (186036)** ....................... 45
- **Rigging: Lifting Equipment and Applications, Part 2 (286021)** .......... 201
- **Routers, Power Planers and Sanders (186059)** ................................... 59
- **Tool Grinding and Sharpening (186057)** .............................................. 58
- **Woodworking Hand Tools (186058)** .................................................... 59
- **Working with Rigging Tools, Part 1 (286018)** ....................................... 200
- **Working with Rigging Tools, Part 2 (286019)** ....................................... 200

#### Mathematics
- **Addition and Subtraction (186008)** .................................................... 56
- **Algebra (2469A-E)** ............................................................................. 49
- **Analytic Geometry (6561A-B)** ............................................................. 51
- **Basic Industrial Math (Block X21)** ......................................................... 51
- **Business Mathematics (5565A-B)** ....................................................... 50
- **Calculus: Function and Use (6618A-D)** .............................................. 51
- **Formulas (186012)** ............................................................................ 56
- **Formulas (2468)** ................................................................................. 49
- **Fractions, Percents, Proportions, and Angles (186010)** ................... 56
- **Introduction to Algebra (186013)** ....................................................... 56
- **Introduction to Algebra, Geometry, and Trigonometry (Block X02)** .... 53
- **Logarithms (5254)** ............................................................................. 50
- **Multiplication and Division (186009)** ............................................... 56
- **Plane Geometry (2310A-F)** ................................................................. 47
- **Plane Trigonometry (2309A-B)** ........................................................... 47
- **Plane Trigonometry (6232A-E)** ........................................................... 51
- **Whole Numbers (007013)** ................................................................. 49
- **Fractions (007014)** ............................................................................. 49
- **Decimals (007015)** ............................................................................. 49
- **Measurement (007016)** .................................................................... 50
- **Ratio, Proportion, and Percent (007017)** .......................................... 50
- **General Review of Math (007018)** ...................................................... 50
- **Practical Geometry (5983A-B)** .......................................................... 51
- **Practical Geometry and Trigonometry (5567)** ..................................... 50
- **Real Life Math and the Power of Numbers (MTM07)** ....................... 63

#### Measurements
- **Bulk Measurement (186022)** ............................................................ 57
- **Electrical Measuring Instruments (4146A-C)** ..................................... 145
- **Energy, Force, and Power (186024)** .................................................. 57
- **Fluid Measurement (186025)** ............................................................. 57
- **Going Metric (2443)** .......................................................................... 48
- **Linear and Distance Measurement (186021)** .................................... 57
- **Metric System (186011)** .................................................................. 56
- **Practical Measurements (Block X22)** ............................................... 57
- **Precision Measuring Instruments, Parts 1-3 (186068, 186069, 186072)** .... 230
- **SI Metric (2453)** ................................................................................. 48
- **Temperature Measurement (186023)** ............................................. 57

#### Reading, Writing, and Verbal Communications
- **The Parts of Speech (007072)** ........................................................... 47
- **Word Usage (007073)** ...................................................................... 48
- **Sentence Skills (007074)** ................................................................ 48
- **The Writing Process, Part 1 (007117)** .............................................. 48
- **The Writing Process, Part 2 (007117)** .............................................. 48
- **Practical English and the Command of Words (ELIM07)** ............. 62
- **Reading Improvement (2400A-H)** .................................................... 47
- **Using Words Well (050001)** ............................................................. 52
- **Proposals and Special Projects (050018)** ........................................ 52
- **Writing Effective Communications (050021)** ................................ 52
- **Organizing, Researching, and Illustrating Your Material (050022)** .... 52
- **Writing the Report (050023)** ............................................................. 52
- **Creating an Informal Proposal (050024)** ........................................ 52
- **Successful Communication for Winning Job Offers (186A10)** .......... 46
- **Technical Writing (065001)** ............................................................. 44

#### Blueprint Reading
- **Building Drawings (186043)** ........................................................... 60
- **Dimensioning and Tolerancing (186082)** ....................................... 59
- **Electrical Blueprint Reading (006036)** ............................................ 60
- **Electrical Drawings and Circuits (186044)** ....................................... 60
- **Electronic Drawings (186045)** .......................................................... 60
- **Elements of Print Reading (6719A-B)** .............................................. 51
- **Geometric Dimensioning and Tolerancing (386E01)** .................... 240
- **Hydraulic and Pneumatic Drawings (186046)** ................................ 60
- **Introduction to Print Reading (186080)** ........................................... 59
- **Piping: Drawings, Materials, and Parts (186047)** ......................... 60
- **Plumbing Plans, Specifications, and Inspection (4516)** ................ 269
- **Print Reading Symbols and Abbreviations (186081)** ...................... 59
- **Reading Architects’ Blueprints (1842A-C)** ....................................... 266
- **Reading Construction Prints (6705)** .............................................. 272
- **Reading Electrical Schematic Diagrams (006022)** ....................... 131
- **Reading Piping Prints (6732)** ............................................................. 209
- **Reading Prints and Schematics (Block X25)** .................................... 59
- **Reading Shop Prints, Part 1 (386043)** ............................................ 239
- **Reading Shop Prints, Part 2 (386044)** ............................................ 239
- **Sheet Metal Basics (186049)** ............................................................ 61
- **Sketching (186050)** ......................................................................... 61
- **Welding Symbols (186048)** ............................................................. 60

#### Troubleshooting
(Also see Resource 4, Electronics Testing and Troubleshooting)
- **Maintenance and Troubleshooting (Block X07)** ................................ 54
- **Electrical Maintenance (286087)** ...................................................... 61
- **Predictive Maintenance: Vibration Analysis (286088)** ................... 62
- **Predictive Maintenance: Advanced Topics (286089)** ................... 62
- **Preventive Maintenance (286085)** ................................................... 61
- **Preventive Maintenance Techniques (286086)** ............................... 61
- **Problem Solving and Troubleshooting (186073)** ............................ 46
Recommended Topical Programs

- Arithmetic and Mathematics Developmental Skills
- Basic Business and Industrial Literacy Skills
- Print Reading Skills
- Distribution Industry: Core Knowledge and Skills Training Program
- Field Service Technician: Core Knowledge and Skills Training Program
Arithmetic and Mathematics Developmental Skills

This topical program provides trainees with the overview of arithmetic, mathematics, and measurements used in common business and industry practices. The second part of the program covers algebra and introduces the principles of geometry and trigonometry.

Upon completion of this program, students will be able to:

- Add, subtract, multiply, and divide whole numbers, fractions, and decimals.
- Measure lengths and distances.
- Calculate areas, volumes, and weights.
- Measure temperature in Fahrenheit and Centigrade, convert from one system to the other, and select the appropriate type of thermometer to be used at given temperatures.
- Measure “work” and recognize the basic machines, lever, inclined plane, wedge, wheel and axle, and screw.
- Measure fluid flow, fluid pressure, and fluid level.
- Work with the units of SI Metric.
- Perform the basic arithmetic operations with signed numbers and signed terms, and transform and solve an equation.
- Perform operations using monomials and polynomials.
- Add, subtract, multiply, and divide algebraic fractions.
- Solve number problems, digit problems, interest, lever, and work-sharing problems.
- Solve linear, simultaneous linear, and quadratic equations.
- Use fractional, positive, and negative exponents.

Special Note:
The individual placement tests covering the topics included in Block X21, Block X22, and Block X02 can be used to evaluate students knowledge in each course and their need for the Arithmetic and Mathematics Developmental Skills program.

Estimated Program Duration: 137 hours.
Number of Exams: 16.

Basic Business and Industrial Literacy Skills

This topical program is suitable for both entry-level and experienced individuals who want to upgrade their everyday foundation skills. Emphasis is placed on the following subjects: arithmetic, business mathematics, English, reading, and writing.

Upon completion of this program, students will be able to:

- Perform basic arithmetic functions.
- Demonstrate the procedures for recording profit and loss, depreciation, insurance, investments, and partial payments.
- Discuss the correct use of phrases, clauses, modern punctuation, and other elements of proper business English.
- Explain the recommended methods for gathering and arranging data, drawing conclusions, preparing rough drafts, and writing concise and effective reports.

Base Program

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186023</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
</tr>
<tr>
<td>Fluid Measurement</td>
<td>186025</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
<tr>
<td>Introduction to Algebra, Geometry, and Trigonometry</td>
<td>Block X02</td>
</tr>
</tbody>
</table>
Print Reading Skills

This topical program provides trainees with the courseware that covers the instructional skills needed to understand the various types of blueprints, shop prints and schematics used in an industrial environment. Trainees will learn how to read and interpret the different types of standard symbols and abbreviations found on these drawings.

Upon completion of this program, students will be able to:
• Define different types of scales used on drawings.
• Identify the height, width, and length dimensions of a drawing.
• Interpret the various symbols and notations used on drawings.
• Interpret electrical construction drawings, schematics, and wiring diagrams.
• Identify and interpret the various types of drawings used in the electronics field, and the various electronics symbols used.
• Interpret the standard symbols and abbreviations on piping drawings, “read” the color coding on piping in industrial and power plants, and interpret dimensions marked on piping drawings.
• Interpret the weld symbols most often found in the drawings used in plant maintenance work, identify by sight the basic types of welds, and describe their uses.
• Draw multiview sketches of simple objects that accurately show all the details of the objects.
• Draw dimension sketches of simple machine parts for their manufacture.

Base Program

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading Prints and Schematics</td>
<td>Block X25</td>
</tr>
<tr>
<td>Introduction to Print Reading</td>
<td>186080</td>
</tr>
<tr>
<td>Print Reading Symbols and Abbreviations</td>
<td>186081</td>
</tr>
<tr>
<td>Dimensioning and Tolerancing</td>
<td>186082</td>
</tr>
<tr>
<td>Print Reading Applications</td>
<td>186083</td>
</tr>
<tr>
<td>Building Drawings</td>
<td>186043</td>
</tr>
<tr>
<td>Electrical Drawings and Circuits</td>
<td>186044</td>
</tr>
<tr>
<td>Electronic Drawings</td>
<td>186045</td>
</tr>
<tr>
<td>Hydraulic and Pneumatic Drawings</td>
<td>186046</td>
</tr>
<tr>
<td>Piping: Drawings, Materials, and Parts</td>
<td>186047</td>
</tr>
<tr>
<td>Welding Symbols</td>
<td>186048</td>
</tr>
<tr>
<td>Sheet Metal Basics</td>
<td>186049</td>
</tr>
<tr>
<td>Sketching</td>
<td>186050</td>
</tr>
<tr>
<td>Elements of Print Reading</td>
<td>6719A-B</td>
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<tr>
<td>Reading Shop Prints, Part 1</td>
<td>386043</td>
</tr>
<tr>
<td>Reading Shop Prints, Part 2</td>
<td>386044</td>
</tr>
<tr>
<td>Geometric Dimensioning and Tolerancing</td>
<td>386E01</td>
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<tr>
<td>Reading Electrical Schematic Diagrams</td>
<td>.006022</td>
</tr>
<tr>
<td>Electrical Blueprint Reading</td>
<td>.006036</td>
</tr>
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</table>

Estimated Program Duration: 176 hours
Number of Exams: 22.

Distribution Industry: Core Knowledge and Skills Training Program

This topical program provides people either entering or currently employed in the Distribution industry with a baseline of knowledge and skills. The training covers both business and technical subjects. The trainee will gain an understanding of business communications, math, using personal computers, and the operation of distribution and warehouse centers.

This program is designed as core training for all people employed in the Distribution Industry. For customized knowledge and skills training, refer to the following programs:
- Electrical Distributor (Resource 4), Industrial Distributor (Resource 6), Plumbing Distributor (Resource 7).

Upon completion of this program, students will be able to:
• Sharpen verbal communication skills and write effective letters and reports.
• Understand the capabilities, functions, and use of personal computers and software applications.
• Interpret drawings, schematics, and diagrams that relate to components and materials that are distributed by your organization.
• Understand the different types of organizations and job functions that comprise the distribution industry.
• Learn the principles and techniques of inventory record keeping, accounting, management and control.

Base Program

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jobs, Companies, and the Economy:</td>
<td>186034</td>
</tr>
<tr>
<td>Basic Concepts for Employees</td>
<td>.060001</td>
</tr>
<tr>
<td>Elements of Business</td>
<td>060002</td>
</tr>
<tr>
<td>Fundamentals of Business</td>
<td>060006</td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
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<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
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<tr>
<td>Bulk Measurement</td>
<td>186022</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186023</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
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<tr>
<td>Fluid Measurement</td>
<td>186025</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
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<tr>
<td>Business Mathematics</td>
<td>5565A-B</td>
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<td>.060008</td>
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<td>.038105</td>
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<td>Microsoft Word for Windows</td>
<td>586002</td>
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<td>Introduction to Print Reading</td>
<td>186080</td>
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<tr>
<td>Dimensioning and Tolerancing</td>
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<td>Reading Shop Prints, Part 1</td>
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<td>386044</td>
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<tr>
<td>Industrial Safety</td>
<td>Block X23</td>
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<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
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</table>
Field Service Technician:
Core Knowledge and Skills
Training Program

This topical program provides people employed as a field service technician with a baseline of knowledge and skills. The training covers both business and technical subjects. The trainee will gain an understanding of safety procedures, math, business communications, and learning software application used with a personal computer.

This program is designed as core training for all people employed as a field service technician. For job specific knowledge and skills training, refer to the following programs: Electrical Field Service Technician (Resource 4); Electronics Field Service Technician (Resource 4); Mechanical Field Service Technician (Resource 5).

Upon completion of this program, students will be able to:
- Sharpen verbal communication skills and write effective letters and reports.
- Perform basic arithmetic functions.
- Diagnose problems using common troubleshooting techniques and advise operators how to properly maintain their equipment.
- Understand the capabilities, functions, and use of personal computers and software applications.

**Course Title** | **Course Number**
--- | ---
Quality Concepts: Terminology for Management | 186035
Trades Safety: Getting Started | 186001
Working Safely with Chemicals | 186002
Fire Safety | 186003
Electrical Safety for the Trades | 186005
Material Handling Safety | 186006
Basic Industrial Math | Block X21
  - Addition and Subtraction | 186008
  - Multiplication and Division | 186009
  - Fractions, Percents, Proportions, and Angles | 186010
  - Metric System | 186011
  - Formulas | 186012
  - Introduction to Algebra | 186013
Practical Measurements | Block X22
  - Linear and Distance Measurement | 186021
  - Bulk Measurement | 186022
  - Temperature Measurement | 186023
  - Energy, Force, and Power | 186024
  - Fluid Measurement | 186025

Problem Solving and Troubleshooting | 186073
Bench Work | Block X0211
  - Practical Trigonometry | X0212
  - Practical English and the Command of Words | ELIM07
Using Words Well | 050001
Proposals and Special Projects | 050018
Writing Effective Communications | 050021
Organizing, Researching, and Illustrating Your Material | 050022
Writing the Report | 050023
Creating an Informal Proposal | 050024

Estimated Program Duration: 287 hours.
Number of Exams: 44.

Optional Personal Computing Training

It is recommended that the field service technician become proficient using Personal Computers and the software applications used within your organization, including the Windows operating system, word processing and spreadsheets. Refer to Resource 1, Career Development, for a list of the applicable courses.

Optional Human Resource Skills Training

It is recommended that the field service technician receive structured training in specific Human Resource Skills disciplines, to improve abilities covering Problem Solving, Communication (verbal and written), Listening, Customer Service and Time Management. Refer to Resource 1, Career Development, for a list of the applicable courses.

Technical Writing

**Duration:** 20 hours (includes 5 tests)

**What Students Learn:**
The Technical Report; Proposals and Special Areas; Principles of Technical Style; Organizing and Outlining; Formatting, Mechanical Elements; Research and Documentation; Writing Effective Sentences.

**Special Note:**
- Course supplement study unit 1715A-E contains the 5 progress examinations.
147008

Learning Strategies

Duration: 5 hours (includes 1 test)

What Students Learn:
• The advantages of your educational, skills development or training program.
• How students can obtain assistance during their studies.
• Describe the study materials you will receive with your program and how they are shipped to you.
• How to use the web site to access information or take an examination.
• Identify what kind of learning style the student employs.
• How to establish a study schedule, organize study materials, and choose an appropriate place to study.
• Describe the SQ3R study method.
• Develop a procedure for building your vocabulary as you study.
• Explain a proper procedure for preparing for, and taking, an examination.

186034

Jobs, Companies, and the Economy: Basic Concepts for Employees

Duration: 5 hours (includes 1 test)

What Students Learn:
• Recognition of how the economy affects the actions of companies, employees, consumers, and investors.
• The concept of capitalism and the principles of supply and demand.
• How government policies affect the amounts of saving, spending, and investing by companies and individuals.
• Understand economic measuring tools such as the inflation rate, the unemployment rate and Gross Domestic Product (GDP).
• How labor is divided into three employment sectors and how wages are set, including the influence of labor unions and the benefits of a multi-functional workforce.
• Recognition of how both the employee and the company must compete in an increasingly international marketplace.

186035

Quality Concepts: Terminology for Management

Duration: 5 hours (includes 1 test)

What Students Learn:
• Define quality and quality management, using examples.
• Describe how quality has evolved to where it is today.
• Explain company and personal motivation for quality improvement.
• Describe how quality-conscious organizations have changed for the better.
• Explain how familiar business practices have led to TQM and how other common practices have gotten in the way of TQM.
• Name successful results of TQM programs.

186036

Quality Concepts: Tools and Applications

Duration: 5 hours (includes 1 test)

What Students Learn:
• Describe how job roles change as a company evolves in its quality consciousness.
• Explain several ways in which you can support TQM.
• Identify approaches, practices and skills associated with positive organizational change.
• Differentiate between the “change process” at the company level and the manufacturing processes that require improvement.
• Describe major causes of process variation and give examples of how they may affect you in your job.
• Explain why and how the reduction of variability is a key factor in process improvement.
• Describe why and how quality and process improvement depend on data-driven decision making.
• Identify seven quality tools and explain their uses.

186037

Introduction to ISO 9000: ISO for the Technician

Duration: 5 hours (includes 1 test)

What Students Learn:
This study unit is designed to introduce the technician to requirements of the international quality control system. It includes an overview of the system and its standards, as well as a description of the document control system. The unit focuses on employee responsibilities within the quality system.

186038

Introduction to ISO 9000: ISO for the Supervisor

Duration: 5 hours (includes 1 test)

What Students Learn:
This study unit includes an overview of the quality system and the development process. More focus is provided concerning the supervisor's responsibilities for system maintenance, corrective action, and training.
186073
Problem Solving and Troubleshooting

Duration: 10 hours (includes 1 test)
What Students Learn:
- Basics of problem solving, troubleshooting, and critical thinking
- Applying a logical procedure to solving problems and troubleshooting systems
- Selecting and using the right troubleshooting tools
- Focusing on and collecting information related to the problem at hand
- “Using what you know” to understand complex systems

This course replaces 2520C

186075
Manufacturing Processes, Part 1

Duration: 10 hours (includes 1 test)
What Students Learn:
- Relate historical trends in manufacturing to modern ones
- Describe the development and importance of modern quality systems
- Explain how available material types shape manufacturing processes
- Describe early factory systems and their impact on modern systems
- Classify modern manufacturing systems by type and abilities

This course replaces 2520A

186076
Manufacturing Processes, Part 2

Duration: 10 hours (includes 1 test)
What Students Learn:
- Explain the relationship between atomic structure and material properties
- Classify materials used in manufacturing based on physical and mechanical properties
- Identify benefits and drawbacks of specific materials for a given application
- Interpret the classifications of various metallic materials
- Compare properties of various metallic materials
- Identify properties of and applications for various nonmetallic materials

This course replaces 2520B

186077
Manufacturing Processes, Part 3

Duration: 10 hours (includes 1 test)
What Students Learn:
- Describe common methods and applications for casting metals and plastics
- Describe and contrast various forming processes including forging, drawing, and others
- Differentiate between the benefits and costs of casting and forming processes
- Explain how the various conventional metal-removal technologies are used in manufacturing
- Identify the benefits of and range of applications for robotics and CNC systems in manufacturing
- Describe the benefits and costs of non-contact metal removal and shaping processes

This course replaces 2520D

186078
Manufacturing Processes, Part 4

Duration: 10 hours (includes 1 test)
What Students Learn:
- Relate the factors of production to how a given manufacturing organization is structured
- List the types of manufacturing production systems
- Suggest modifications of equipment layout to improve productivity
- Evaluating automation strategies and problems
- Benefits of quality management methods
- Describe their role in JIT, Lean, and e-Manufacturing systems

This course replaces 2520D

186A10
Successful Communication for Winning Job Offers

Duration: 60 hours (includes 2 tests)
What Students Learn:
- The keys to obtaining the best job offers.
- How to communicate more effectively and clearly.
- Choosing the appropriate format for your resume.
- How to prepare a cover letter to accompany your resume.
- Establishing and maintaining a network of contacts.
- Discuss past employment history and communicate your qualifications for a new position.

Study Units:
- Introduction
  - Job Hunting in the ’90s: The Era of Downsizing and Right Sizing; Remaining Positive; Selling Yourself - Your Own Product; How to Use This Study Guide.
  - Successful Job Searching: A Comprehensive Approach
  - Introduction to the Street Smart Job Seeker; Using the Video as a Career Counselor; Resume Preparation; Psychological Impact of a Layoff; Cover Letter Preparation; Telephone Scripts; Networking; Interviewing Techniques; Anatomy of an Interview; Relating to the Interviewer; The Purpose and Value of Informational Interviews; The Hidden Job Market; Managing Your Job Search; Refresher Tips for Job Seekers.
- Resume Development
  - Preparing to Write a Resume: Style and Content Tips; Clarity and Conciseness: The Deadly Don’ts; Using Active Verbs.
  - Types of Resumes: Functional Resumes; Chronological Resumes; Tailoring Your Resume to a Specific Job or Employer.
- Winway Resume V 4.0
  - Introduction and Installation:
  - Where to Begin: Tutorial; Editing Your Resume; Quick How-to Guide.
  - Helpful Highlights: Using AutoWriter; Dictionary of Occupational
Titles; Resume and Letter Samples; Video Segments; Using the Microsoft Internet Explorer; Interview Simulator; Networking Contact Keeper; Negotiation Tips.

- Practical English and the Command of Words
  - See course number ELIM07 for a complete course description.

**Special Notes:**

- This course is a three (3) component integrated program consisting of *Practical English and the Command Of Words* (print-based, independent study), the *Street Smart Job Seeker* (a linear video series) and *WinWay Resume V 4.0* (computer-based software, which requires a personal computer). Call your Training Consultant or Customer Service for complete specifications.

- A Certificate of Completion is awarded upon completion of the entire course.

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### 2309A-B

**2309A-B**  
**Plane Trigonometry**  
*Accompanied by Trigonometric Tables (5515)*

**Duration:** 24 hours (includes 2 tests)

**Course Prerequisites:**
Introduction to Algebra, Geometry, and Trigonometry (Block X02)  
Practical Geometry (5983A-B)

**What Students Learn:**

Part 1 (2309A). Solving a Triangle; Deriving Trigonometric Functions; Trigonometric and Geometric Identities; Values for the Trigonometric Functions; Using the Table of Natural Trigonometric Functions; Interpolation; Solving the Right Triangle; Solving the Right Triangle by Using Logarithms.

Part 2 (2309B). Angles and Their Measurement; Degrees and Radians; Rectangular Coordinates; The Trigonometric Formulas; Finding the Values of the Functions of Angles; Reduction Formulas; Solving the Oblique Triangle; Law of Tangents; Using Half-Angle Formulas; Area of a Triangle; Radius of an Inscribed Circle; Radius of a Circumscribed Circle.

**Special Note:**
- Covers subject at an advanced, in-depth level.

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### 2310A-F

**2310A-F**  
**Plane Geometry**

**Duration:** 60 hours (includes 6 tests)

**Course Prerequisite:**
Introduction to Algebra, Geometry, and Trigonometry (Block X02)

**What Students Learn:**

Part 1 (2310A). Introduction to Geometry; Basic Facts about Angles; Language of Geometry; Reasoning in Geometry; Beginning Theorems.

Part 2 (2310B). Constructions; Parallelism; Quadrilaterals.

Part 3 (2310C). Polygons; Inequalities; Loci; Cevians.

Part 4 (2310D). Introduction to Circles; Relationships of Chords and Circles; Tangents; Measurement of Angles and Arcs in a Circle; Inequalities, Constructions and Loci involving Circles.

Part 5 (2310E). Introduction to Proportion; Proportional Relationships in a Triangle; Similar Figures; The Pythagorean Theorem; Proportional Line Segments.

Part 6 (2310F). Areas of Triangles and Quadrilaterals; Areas of Similar Figures; The Circle – its Circumference and Area.

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### 2400A-H

**2400A-H**  
**Reading Improvement**

**Duration:** 80 hours (includes 8 tests)

**What Students Learn:**

Part 1 (2400A). This part covers the steps to be taken to improve reading ability.

Part 2 (2400B). The habits of poor readers are discussed. The text then explains how to read in thought units and how to read a paragraph. Prereading as a means of improving reading ability is then covered.

Part 3 (2400C). This text tells the student how to read for information and relaxation and how to read material that is written specifically to influence the reader.

Part 4 (2400D). Here the student is taught how to read a newspaper – how to select articles, how to organize his reading, and how to budget time. Prereading enters the discussion again. The student learns how to take notes and how to make those notes meaningful and helpful. The purpose of outlining is then discussed.

Part 5 (2400E). This text explains how to read fiction – short stories, novels, and dramas. The student then learns how to read, interpret, and appreciate poetry. The text covers how to judge works of fiction so as to help select reading material wisely.

Part 6 (2400F). This entire text is devoted to improving the student's vocabulary.

Part 7 (2400G). The student learns the causes and cure of slow reading and then learns how to use different speeds in reading.

Part 8 (2400H). The final text reviews some of the techniques used to attain good reading habits. The text then discusses the techniques of study reading, reflective reading, and critical reading. Finally, the student learns how to use the classification and cataloguing systems of public libraries.

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**007072**

**The Parts of Speech**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**

- Improving Spoken and Written Language
- Recognizing when and why improved communication skills are beneficial
- Identify the eight parts of speech
- Effectively organize the parts of speech in verbal and written communication

**Special Note:**
- This course is part of a series (007072 through 007074, 007117, and 007118), which replaces Practical English, Parts 1-6 (2430A-F). Units in the series can be used individually, if desired.
007073

Word Usage

Duration: 10 hours (includes 1 test)

What Students Learn:
• Select the correct pronoun
• Identify parts of sentences
• Correctly form plurals and possessive nouns
• Use modifiers, prepositions, and conjunctions
• Understand rules related to capitalization, hyphenation, and punctuation

Special Note:
• This course is part of a series (007072 through 007074, 007117, and 007118), which replaces Practical English, Parts 1-6 (2430A-F). Units in the series can be used individually, if desired.

007074

Sentence Skills

Duration: 10 hours (includes 1 test)

What Students Learn:
• Recognize sentence components and structure
• Identify independent and dependent clauses
• Correct common writing errors
• Analyze punctuation selection
• Write effective sentences

Special Note:
• This course is part of a series (007072 through 007074, 007117, and 007118), which replaces Practical English, Parts 1-6 (2430A-F). Units in the series can be used individually, if desired.

007117

The Writing Process, Part 1

Duration: 10 hours (includes a graded writing assignment that's returned to the school for evaluation)

What Students Learn:
• Consider how and why different written documents are prepared, designing the document to fit the need
• Write effectively to meet goals and objectives
• How to plan prior to writing
• Working with drafts, editing, and proofreading
• Building effective paragraphs

Special Note:
• This course is part of a series (007072 through 007074, 007117, and 007118), which replaces Practical English, Parts 1-6 (2430A-F). Units in the series can be used individually, if desired.

007118

The Writing Process, Part 2

Duration: 10 hours (includes a graded writing assignment that's returned to the school for evaluation)

What Students Learn:
• Create documents with unified introductions, bodies, and conclusions
• Write various types of letters
• Recognize which type of correspondence suits a need
• Organize documents in a visually functional manner
• Write effective reports

Special Note:
• This course is part of a series (007072 through 007074, 007117, and 007118), which replaces Practical English, Parts 1-6 (2430A-F). Units in the series can be used individually, if desired.

2443

Going Metric

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Basic Industrial Math (Block X21)

What Students Learn:
Meaning of Metric Measurements in General; Introduction to Decimal Nature of Metric Measurement; Conversion within Metric System by Moving Decimal Point; Conversion of International and Other Metric Units to English Units, and Vice Versa; Application of Conversion Tables for Units of Length, Area, Volume, Liquid Capacity, Mass (Weight), Temperature, Force, Energy, Power, Electricity, Magnetism, and Light; Appendix: Conversion Tables.

2453

SI Metric

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Basic Industrial Math (Block X21)

What Students Learn:
International System of Units, or SI Metric System, Comprised of Base, Supplementary, and Derived Units; Prefixes for Multiples and Submultiples of Basic Units; Meaning of Significant Digits; Rounding Off Numbers; How to Use SI Units; How to Convert Non-SI, U.S. Customary, and Imperial Units to SI Metric Units; Use of Conversion Factors; Conversion to SI Units of Length, Time, Velocity, Acceleration, Area, Volume, Flow, Temperature, Mass, Density, Force, Torque, Pressure and Stress, Viscosity, Energy, Power, Heat Transfer, Electricity, Magnetism, and Length; SI Standard Paper Sizes.
2468

Formulas

Duration: 10 hours (includes 1 test)

Course Prerequisite: Basic Industrial Math (Block X21)

What Students Learn:
Use of Letters in Calculations; Substitution in Simple Formulas; Positive and Negative Numbers; Operations with Algebraic Terms; Simple Equations; Transformation of Formulas.

Special Note:
• This course has been updated and is replaced by Formulas, study unit 186012.

2469A-E

Algebra

Duration: 50 hours (includes 5 tests)

Course Prerequisite: Basic Industrial Math (Block X21)

What Students Learn:
Part 1 (2469A). Operations with Grouping Symbols, such as Parentheses, Brackets, and Braces; Powers and Roots of Monomials; Operations with Polynomials; Special Products of Binomials; Factoring Monomials and Polynomials; Typical Cases of Factoring; Factor Theorem; Lowest Common Multiple; Solution of Equations by Factoring.
Part 2 (2469B). Reduction of Algebraic Fractions; Addition, Subtraction, Multiplication, and Division of Algebraic Fractions; Complex and Continued Algebraic Fractions.
Part 3 (2469C). Linear Equations with One Unknown; Solving Special Problems by a Linear Equation; Linear Equations with Two Unknowns; Graphical Representation of Equations; Methods of Solving Equations with Two Unknowns; Linear Equations with Three Unknowns.
Part 4 (2469D). Use of Determinants in Solving Linear Equations with Two and Three Unknowns; Quadratic Equations with One Unknown; Quadratic Formulas; Discriminant of a Quadratic Equation; Roots of a Quadratic Equation; Quadratic Equations with Two Unknowns.
Part 5 (2469E). How to Work with Exponents in Algebra; Fractional Exponents of Monomials and Polynomials; Radical Expressed as Fractional Power; Fractional Power Expressed as Radical; Basic Operations with Radicals; Removing Radical from the Denominator or Rationalization of Denominator; Solving Equations Containing Radicals; Imaginary Numbers; Operations with Imaginary Numbers; Equations with Imaginary Roots.

Special Note:
• Covers subject at an advanced, in-depth level.

007013

Whole Numbers

Duration: 10 hours (includes 1 test)

What Students Learn:
• Describe what whole numbers are and how they are used
• Identify the mathematical operations performed on whole numbers
• Add, subtract, multiply, and divide whole numbers
• Read and write whole numbers
• Solve practical word problems involving whole numbers

Special Note:
• This course covers mathematics from a general, non-technical point of view
• This course replaces 2750A

007014

Fractions

Duration: 10 hours (includes 1 test)

What Students Learn:
• Explain what a specific fraction or mixed number represents
• Convert between proper and improper fractions and mixed numbers
• Add, subtract, multiply, and divide fractions
• Find the reciprocal of a fraction
• Solve practical word problems involving fractions and mixed numbers

Special Note:
• This course covers mathematics from a general, non-technical point of view
• This course replaces 2750B

007015

Decimals

Duration: 10 hours (includes 1 test)

What Students Learn:
• Explain what decimals, mixed decimals, and repeating decimals represent
• Convert between fractions and decimals
• Add, subtract, multiply, and divide decimals
• Compare the size of and round decimals
• Solve practical word problems involving decimals

Special Note:
• This course covers mathematics from a general, non-technical point of view
• This course replaces 2750C
## Measurement

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Identify common units of measurement in English and Metric systems
- Convert between English and Metric measurements
- Measure length, volume, capacity, weight, temperature and time in various units
- Compare measured values by equalizing units
- Solve practical word problems involving measured quantities

**Special Note:**
- This course covers mathematics from a general, non-technical point of view
- This course replaces 2750E

## Ratio, Proportion, and Percent

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Explain the concepts of ratio and proportion
- Find equivalent proportions
- Convert fractions and decimals to percents
- Determine the percentage increase or decrease in values
- Solve practical problems involving ratios and percentages

**Special Note:**
- This course covers mathematics from a general, non-technical point of view
- This course replaces 2750F

## General Review (of Math)

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Checking the results of addition, subtraction, multiplication, and division
- Use shortcuts when multiplying and dividing
- Find factors, prime factors, and least common multiples
- Interpret circle graphs
- Solve advanced word problems

**Special Note:**
- This course covers mathematics from a general, non-technical point of view
- This course replaces 2750D

## Logarithms

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- Practical Measurements (Block X22)

**What Students Learn:**
- Table of Common Logarithms; Table of Useful Numbers; Exponents; Logarithms of Numbers; Determination of Characteristics of a Logarithm; Determination of Mantissa of a Logarithm; Proportional Parts; Determination of Antilogarithms; Multiplication by Use of Logarithms; Division by Use of Logarithms; Finding Powers and Roots by Logarithms; Cologarithms; Hyperbolic Logarithms.

## Business Mathematics

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisite:**
- Basic Industrial Math (Block X21)

**What Students Learn:**
- Part 1 (5565A). Practical Everyday Arithmetic; Addition, Subtraction, Multiplication, and Division; How Percent is Used; Discounts; Brokerage; Simple Interest; Compound Interest; Present Worth; Sinking Funds; Installment Buying.
- Part 2 (5565B). Promissory Notes; Discount, Giving the Two Ways of Finding the Number of Days between Two Dates; Partial Payments by Either the United States Rule or the Merchants’ Rule; Profit and Loss; Depreciation, and Methods of Fixing the Price of Goods that are Sold; Savings, Investments, and Insurance.

## Practical Geometry and Trigonometry

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- Practical Measurements (Block X22)

**What Students Learn:**
- Points, Lines, and Angles; Triangles and Quadrilaterals; Polygons; Circles; Prisms and Cylinders; Pyramids and Cones; Spheres Pythagorean Theorem; Perimeters and Areas of Plane Figures; Surface Areas and Volumes of Solids; Trigonometric Functions; Applications of Trigonometric Functions; Laws of Sines and Cosines.

**Special Note:**
- This course will be replaced by two study units currently in development (186085 and 186086)
5983A-B
Practical Geometry

Duration: 20 hours (includes 2 tests)

Course Prerequisite:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)

What Students Learn:
Part 1 (5983A). Points, Lines, Surfaces, and Angles; Perpendicular and Parallel Lines; Triangles; Quadrilaterals; Other Polygons.
Part 2 (5983B). The Circle; Arcs and Areas of Figures Bounded by Them; Solids; Areas and Volumes of Unusual Figures.

Special Note:
• Covers subject at an advanced, in-depth level.

6232A-E
Plane Trigonometry

Accompanied by Trigonometric Tables (5515)

Duration: 50 hours (includes 5 tests)

Course Prerequisite:
Plane Geometry (2310A-F)

What Students Learn:
Part 1 (6232A). Trigonometry and Trigonometric Functions; How to Find the Trigonometric Functions from a Table; Interpolation; Approximate Number Computations; Solving the Right Triangle.
Part 2 (6232B). Angles and Angular Measure; The Rectangular Coordinate System; General Definitions of the Trigonometric Functions; Trigonometric Identities.
Part 3 (6232C). The Functions of any Angle; Reduction Formulas; Logarithms of Trigonometric Functions; The Importance of Orderly Work; Solving the Oblique Triangle.
Part 4 (6232D). The Area of any Triangle; The Functions of the Sum of Two Angles; Application of the Functions of the Sum of Two Angles; Functions of Twice an Angle and of Half an Angle.
Part 5 (6232E). Variation of the Trigonometric Functions; Formulas of a Periodic Curve; Verifying the Reduction Formulas; Simple Trigonometric Equations; More Difficult Trigonometric Equations; Inverse Trigonometric Functions.

Special Note:
• Covers subject at an advanced, in-depth level.

6561A-B
Analytic Geometry

Duration: 20 hours (includes 2 tests)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Plane Trigonometry (2309A-B)

What Students Learn:
Part 1 (6561A). Number Line; Rectangular Coordinates; Length and Midpoint of Line Segment; Graph of Linear Equation; Slope, Intercept, and Angle of Inclination of Straight Line; Finding Equation for Line from Slope and One Point and from Two Points; Intersection of Two Lines; Angle between Two Lines; Perpendicular Lines; Parallel Lines.
Part 2 (6561B). Conic Sections and Methods of Analytic Geometry; Circle as a Locus; Equation of Circle; Translation of Axes; Equation of Ellipse; Problems Concerning Ellipse; Equation of Parabola in Various Positions; Equation of Hyperbola; Asymptotes of Hyperbola; Tangents of Conic Sections and Their Equations; Meaning of Functions; Exponential, Logarithmic, and Trigonometric Functions; Polar Coordinate System; Relations between Polar and Rectangular Coordinates; Three-Dimensional Coordinate System.

Special Note:
• Covers subject at an advanced, in-depth level.

6618A-D
Calculus: Function and Use

Duration: 40 hours (includes 4 tests)

Course Prerequisites:
Analytic Geometry (6561A-B)
Plane Trigonometry (2309A-B)

What Students Learn:
Part 1 (6618A). Basic Discussion of Continuity, Limits, and Average Rate of Change; Exact Rate of Change; Derivatives; Application of Derivatives.
Part 2 (6618B). The Antiderivative; The Integral; Application of the Integral to Variable Quantities such as Velocity, Distance, Area, Volume Charge, Voltage, and Power.
Part 3 (6618C). Derivatives of Trigonometric, Exponential, and Logarithmic Functions; Applications.
Part 4 (6618D). More Forms of Integrals; Additional Applications such as: Areas and Volumes of Conics, First Moments, Centroids and Centers of Gravity, Second Moments and Moments of Inertia, Work on Variable Loads, and Transients in Electric Circuits.

Special Note:
• Covers subject at an advanced, in-depth level.

6719A-B
Elements of Print Reading

Duration: 20 hours (includes 2 tests)

What Students Learn:
Part 1 (6719A). Need for Prints; Methods of Making Prints; Perspective Drawings; Isometric Drawing; Orthographic Projection Drawings; Working Drawings; Sketches; Dimensions and Scales; Fits and Tolerances; Surface Finishes.
Part 2 (6719B). Symbols and Common Conventions; Ways of Showing Taper; Full Sections; Partial Sections; Conventional Sections; Examples in Print Reading; Steel Liner, Pin, Bottom Plate Support; Adjusting Wedge, Drive Shaft for Pump, V-Belt Sheave; Scales for Metric Drawing.

Special Note:
• This course has been replaced by study units 186080, 186081, and 186082.
050001
Using Words Well

Duration: 10 hours (includes 1 test)

What Students Learn:
- Identify different kinds of audiences and select writing that's appropriate
- Identify the parts of speech in a sentence
- Use pronouns correctly
- Select the correct verb form for the subject of a sentence
- Choose proper and effective words

Special Note:
- This course is part of a series (050001, 018 and 021 through 024), which replaces Report Writing, Parts 1-5 (7000A-E). Units in the series can be used individually, if desired.

050018
Proposals and Special Projects

Duration: 10 hours (includes 1 test)

What Students Learn:
- Understand the purpose and preparation of an informal proposal
- Explain the nature and organization of a formal proposal
- Describe a process and prepare a set of instructions
- Read and interpret technical articles
- Explain the use and preparation of technical manuals

Special Note:
- This course is part of a series (050001, 018 and 021 through 024), which replaces Report Writing, Parts 1-5 (7000A-E). Units in the series can be used individually, if desired.

050021
Writing Effective Communications

Duration: 10 hours (includes a graded writing assignment that’s returned to the school for evaluation)

What Students Learn:
- Avoid fragments and run-on sentences in your writing
- Use action verbs to provide clarity to your writing
- Use the active and passive voice properly
- Use parallel construction where necessary
- Organize sentences correctly and effectively
- Explain how to construct a coherent paragraph
- Format and write an interoffice memorandum, a routine business letter, and an effective e-mail
- Describe effective uses of e-mail

Special Note:
- This course is part of a series (050001, 018 and 021 through 024), which replaces Report Writing, Parts 1-5 (7000A-E). Units in the series can be used individually, if desired.

050022
Organizing, Researching, and Illustrating Your Material

Duration: 10 hours (includes a graded writing assignment that’s returned to the school for evaluation)

What Students Learn:
- The process of organizing your thoughts and collected information
- Establishing the purpose of a report or proposal
- Describe various patterns you can use in organizing your material
- Effective outlining in business and technical writing
- Differentiate between primary and secondary research
- Explain how to convert report data into graphic form through tables, line graphs, bar graphs, and pie graphs
- Properly document your sources in a report

Special Note:
- This course is part of a series (050001, 018 and 021 through 024), which replaces Report Writing, Parts 1-5 (7000A-E). Units in the series can be used individually, if desired.

050023
Writing the Report

Duration: 10 hours (includes a graded writing assignment that’s returned to the school for evaluation)

What Students Learn:
- Explain the purpose and importance of reports
- Describe the various kinds of informal reports
- Describe the nature of formal reports and identify their components
- Explain the elements of style suitable for effective report writing

Special Note:
- This course is part of a series (050001, 018 and 021 through 024), which replaces Report Writing, Parts 1-5 (7000A-E). Units in the series can be used individually, if desired.

050024
Creating an Informal Proposal

Duration: 10 hours (course requires developing a proposal that’s returned to the school for evaluation)

What Students Learn:
- Draw on previous instruction to develop a well- written proposal outlining a plan of action including development of staffing plans, budget requirements, schedules, and requests for authorization.

Special Note:
- This course is part of a series (050001, 018 and 021 through 024), which replaces Report Writing, Parts 1-5 (7000A-E). Units in the series can be used individually, if desired.
**Foundation Skills**

**Effective Training**

What Students Learn:
A Guide for the Training Program Coordinator or Instructor: Planning the Training Program; The Learning Process; Communication; Planning the Individual Session; Communication Aids; Methods of Teaching; Conduct of the Instructor; Motivation and Control of the Group; The Art of Questioning; Evaluation.

**Block X02**

*Introduction to Algebra, Geometry, and Trigonometry*

**Duration:** 72 hours (includes 4 tests)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)

**What Students Learn:**
This twelve lesson block is for those trainees requiring more advanced math subjects. The subject of algebra is covered in detail and the subjects of geometry and trigonometry are introduced in a practical manner. Because math skills vary widely, a placement test is available to determine the trainee's specific knowledge of the various areas. Test X0250:
Introduction to Algebra, Geometry, and Trigonometry is divided into four sections: lessons X0201 through X0204; lessons X0205 through X0208; lessons X0209 through X0210; and lessons X0211 and X0212.

**Components:**
- X0201 Algebra: Monomials and Polynomials
- X0202 Algebra: Factoring
- X0203 Algebra: Addition and Subtraction of Fractions
- X0204 Algebra: Multiplication and Division of Fractions
- X0221 Progress Examination
- X0205 Algebra: Linear Equations
- X0206 Algebra: Simultaneous Linear Equations
- X0207 Algebra: Determinants
- X0208 Algebra: Quadratic Equations
- X0222 Progress Examination
- X0209 Algebra: Exponents
- X0210 Algebra: Radicals and Imaginary Numbers
- X0223 Progress Examination
- X0211 Applied Geometry
- X0212 Practical Trigonometry
- X0224 Progress Examination
- X0220 Progress Examination Booklet

**X0201 Algebra: Monomials and Polynomials**

**Objectives:**
- Remove grouping symbols from algebraic expressions, dividing by a monomial when indicated.
- Multiply binomials by monomials, trinomials, and other inomials.
- Calculate the square root and the third power of given monomials.
- Find special products involving binomials.
- Divide one polynomial by another polynomial of lower degree.

**X0202 Algebra: Factoring**

**Objectives:**
- Find the prime factors of certain binomials and trinomials.
- Factor a given trinomial.
- Use the Factor Theorem to factor a given polynomial.
- Use factoring to find the roots of an equation.
- Divide one polynomial by another polynomial of lower degree.
- Find the lowest common multiple of several polynomials.

**X0203 Algebra: Addition and Subtraction of Fractions**

**Objectives:**
- Recognize equivalent algebraic fractions.
- Perform additions and subtractions involving algebraic fractions.
- Reduce an algebraic fraction to its lowest terms.
- Find the least common denominator for a group of algebraic fractions.

**X0204 Algebra: Multiplication and Division of Fractions**

**Objectives:**
- Perform multiplications and divisions involving algebraic fractions.
- Reduce an algebraic fraction to its lowest terms.
- Find the least common denominator for a group of algebraic fractions.
- Solve equations involving fractions or decimals.
- Simplify complex fractions.

**X0205 Algebra: Linear Equations**

**Objectives:**
- Recognize equations expressing mixture problems and other word problems.
- Solve number problems, digit problems, and age problems.
- Recognize the graph of a linear equation, given the graph or a set of points.
**X0206**
**Algebra: Simultaneous Linear Equations**

**Objectives:**
- Recognize essential steps in the solving of simultaneous linear equations by addition, subtraction, comparison, graphing, and clearing of fractions.
- Identify the classification of a system of equations.
- Solve a system of linear equations.
- Solve interest problems, lever problems, and work-sharing problems.

**X0207**
**Algebra: Determinants**

**Objectives:**
- Evaluate a second-order determinant and expand a third-order determinant.
- Recognize the standard form to be used in solving simultaneous equations by determinants.
- Recognize determinants that represent the solutions of simultaneous equations in two or three unknowns.

**X0208**
**Algebra: Quadratic Equations**

**Objectives:**
- Recognize the graphical solution of two equations.
- Solve and recognize steps in the solution of systems of quadratic equations and systems of a quadratic and linear equation.
- Solve a fourth-degree polynomial equation in quadratic form.
- Use the quadratic formula to solve a quadratic equation, calculate the discriminant of a quadratic equation, and point out what can be known from a given discriminant.
- Write a quadratic equation which has given roots.
- Solve word problems involving quadratic equations.

**X0209**
**Algebra: Exponents**

**Objectives:**
- Demonstrate an understanding of the meaning of a fractional exponent.
- Apply the rules for positive and negative exponents in multiplication, division, and raising to powers.
- Use radicals to convert fractional exponents and use fractional exponents to convert radicals.
- Write a given number in standard form.

**X0210**
**Algebra: Radicals and Imaginary Numbers**

**Objectives:**
- Simplify several radicals and then add like terms.
- Rationalize the denominator of a fraction and eliminate an imaginary number from the denominator of a fraction.
- Solve an equation containing several square roots.
- Multiply, divide, and raise to powers terms containing radicals.

**X0211**
**Applied Geometry**

**Objectives:**
- Recognize characteristics of angles and closed plane figures.
- Distinguish between common geometric solids.
- Apply the Pythagorean theorem.
- Calculate perimeters and areas of a polygon, circle, and ellipse.
- Apply the formula for area and volume of geometric solids.

**Special Note:**
- This course will be replaced by a new version (186085) currently in development.

**X0212**
**Practical Trigonometry**

**Objectives:**
- Define trigonometric functions.
- Use trigonometric tables and apply interpolation.
- Solve right triangles.
- Apply the laws of sines and cosines in solving oblique triangles.

**Special Note:**
- This course will be replaced by a new version (186086) currently in development.

**Block X07**
**Maintenance and Troubleshooting**

**Duration:** 21 hours (includes 2 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- Practical Measurements (Block X22)

**What Students Learn:**
This block introduces the trainee to the basic methods of industrial maintenance and troubleshooting. The trainee will learn how to handle preventive maintenance and the procedures, tests, and reports required for scheduled and emergency downtime of industrial equipment. Troubleshooting lessons cover using the information, tools, and procedures needed to perform your job safely. The trainee will learn that troubleshooting is a basic skill for the maintenance of electrical and mechanical equipment.
Emergency Downtime

Objectives:
- Demonstrate how to handle emergency repairs with confidence.
- Evaluate equipment breakdowns with the help of meters, gauges,
  recorders, diagrams, schematics, and manufacturers’ manuals.
- How to function as a member of an emergency repair team.
- Evaluate repaired equipment, at restart.
- Fill out, read, and keep maintenance department forms, orders,
  and records.
- Fill out requests for tools and materials, and draw them from tool
  cribs and storerooms.

Mechanical Maintenance

Objectives:
- Troubleshoot and repair a bad bearing, bad packing, shaft seal,
  vibrating pump, an electrical malfunction, and bad piping.
- Troubleshoot and repair a gate valve, globe valve, check valve,
  butterfly valve, and diaphragm valve.

Electrical Maintenance

Objectives:
- Name and describe the various types of electrical circuits and power
  distribution systems in a plant.
- Identify utilization equipment by name, and as service or
  process equipment.
- Distinguish between panelboards and switchboards.
- Describe the difference between preventive maintenance
  and troubleshooting.
- Select and safely use the proper tools for electrical maintenance.
- Work safely with electrical circuits and with electrical equipment.
- Perform basic electrical troubleshooting jobs.
- State the purpose of ground-fault circuit interrupter devices.
### 186010 Fractions, Percents, Proportions, and Angles

**Objectives:**
- Define the terms: fraction, proper fraction, improper fraction, lowest common denominator, percent, ratio, and proportion.
- How to add, subtract, multiply, and divide fractions and decimals.
- How to change fractions to decimals and decimals to fractions.
- Solve problems involving percent.
- How to use a protractor to measure angles.
- Lay out templates for checking angles.
- How to use a calculator to solve percent problems and to convert fractions to decimals.

### 186011 Metric System

**Objectives:**
- Name the base units most commonly used in the metric system.
- Identify metric prefixes and their values.
- Apply conversion factors to increase or decrease metric base units.
- Estimate lengths in metric units.
- Express temperature in degrees Celsius.
- Define the terms: mass, density, force, torque, and pressure. Identify the metric units used to measure each one.
- How to use a calculator to convert one metric unit to another.
- How to use a calculator to convert one metric unit to another.

### 186012 Formulas

**Objectives:**
- Explain the use of letters in formulas.
- Prepare and use formulas to solve problems.
- The use of formulas to calculate the perimeter of a triangle and rectangle, distance, area of a triangle, rectangle, and circle, volume of a pyramid, current in a circuit, and volume of a sphere.
- How to use a calculator to find square root and solve formulas.
- Transform and solve an equation.
- Perform basic arithmetic operations with signed terms.
- Substitute given numerical values for letters in a formula and find the unknown quantity.

### 186013 Introduction to Algebra

**Objectives:**
- Define the terms: term, constant, coefficient, exponent, monomial, trinomial, and polynomial.
- Identify and combine like terms in an expression.
- Multiply and divide terms containing exponents.
- Remove parentheses from an expression and simplify the expression.
- Perform basic arithmetic operations with signed terms.
Block X22

Practical Measurements

Duration: 25 hours (includes 5 tests)

What Students Learn:
The five lessons in this block present the trainee with a broad overview of measurements found in an industrial setting. In addition to the basic measurements of length, temperature, energy, force, and power, the trainee will learn how materials are measured and handled in bulk quantities. Fluid measurements include the measuring of fluid flow, fluid pressure, and fluid level. All lessons include the metric conversions in addition to the English units.

Special Note:
• This Block replaces the X0105 to X0109 lessons contained within Practical Math and Measurements. Each study unit contains a progress exam.

Components:
186021 Linear and Distance Measurement
186022 Bulk Measurement
186023 Temperature Measurement
186024 Energy, Force, and Power
186025 Fluid Measurement

186021

Linear and Distance Measurement

Objectives:
• Recognize the difference between English and metric units of length.
• Find the perimeter of rectangular, square, or triangular areas or objects, such as rooms or machine bases, after measuring the sides.
• Calculate the circumference of circular objects like pipes of tanks after measuring the diameter.
• Measure lengths with the aid of rigid and flexible rules, thickness gauges and screw pitch gauges.
• Read a typical vernier scale and micrometer to take precise measurements.

186022

Bulk Measurement

Objectives:
• Measure an angle by degrees.
• Find the areas of rectangles, triangles, and circles.
• Find the volumes of prisms, cylinders, and cones.
• Find the weight of material stored in a container.
• Determine the amount of material that can be stored or handled.
• Discuss the types and uses of conveyors and weighing systems.

186023

Temperature Measurement

Objectives:
• Change temperature units from one system to another.
• Discuss the use of the various types of thermometers.
• Select the type of thermometer to be used at certain temperatures.
## 186052 Common Hand Tools, Part 1

Objectives:
- Identify common hand tools and their function.
- Explain how to safely use common hand tools.
- Maintain most types of hand tools.
- Describe the benefits of several special features available for some hand tools.

## 186053 Common Hand Tools, Part 2

Objectives:
- Identify and use various chisels and punches safely.
- Use and care for cutting tools.
- Understand the need for specialized maintenance tools.
- Correctly use threading and other precision tools.

## 186068 Precision Measuring Instruments, Part 1

Objectives:
- Students will learn the following concepts and how to use the following instruments: Purpose and Language of Measurement; Scale Instruments and Accessories; Vernier Caliper; Micrometers, Gages, and Protractors.

## 286042 Plumbing and Pipefitting Tools

Objectives:
- Identify the various tools available for various tasks by appearance.
- Demonstrate your knowledge of job safety and tool safety.
- Identify the tools required to join and assemble pipes of different material composition.
- Determine when and how to use pipe-joint assembly tools.
- Identify the tools required to perform layout, cutting, and boring tasks.
- Identify the tools needed for testing and maintaining piping systems.
- Determine when and how to use finishing, testing, and maintenance tools for piping systems.

## 006026 Electricians' Tools

Objectives:
- Students will learn the concepts and how to use the following tools: Electricians’ Equipment; Basic Hand Tools; Wire-Working Tools; Conduit-Working Tools; Power Tools; Knowledge as a Tool with Basic Introduction to the Metric System; Units of Electricity; Static Electricity; Electric Current, Measuring Instruments, and the Symbols and Terminology Used by Electricians.

## 186057 Tool Grinding and Sharpening

Objectives:
- Select and (with practice) use the proper saw; saber saw, portable band saw, reciprocating saw, cut-out saw, cut-off saw, for a given application.
- Operate (with practice) the stationary circular, radial, band and scroll saws safely.
- Observe the various safety precautions when using power saws and stationary power tools.
- Use a grinding machine, following all safety procedures.
- Hone or whet tools with an oilstone.
- Explain the procedures for grinding metal stock.
- Compare the methods used in grinding screwdrivers, snips, chisels, plane irons, and twist drills.
186058
Woodworking Hand Tools

Objectives:
• Distinguish between the types of hand saws and use them correctly.
• Learn how to bore and drill holes in wood.
• Explain the differences between planes and use planes effectively.
• Use abrasive tools correctly.

186059
Routers, Power Planers, and Sanders

Objectives:
• Operate (with practice) the portable router.
• Outline the procedures for using a portable power planer.
• Recognize by sight the common stationary power sanders and compare their operation.
• Choose the right portable sander for a given job, and operate (with practice) the portable belt sander.

186060
Jacks, Hoists, and Pullers

Objectives:
• Identify the many forms of jacks and hoists.
• Safely operate jacks and hoists.
• Understand the construction details of fiber ropes, wire ropes, and chains.
• Properly use and maintain fiber rope, wire rope, and chain slings.
• Properly use jaw and push pullers.

Block X25

Reading Prints and Schematics

Duration: 96 hours (includes 12 tests)

Course Prerequisite:
Basic Industrial Math (Block X21)

What Students Learn:
This block introduces the trainee to the various types of prints, drawings, and schematics used in an industrial environment. The trainee will learn how to read and interpret the different types of standard symbols and abbreviations found on these drawings. This block will benefit trainees entering any industrial trade.

Special Note:
• This course replaces Reading Prints and Schematics, Block X05. Each study unit contains a progress exam.

Components:
186080 Introduction to Print Reading
186081 Print Reading Symbols and Abbreviations
186082 Dimensioning and Tolerancing
186083 Print Reading Applications
186043 Building Drawings
186044 Electrical Drawings and Circuits
186045 Electronic Drawings

186060: Introduction to Print Reading

What Students Learn:
• Describe the basic format for conveying technical information in a drawing
• Interpret the various drawing views used in technical drawings
• Extract information from notes and title blocks
• Recognize and interpret the different line types used in drawings
• Understand the concept of drawing scale and how it affects information shown in the drawing
• Identify various types of building, electrical, and mechanical drawings

Special Note:
• This study unit takes the place of study units 186039 and 6719A.

186081: Print Reading Symbols and Abbreviations

Course Prerequisite:
Introduction to Print Reading (186080)

What Students Learn:
• Recognize, understand, and interpret the most common abbreviations used on a wide range of drawing types used in construction and maintenance trades
• Understand and interpret the various symbols and notations used on drawings for electrical, architectural, mechanical, welding, fluid power, and other types of applications
• Explain how symbols are used to show standard materials, parts, and assemblies

Special Note:
• This study unit takes the place of study units 186041 and 6719B.

186082: Dimensioning and Tolerancing

Course Prerequisite:
Introduction to Print Reading (186080)

What Students Learn:
• Recognize the international standards and conventions that apply to drawings
• Explain how different numbering systems were developed and how they are applied to prints
• Read and interpret various systems of dimensions and tolerances on drawings
• Recognize and interpret common symbols and nomenclature used in geometric dimensioning and tolerancing (GD&T) systems
• Understand how GD&T symbols describe the designer’s intent to those making or inspecting the part, eliminating misinterpretation of the print

Special Note:
• This study unit takes the place of study units 186040 and 6719B.

186083
Print Reading Applications

Course Prerequisite:
Introduction to Print Reading (186080)
Print Reading Symbols and Abbreviations (186081)
Dimensioning and Tolerancing (186082)

What Students Learn:
• Work with standard drawing formats to obtain information such as part titles, part numbers, dimensional standards, revisions, and materials
• Explain how various components shown on prints are connected or related to each other
• Obtain information from a drawing about quantities, materials, assembly processes, or dimensions
• Visualize the three-dimensional parts and assemblies represented by two-dimensional drawings
• Effectively interpret electrical, architectural, mechanical, fluid power, and other types of prints.

Special Note:
• This study unit takes the place of study unit 186042.

186043
Building Drawings

Objectives:
• Identify the various kinds of building drawings.
• Compare elevations, plans, and sections.
• Match the symbols used on drawings with the various building materials they stand for.
• Interpret the explanations and abbreviations used on building drawings.
• Read steel and concrete structural drawings.

186044
Electrical Drawings and Circuits

Objectives:
• Identify electrical construction drawings, schematics, and wiring diagrams.
• Interpret various electrical symbols.
• Read standard abbreviations used in electrical diagrams.
• Tell if a diagram is a block diagram, a schematic diagram, or a wiring diagram.
• Compare closed circuits, open circuits, grounded circuits, and short circuits.

186045
Electronic Drawings

Objectives:
• Identify and interpret the various electronics symbols used on drawings.
• Identify and interpret the various types of drawings used in the electronics field.

186046
Hydraulic and Pneumatic Drawings

Objectives:
• Graphic symbols for lines, flows, and reservoirs.
• Pump and valve symbols.
• Fluid circuit and air circuit components.
• Graphical, circuit, cutaway, pictorial, and combined diagrams.

186047
Piping: Drawings, Materials, and Parts

Objectives:
• Define the term “piping drawings.”
• Recognize plans, elevations, and sectional views.
• Identify a view by its placement on a drawing.
• List what working drawings include.
• Evaluate whether or not a freehand sketch serves its intended purpose.
• Interpret the standard symbols and abbreviations and “read” the color coding on piping in industrial and power plants.
• Interpret dimensions marked on piping drawings.

186048
Welding Symbols

Objectives:
• Identify by name the welding processes commonly used in plant maintenance work.
• Name the best welding processes for a given welding job.
• Identify by sight, the basic joint and groove designs used in welding.
• Identify by sight, the basic types of welds and describe their uses.
• Interpret the weld symbols most often found in the drawings used in plant maintenance work.

Special Note:
• This study unit takes the place of study unit 186042.
### 186049
**Sheet Metal Basics**

**Objectives:**
- Identify sheet metal of known material and thickness by page and weight.
- Figure allowances for bends, circumferences, seams, locks, and edges.
- Know when and where to cut relief radi.
- Catalog and identify by sight the various seams, locks, and edges.
- Name and describe the major tools and machines used in sheet metal working.
- Explain how large fittings can be constructed.
- List the characteristics of PVC and PVF sheet and laminates.

### 286085
**Preventive Maintenance**

**Objectives:**
- Describe the function of inspection and scheduled maintenance as the basis of preventive maintenance.
- Explain why preventive maintenance is performed and how it’s scheduled.
- Identify those within industry who should be part of preventive maintenance planning and execution.
- Discuss the causes, effects, and goals of a successful preventive maintenance program.
- Explain how a computerized preventive maintenance program can be developed and implemented.

### 186050
**Sketching**

**Objectives:**
- Use the right techniques for sketching straight and curved lines, and circles and arcs.
- Draw, with practice, multiview sketches of simple objects that accurately show all the details of the objects.
- Draw dimension sketches of simple machine parts with enough detail that parts can be made.
- Draw, with practice, realistic sketches of objects that have simple rectangular and circular shapes.

### Block X27
**Maintenance and Troubleshooting**

**Duration:** 25 hours (includes 5 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- Practical Measurements (Block X22)
- Trades Safety: Getting Started (186001)

**What Students Learn:**
This new series of study units provides detailed instruction covering both preventive and predictive maintenance methods, procedures and applications for commonly used machinery and components.

**Special Note:**
- This course updates *Maintenance and Troubleshooting*, Block X07, covering many industrial manufacturing concepts and practices used by organizations currently. Each study unit contains a progress exam.

**Components:**
- 286085 Preventive Maintenance
- 286086 Preventive Maintenance Techniques
- 286087 Predictive Maintenance
- 286088 Predictive Maintenance: Vibration Analysis
- 286089 Predictive Maintenance: Advanced Topics

### 286086
**Preventive Maintenance Techniques**

**Objectives:**
- Explain how to inspect and properly maintain a belt, chain, and gearbox power transmission system.
- Discuss why proper alignment is necessary when operating a power transmission system.
- List the steps needed to properly maintain an AC or DC motor.
- Explain how to perform a start-up or bump test of a motor.
- Describe how to perform Preventive Maintenance (PM) tasks on pneumatic systems.
- Describe how to maintain both floor and elevated conveyor systems.
- Identify the types of elevators and vertical lifts in your plant and the proper PM procedures for this equipment.
- Explain how to maintain liquid and vacuum pump systems.
- Describe how to perform a basic alignment of in-line shafts.
- List the proper PM procedures for electronic controllers and robot systems.

### 286087
**Predictive Maintenance**

**Objectives:**
- Define what Predictive Maintenance (PDM) is and how it can be used in industry.
- Identify the various types of technologies used in PDM.
- Explain what goals should be considered for a new and a maturing PDM program.
- Discuss the scope of basic mechanical PDM.
- Explain how a time waveform and a frequency spectrum can be used to identify machine faults.
286088

Predictive Maintenance: Vibration Analysis

Objectives:
- Explain how vibration measurements are taken and the systems used to identify measurement points.
- Identify balance, looseness, and misalignment problems.
- Discuss the techniques used to diagnose rolling-element bearing faults.
- Explain how journal bearing condition monitoring and fault analysis is performed.
- Identify speed reducer faults that occur in the gear sets or the internal bearings.
- Describe how resonance can affect the operation of equipment.

286089

Predictive Maintenance: Advanced Topics

Objectives:
- Explain the steps involved in performing balance and alignment on industrial machines.
- Discuss the use and operation of ultrasonic equipment to find problems such as electrical arcing, bearing faults, and internal and external air leaks in pneumatic systems.
- Describe the procedures used in electrical signature analysis (ESA) and how this inspection system can find motor problems.
- Explain how oil analysis can find lubricant problems and contamination.
- Describe how thermography can be used in a PDM environment.

ELIM07

Practical English and the Command of Words

Duration: 36 hours (includes 4 tests)

What Students Learn:
Practical English and the Command of Words is a self-paced study course designed to improve the speaking, writing, and reading skills of today's working adult. The course consists of 48 four-page study units, with each unit containing a variety of topics. All units are structured to enhance the adult's interest and to guarantee organized and orderly learning. Effective communications skills are brought to life with real world examples, using a practical "hands-on" approach. ELI is an accredited member of the Distance Education and Training Council. Practical English and the Command of Words has been evaluated by the American Council on Education's (ACE) Program of Non-Collegiate Sponsored Instruction (PONSI) and has been recommended for academic credit as both an English course and as a Business Communications course.

Upon completion of this course, students will be able to:
- Improve their language skills.
- Master the art of conversation; learning how to converse easily and convincingly.
- Develop good speech habits.
- Use active, dynamic words to get their point across.
- Pronounce virtually any word properly – the first time.
- Avoid tired, overused words and break "lazy" speech habits.
- Sharpen their thinking skills.
- Expand their vocabulary.
- Correctly punctuate any sentence.
- Write effective memos, give memorable speeches, and communicate ideas effortlessly.
- Spell even the most commonly misspelled words correctly.
- Recognize and correct embarrassing grammatical mistakes.
- Put the power of words to work for the individual.

Testing/Completion:
- A Final Examination is available (optional) covering mastery of the 48 study units in the course. Contact our Customer Service Department regarding setting up proctored examinations required for academic credit.
- Individual Placement Tests and Answer Keys are available covering the following groups of study units: 1-6, 7-12, 13-18, 19-24, 25-30, 31-36, 37-42, 43-48.
- Progress Examinations and Answer Keys are available (taken with the study units) on a quarterly basis, covering the following groups of study units: 1-12, 13-24, 25-36, 37-48.
- Recommended course completion time per student by ELI – 6 months to 1 year (maximum allowed).
- Upon successful completion, students will receive a dictionary and a certificate of completion.

Study Units:
Study Unit 1: The Magic Power of Words: Introduction, Parts of Speech.
Study Unit 2: Dress Your Ideas Appropriately: Synonyms for Get and Guess; Subjects and Predicates.
Study Unit 3: It's Wonderful! It's Marvelous! It's Terrific!: Vocabulary Development, Phrases and Clauses.
Study Unit 4: You Can Do More Than Just Look: Synonyms for Look; Commonly Confused Words, Double Negatives, Correct Pronunciations.
Study Unit 5: Harmony Makes Listening Easy: Subject-Verb Agreement, Commonly Confused Words.
Study Unit 7: Troublesome Subjects: Subject-Verb Agreement, Avoiding Redundancy.
Study Unit 8: Verbs In Time: Verb Tenses, Dictionary Terms.
Study Unit 9: Fragrance, Odor or Aroma?: Synonym Study, Correct Pronunciations, Common Errors.
Study Unit 10: Troublesome Twins: Commonly Confused Words, Irregular Verb Tenses.
Study Unit 11: Rubber-Stamp Language: Avoiding Cliches, Verb Tenses.
Study Unit 12: When Words Send Different Messages: Word Connotations, Avoiding Cliches, The Verbs Sit and Set.
Study Unit 13: Your Telephone Personality: Speaking on the Telephone, Direct Objects and Voice of Verbs, The Verb Lie.
Study Unit 14: Word Concentrates: Concise Language, Common Errors, Synonyms for OK, The Verb Lay.
Study Unit 15: Positions and Prepositions: Prepositions and Their Objects, Parallel Construction in Writing, Words from Other Languages.
Study Unit 16: The Invisible Preposition: Indirect Objects and Reflexive Pronouns, Compound Objects of Prepositions.
Study Unit 17: The Weak Passive: Using the Active Voice, The Verbs Shall and Will.
Study Unit 18: Opposites in Language: Antonym Study, Identifying Conjunctions, Spellings and Definitions, Common Errors.
Study Unit 19: Are You Related to Mrs. Malaprop?: Commonly Confused Words, Correct Pronunciations, Correlate, Correlative, and Subordinate Conjunctions, Correct Pronunciations.
Study Unit 20: The Versatile Infinitive: Use of the Infinitive Verb Form,
Greek Origin PH, Correct Pronunciations, Words from French, Words from Other Languages.

Study Unit 21: *Initiative Words: Words That Echo Nature’s Sounds, Prefixes, Choosing the Correct Pronoun.*

Study Unit 22: *What’s In a Name? Vocabulary Development, Words from Other Languages, Choosing the Correct Pronoun.*

Study Unit 23: *True or False? Vocabulary Development, Adjectives and Adverbs.*

Study Unit 24: *Voice Impressions: Speaking on the Telephone, Capitalization Rules, End Punctuation, Words from Other Languages.*

Study Unit 25: *The Literal and the Figurative: Vocabulary Development, Concise Language.*

Study Unit 26: *Dangerous Resemblances: Commonly Confused Words, Clauses as Subjects and Objects, Common Errors.*

Study Unit 27: *Degrees of Comparison: Comparative and Superlative Forms of Adjectives, Legal Terms, Correct Pronunciations.*


Study Unit 29: *Overburdened Sentences: Shapeless Sentences and Wordiness, Pronunciations of Nouns and Verbs, Common Errors.*

Study Unit 30: *Negative from Positives: Prefixes Meaning Not, Greek and Latin Combining Forms.*

Study Unit 31: *That Little Word Big: Synonyms for Big, Relative Pronouns.*


Study Unit 33: *Word Portraits/Personality: Vocabulary Development, Correct Pronunciations, Positive, Comparative, and Superlative Forms.*

Study Unit 34: *Beginning a Sentence: Varying Sentence Beginnings, Possessives.*

Study Unit 35: *Telephone Courtesy in Business: Points and Procedures, Spelling Rules.*

Study Unit 36: *Word Building: Greek and Latin Combining Forms, Spelling Rules, Correct Pronunciations.*

Study Unit 37: *Word Portraits/Co-Workers: Vocabulary Development, Correct Pronunciations, Doubling the Final Consonant.*

Study Unit 38: *Signal for a Short Pause: Commas, Common Errors, Words from French.*


Study Unit 40: *Word Portraits/Character: Vocabulary Development, Common Errors.*

Study Unit 41: *Where Does It Point? Placement of Pronouns, Phrases, Clauses, Negative Prefixes.*


Study Unit 44: *The Relativity of Age: Vocabulary Development, Words from Latin.*

Study Unit 45: *Signal Your Paragraphs: Three Common Errors, Correct Pronunciations, Common Errors, Correct Pronunciations.*

Study Unit 46: *The Art of Conversation: Words from Other Languages, Colons, Dashes, Quotation Marks, and Parentheses.*

Study Unit 47: *Writing Memos: Methods and Techniques for Planning, Organizing, and Writing Effective Memos.*


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**MTHM07**

*Real Life Math and the Power of Numbers*

**Duration:** 36 hours (includes 4 tests)

**What Students Learn:**

*Real Life Math and the Power of Numbers* is a self-paced study course that concentrates on how to solve real-life mathematical problems that are commonly used by people working in business and industry. Adult literacy research reports that the average U.S. worker's mathematical skill level is at a 7th grade (or lower) level, when today's technology demands it be at a 10th to 12th grade level. The course consists of 48 four-page study units. Each unit focuses on a narrowly defined topic. Mathematical solutions are presented in a step-by-step format. Starting with Unit 4, the student learns how to solve problems using a calculator.

Course features designed to provide learning continuity include:

- Speaking the Language – Short definitions of new terms introduced in the unit.
- Improving the Odds – Tips providing concise rules, shortcuts, warnings, and pitfalls.
- It’s Your Turn! – Practice exercises related to mathematical problems that adults may encounter in daily life, primarily business.
- Solve It! – Concluding unit exercises designed to reinforce skills learned during the lesson.

ELI is an accredited member of the Distance Education and Training Council.

Upon completion of this course, students will be able to:

- Better understand the importance of math.
- Perform basic math skills: addition, subtraction, multiplication, division, fractions, ratios, proportions, decimals, and percentages.
- Apply common math skills to solving problems and performing business calculations: currency, interest problems, checkbook/bank statement balancing, payroll, inventory, depreciation, discounts, markups, consumer issues, loans, credit, and insurance.
- Read tables and graphs: decipher statistics; metric measurement; problem solving and word problems.

**Testing/Completion:**

- A Final Examination is available (optional) covering mastery of the 48 study units in the course.
- Individual Placement Tests and Answer Keys are available covering the following groups of study units: 1-6, 7-12, 13-18, 19-24, 25-30, 31-36, 37-42, 43-48.
- Progress Examinations and Answer Keys are available (taken with the study units) on a quarterly basis, covering the following groups of study units: 1-12, 13-24, 25-36, 37-48.
- Recommended course completion times per student by ELI - 6 months to 1 year (maximum allowed).
- Upon successful completion, students will receive a calculator and a certificate of completion.

**Study Units:**

Study Unit 1: *Math! Who Needs It? Course Overview.*

Study Unit 2: *You Can Count on Them: Whole Numbers, Addition and Subtraction.*

Study Unit 3: *Enough for Everyone: Whole Numbers, Multiplication and Division.*

Study Unit 4: *The Answer Can’t Be Wrong . . . I Used a Calculator! Calculator Skills.*

Study Unit 5: *A Piece of the Rock: Fraction Addition and Subtraction.*

Study Unit 6: *Ours Not to Reason Why . . . Fraction Multiplication and Division.*

Study Unit 7: *Mix Well Before Serving: Mixed Numbers.*

Study Unit 8: *Two Out of Three’s Not Bad: Working with Ratios.*
Study Unit 9: Sounds Like . . . Looks Like: Understanding Proportions.
Study Unit 10: Decadent Expressions: Decimal Addition and Subtraction.
Study Unit 11: When More is Less: Decimal Multiplication and Division.
Study Unit 12: Money Talks: Currency Concepts.
Study Unit 13: That's Unreasonable! Estimating Answers.
Study Unit 14: There's a Discrepancy: Bank Statements.
Study Unit 15: I Can't Be Out of Money . . . I Still Have Checks Left: Checkbook Balancing.
Study Unit 16: He's Batting a Thousand: Introductory Percent Concepts.
Study Unit 17: Practical Percents: Using Percents.
Study Unit 18: Can I Interest You in . . .? Simple Interest.
Study Unit 19: The Magic of Compounding: Compound Interest.
Study Unit 20: Where Did It Go? Net Pay.
Study Unit 22: Closed for Inventory: Inventory.
Study Unit 23: The Old Gray Mare Ain't What She Used To Be: Depreciation.
Study Unit 24: Complements Make Life Easier: Trade Discounts.
Study Unit 25: Save Money By Borrowing: Cash Discounts.
Study Unit 26: He's Making a Fortune: Markups.
Study Unit 27: I'm Not Making a Cent on This Deal: Markdowns.
Study Unit 28: Look Out for . . . Reading Labels.
Study Unit 30: How Much is Mine: Mortgages.
Study Unit 31: Charge It! Credit Cards.
Study Unit 32: Covered: Life and Fire Insurance.
Study Unit 33: A Fender Bender: Automobile and Medical Insurance.
Study Unit 34: I Know It's in Here Somewhere: Using Tables.
Study Unit 35: A Picture is Worth a Lot of Words: Interpreting Graphs.
Study Unit 36: The Mythical "Average" Person: Statistical Average and Variations.
Study Unit 37: Nine Out of Ten People Agree: Deciphering Statistics.
Study Unit 38: Who Owns It? Stocks.
Study Unit 39: Lending to Uncle Sam: Bonds.
Study Unit 40: A Weighty Issue: Metric Measures.
Study Unit 41: An Inch by Any Other Name: Metric Conversions.
Study Unit 43: What Will I Use This for in Real Life? Problem-Solving Applications.
Study Unit 44: Keep It Balanced: Equations.
Study Unit 45: Is That All There Is? Building on What You've Learned.
Industrial Safety
## General Safety & Health Kits

### Industrial Safety
- Electrical Safety for the Trades (186005) ........................................ 70
- Fire Safety (186003) ........................................................................ 70
- Industrial Safety (Block X03) ......................................................... 70
- Industrial Safety (Block X23) ......................................................... 70
- Machine Shop Safety (186007) ..................................................... 71
- Material Handling Safety (186006) ................................................ 71
- Safe Handling of Pressurized Gases and Welding (186004) .......... 71
- Safety in Welding and Cutting (6154) ............................................ 74
- Trades Safety: Getting Started (186001) ....................................... 71
- Working Safely with Chemicals (186002) ...................................... 71
- Working Safely with Electricity (4400) .......................................... 146

### General Safety & Health DVDs
- Sexual Harassment (V0000519EM) ................................................. 72
- Fire Prevention & Safety (V0000459EM) ........................................ 72
- Fire Prevention & Safety (V0000469EM) ........................................ 72
- Sexual Harassment (V0000479EM) ................................................ 72
- Sexual Harassment (V0000489EM) ................................................ 72
- Sexual Harassment (V0000499EM) ................................................ 72
- Fire Prevention & Safety (V0000319EM) ........................................ 73
- Fire Prevention & Safety (V0000329EM) ........................................ 73
- Spill Cleanup (V0000129EM) ........................................................ 73
- Hazardous Labeling (V0000139EM) .............................................. 73
- Office Ergonomics (V0000199EM) ............................................... 73
- Office Safety (V0000209EM) ......................................................... 73
- Computer Workstation Safety (V0000219EM) ............................... 73
- Accident Investigation (V0000239EM) ......................................... 73
- Back Safety (V0000439EM) .......................................................... 73
- Compressed Gas Cylinders (V000CGC9M) .................................... 74
- Crane Safety (V000CST9EM) ......................................................... 74
- Driving Safety (V000DRV9EM) ...................................................... 74
- Electrical Safety (V000ELC9EM) ................................................... 74
- Industrial Ergonomics (V000ERG9EM) ......................................... 74
- Fall Protection (V000FTW9EM) .................................................... 74
- Fitness & Wellness (V000FTW9EM) ............................................... 72
- Hand & Power Tool Safety (V000HFT9EM) ................................... 74
- Ladder Safety (V000LAD9EM) ....................................................... 75
- Accident Prevention (V000SHK9EM) ............................................ 75
- Slips, Trips, & Falls (V0000429EM) .............................................. 75
- Safety Audits (V000SAU9EM) ..................................................... 75
- Spill Cleanup (V000012VEM) ....................................................... 80
- Computer Workstation Safety (V000021VEM) ............................... 78
- Accident Investigation (V000AINVEM) ......................................... 78
- Driving Safety (V000DRVVEM) .................................................... 78
- Fall Protection (V000FAL9EM) ..................................................... 75
- Job Safety (V000J079EM) ............................................................. 75
- Material Handling Safety (V000MHSVEM) .................................... 77
- Compressed Gas Cylinders (K000CGCVEM) ................................. 77
- Machine Guard Safety (V000MGDVEM) ...................................... 77
- Welding Safety (K0000WLDVEM) .............................................. 77
- Workplace Violence (K0000VILVEM) .......................................... 78
- Accident Investigation (K000AINVEM) ......................................... 78
- Safety Audits (K000SAU9EM) ..................................................... 78
- Crane Safety (K000CSTVEM) ........................................................ 78
- Rigging Safety (K000RGGVEM) .................................................... 78
- Back Safety (K000043VEM) .......................................................... 78
- Spill Cleanup (K000012VEM) ....................................................... 80
- Computer Workstation Safety (K000021VEM) ............................... 78
- Accident Investigation (K000AINVEM) ......................................... 78
- Driving Safety (K000DRVVEM) .................................................... 78
- Fall Protection (K000FAL9EM) ..................................................... 75
- Job Safety (K000J079EM) ............................................................. 75
- Material Handling Safety (K000MHSVEM) .................................... 77
- Compressed Gas Cylinders (K000CGCVEM) ................................. 77
- Machine Guard Safety (K000MGDVEM) ...................................... 77
- Welding Safety (K0000WLDVEM) .............................................. 77
- Workplace Violence (K0000VILVEM) .......................................... 78
- Accident Investigation (K000AINVEM) ......................................... 78
- Safety Audits (K000SAU9EM) ..................................................... 78
- Crane Safety (K000CSTVEM) ........................................................ 78
- Rigging Safety (K000RGGVEM) .................................................... 78
- Back Safety (K000043VEM) .......................................................... 78
- Slips, Trips, & Falls (K000042VEM) .............................................. 78
- Hand & Power Tool Safety (K000044VEM) ................................... 79
- Accident Prevention (K0000479EM) ............................................ 79
- Office Safety (K000020VEM) ....................................................... 79
- Fitness & Wellness (K000048VEM) ............................................... 79
- Office Ergonomics (K0000199EM) .............................................. 79
- Industrial Ergonomics (K000ERG9EM) ......................................... 79
- Hand, Wrist, & Finger Safety (K000HFTVEM) ............................... 79
- Fitness & Wellness (K000FTW9EM) ............................................... 79
- Ladder Safety (K000LAD9EM) ....................................................... 79
- Workplace Stress (K0000219EM) ............................................... 80
- Heat Stress (K000HTSVEM) ........................................................ 80
- Computer Workstation Safety (K0000219EM) ............................... 80
- Accidents Investigation (K000AIN9EM) ........................................ 81
- Fire Prevention & Safety (K0000459EM) ........................................ 81
- Fire Prevention & Safety (K0000469EM) ........................................ 81
- Sexual Harassment (K0000479EM) .............................................. 81
- Industrial Ergonomics (K000ERG9EM) ......................................... 81
- Eye Safety (K000EYE9EM) ............................................................ 82
- Fall Protection (K000042VEM) .................................................... 82
- Hand & Power Tool Safety (K000044VEM) ................................... 82
- Heat Stress (K000048VEM) .......................................................... 82
- Hand, Wrist, & Finger Safety (K000HFTVEM) ............................... 82
- Ladder Safety (K000LAD9EM) ....................................................... 82
- ANSI MSDS (K000MAS9EM) ...................................................... 82
### Laboratory Safety DVDs

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Showers &amp; Eye Washes</td>
<td>84</td>
</tr>
<tr>
<td>Preventing Contamination</td>
<td>84</td>
</tr>
<tr>
<td>ANSI MSDS</td>
<td>84</td>
</tr>
<tr>
<td>Laboratory Ergonomics</td>
<td>84</td>
</tr>
<tr>
<td>Laboratory Emergencies</td>
<td>85</td>
</tr>
<tr>
<td>Laboratory Glassware</td>
<td>85</td>
</tr>
<tr>
<td>Formaldehyde Standard</td>
<td>85</td>
</tr>
<tr>
<td>Flammables &amp; Explosives</td>
<td>85</td>
</tr>
<tr>
<td>Electrical Safety</td>
<td>86</td>
</tr>
<tr>
<td>Laboratory Safety</td>
<td>86</td>
</tr>
<tr>
<td>Compressed Gas Cylinders</td>
<td>86</td>
</tr>
<tr>
<td>Laboratory Hoods</td>
<td>86</td>
</tr>
</tbody>
</table>

### Regulatory Compliance DVDs

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOT General Awareness</td>
<td>86</td>
</tr>
<tr>
<td>DOT Safety Training</td>
<td>86</td>
</tr>
<tr>
<td>DOT Security Awareness</td>
<td>86</td>
</tr>
<tr>
<td>OSHA Recordkeeping</td>
<td>87</td>
</tr>
<tr>
<td>OSHA Recordkeeping</td>
<td>87</td>
</tr>
<tr>
<td>OSHA Recordkeeping</td>
<td>87</td>
</tr>
<tr>
<td>Indoor Air Quality</td>
<td>87</td>
</tr>
<tr>
<td>Asbestos Awareness</td>
<td>87</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>87</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>87</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>87</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>87</td>
</tr>
<tr>
<td>Confined Space Entry</td>
<td>88</td>
</tr>
<tr>
<td>Right-To-Know</td>
<td>88</td>
</tr>
<tr>
<td>Confined Space Entry</td>
<td>88</td>
</tr>
<tr>
<td>Emergency Planning</td>
<td>88</td>
</tr>
<tr>
<td>Right-To-Know</td>
<td>88</td>
</tr>
<tr>
<td>Hearing Conservation</td>
<td>88</td>
</tr>
<tr>
<td>Forklift/Powered Industrial Truck Safety</td>
<td>89</td>
</tr>
<tr>
<td>Laboratory Standard</td>
<td>89</td>
</tr>
<tr>
<td>Lead Standard</td>
<td>89</td>
</tr>
<tr>
<td>Lead Standard</td>
<td>89</td>
</tr>
<tr>
<td>Laboratory Standard</td>
<td>89</td>
</tr>
<tr>
<td>Lock-Out/Tag-Out</td>
<td>89</td>
</tr>
<tr>
<td>Lock-Out/Tag-Out</td>
<td>89</td>
</tr>
<tr>
<td>Suspended Scaffolding</td>
<td>90</td>
</tr>
<tr>
<td>Personal Protective Equipment</td>
<td>90</td>
</tr>
<tr>
<td>Right-To-Know</td>
<td>90</td>
</tr>
<tr>
<td>Right-To-Know</td>
<td>90</td>
</tr>
<tr>
<td>Right-To-Know</td>
<td>90</td>
</tr>
<tr>
<td>Right-To-Know</td>
<td>90</td>
</tr>
<tr>
<td>Right-To-Know</td>
<td>91</td>
</tr>
<tr>
<td>Right-To-Know</td>
<td>91</td>
</tr>
<tr>
<td>Right-To-Know</td>
<td>91</td>
</tr>
<tr>
<td>Right-To-Know</td>
<td>91</td>
</tr>
<tr>
<td>Right-To-Know</td>
<td>91</td>
</tr>
<tr>
<td>Right-To-Know</td>
<td>91</td>
</tr>
<tr>
<td>Right-To-Know</td>
<td>91</td>
</tr>
<tr>
<td>Accidental Release Measures &amp; Spill Cleanup Procedures</td>
<td>91</td>
</tr>
<tr>
<td>Personal Protective Equipment</td>
<td>91</td>
</tr>
<tr>
<td>Confined Space Entry</td>
<td>92</td>
</tr>
<tr>
<td>Dealing with the Media</td>
<td>92</td>
</tr>
<tr>
<td>Decontamination Procedures</td>
<td>92</td>
</tr>
<tr>
<td>Electrical Safety</td>
<td>92</td>
</tr>
<tr>
<td>Exposure Monitoring &amp; Medical Surveillance</td>
<td>92</td>
</tr>
<tr>
<td>Emergency Response</td>
<td>92</td>
</tr>
<tr>
<td>Work Practices and Engineering Controls</td>
<td>92</td>
</tr>
<tr>
<td>Fire Prevention &amp; Safety</td>
<td>93</td>
</tr>
<tr>
<td>HAZMAT Labeling</td>
<td>93</td>
</tr>
<tr>
<td>Understanding HAZWOPER</td>
<td>95</td>
</tr>
<tr>
<td>Heat Stress</td>
<td>95</td>
</tr>
<tr>
<td>HAZWOPER 8 hour Annual Retraining Package</td>
<td>95</td>
</tr>
<tr>
<td>HAZWOPER General Training Package</td>
<td>95</td>
</tr>
<tr>
<td>HAZWOPER Complete 40 hour Training Package</td>
<td>95</td>
</tr>
<tr>
<td>HAZWOPER all 23 Programs</td>
<td>95</td>
</tr>
<tr>
<td>HAZWOPER Emergency Response: HAZMAT Training Package</td>
<td>94</td>
</tr>
<tr>
<td>HAZWOPER Emergency Response: HAZMAT Awareness Package</td>
<td>94</td>
</tr>
<tr>
<td>HAZWOPER Emergency Response: HAZMAT Operations Package</td>
<td>94</td>
</tr>
<tr>
<td>HAZWOPER Emergency Response: HAZMAT Supplemental Training Package</td>
<td>95</td>
</tr>
<tr>
<td>HAZWOPER Retraining</td>
<td>95</td>
</tr>
<tr>
<td>ANSI MSDS</td>
<td>95</td>
</tr>
<tr>
<td>Medical Surveillance Programs</td>
<td>95</td>
</tr>
<tr>
<td>Handling Hazardous Materials</td>
<td>95</td>
</tr>
<tr>
<td>Monitoring Procedures &amp; Equipment</td>
<td>96</td>
</tr>
<tr>
<td>PPE &amp; Decontamination Procedures</td>
<td>96</td>
</tr>
<tr>
<td>Respiratory Safety</td>
<td>96</td>
</tr>
<tr>
<td>Understanding Chemical Hazards</td>
<td>96</td>
</tr>
<tr>
<td>Safety Orientation</td>
<td>96</td>
</tr>
<tr>
<td>Site Safety &amp; Health Plan</td>
<td>96</td>
</tr>
</tbody>
</table>

### Regulatory Compliance Kits

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lock-Out/Tag-Out</td>
<td>97</td>
</tr>
<tr>
<td>Laboratory Standard</td>
<td>97</td>
</tr>
<tr>
<td>Lead Standard</td>
<td>97</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>97</td>
</tr>
<tr>
<td>Topic</td>
<td>Page</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Tuberculosis (K000TSHVEX)</td>
<td>97</td>
</tr>
<tr>
<td>Tuberculosis (K000TSIVEX)</td>
<td>97</td>
</tr>
<tr>
<td>Asbestos Awareness (K000ASBVEO)</td>
<td>97</td>
</tr>
<tr>
<td>Supported Scaffolding (K000SPSVEO)</td>
<td>98</td>
</tr>
<tr>
<td>Bloodborne Pathogens (K000B3HVEO)</td>
<td>98</td>
</tr>
<tr>
<td>Bloodborne Pathogens (K000B21VEO)</td>
<td>98</td>
</tr>
<tr>
<td>Bloodborne Pathogens (K000B2YVEO)</td>
<td>98</td>
</tr>
<tr>
<td>Bloodborne Pathogens (K000B3FVEO)</td>
<td>98</td>
</tr>
<tr>
<td>Confined Space Entry (K000CSEVEC)</td>
<td>98</td>
</tr>
<tr>
<td>DOT General Awareness (K000033VEX)</td>
<td>98</td>
</tr>
<tr>
<td>DOT Safety Training (K000035VEX)</td>
<td>98</td>
</tr>
<tr>
<td>Emergency Planning(K000EPL9EX)</td>
<td>99</td>
</tr>
<tr>
<td>Lead Standard (K000LDSVE)</td>
<td>99</td>
</tr>
<tr>
<td>Right-To-Know (K000RINVEO)</td>
<td>99</td>
</tr>
<tr>
<td>Right-To-Know (K000RBLVEO)</td>
<td>99</td>
</tr>
<tr>
<td>Right-To-Know (K000RHCVEO)</td>
<td>99</td>
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<tr>
<td>Right-To-Know (K000FODVEO)</td>
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<td>Right-To-Know (K000RCMVEO)</td>
<td>99</td>
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<tr>
<td>Right-To-Know (K000RHSVEO)</td>
<td>99</td>
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<td>Right-To-Know (K000CHMVER)</td>
<td>100</td>
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<tr>
<td>Bloodborne Pathogens (K000B2PVER)</td>
<td>100</td>
</tr>
<tr>
<td>Confined Entry Space (K000CFSVVER)</td>
<td>100</td>
</tr>
<tr>
<td>Lock-Out/Tag-Out (K000LTRVEK)</td>
<td>100</td>
</tr>
<tr>
<td>Laboratory Standard (K000LSDVER)</td>
<td>100</td>
</tr>
<tr>
<td>OSHA Recordkeeping (K000017VEX)</td>
<td>100</td>
</tr>
<tr>
<td>Emergency Planning (K000EPLYVEX)</td>
<td>100</td>
</tr>
<tr>
<td>Forklift/Powered Industrial Truck Safety (K000K2SVEO)</td>
<td>100</td>
</tr>
<tr>
<td>Suspended Scaffolding (K000PNSVEO)</td>
<td>101</td>
</tr>
<tr>
<td>Personal Protective Equipment (K000PPSVEO)</td>
<td>101</td>
</tr>
<tr>
<td>Hearing Conservation (K000HESVEO)</td>
<td>101</td>
</tr>
<tr>
<td>OSHA Recordkeeping (K000015VEO)</td>
<td>101</td>
</tr>
<tr>
<td>OSHA Recordkeeping (K000017VEO)</td>
<td>101</td>
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<tr>
<td>OSHA Recordkeeping (K0000159EO)</td>
<td>101</td>
</tr>
<tr>
<td>OSHA Recordkeeping (K0000179EO)</td>
<td>102</td>
</tr>
<tr>
<td>Indoor Air Quality (K000AQ9EO)</td>
<td>102</td>
</tr>
<tr>
<td>Asbestos Awareness (K000ASB9EO)</td>
<td>102</td>
</tr>
<tr>
<td>Bloodborne Pathogens (K000B219EO)</td>
<td>102</td>
</tr>
<tr>
<td>Bloodborne Pathogens (K000B2P9ER)</td>
<td>102</td>
</tr>
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<td>102</td>
</tr>
<tr>
<td>Bloodborne Pathogens (K000B3H9EO)</td>
<td>102</td>
</tr>
<tr>
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<td>103</td>
</tr>
<tr>
<td>Right-To-Know (K000CHM9ER)</td>
<td>103</td>
</tr>
<tr>
<td>Confined Space Entry (K000CSE9EC)</td>
<td>103</td>
</tr>
<tr>
<td>Right-To-Know (K000FOD9EO)</td>
<td>103</td>
</tr>
<tr>
<td>Hearing Conservation (K000HES9EO)</td>
<td>103</td>
</tr>
<tr>
<td>Forklift/Powered Industrial Truck Safety (K000K2S9EO)</td>
<td>103</td>
</tr>
<tr>
<td>Laboratory Standard (K000LAS9EO)</td>
<td>103</td>
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<tr>
<td>Laboratory Standard (K000LSD9ER)</td>
<td>103</td>
</tr>
<tr>
<td>Lock-Out/Tag-Out (K000LTR9ER)</td>
<td>104</td>
</tr>
<tr>
<td>Lock-Out/Tag-Out (K000LTR9EC)</td>
<td>104</td>
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<tr>
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<td>104</td>
</tr>
<tr>
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</tr>
<tr>
<td>Right-To-Know (K000RCM9EO)</td>
<td>104</td>
</tr>
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</table>
186005

**Electrical Safety for the Trades**

**Objectives:**
- Explain how electricity can harm you and your property.
- Discuss the importance of properly using quality electrical components.
- Follow the basic methods of protection when wiring electrical installations.
- Tell why it is important to ground electrical equipment and systems.
- Select the type of electrical equipment to use in a hazardous location.
- List the safety practices required in an electrical work area.
- Talk about the importance of a clear working space around electrical equipment.
- Educate your own level of safety training to be sure it matches the electrical work you are performing.

186003

**Fire Safety**

**Objectives:**
- Describe the types of property losses and injuries associated with fires.
- Explain how fires are ignited.
- Identify the four classes of fire.
- Describe the primary fire hazards found in the workplace.
- Explain the various ways in which fires can be prevented.
- Describe the operation of several different fixed fire protection systems.
- Identify the proper type of portable fire extinguisher to use on a fire.
- Describe the operation of several different types of fire extinguishers.
- Explain how to defend yourself and others in a fire situation.
- Describe how to safely evacuate a burning building.

Block X23

**Industrial Safety**

**Duration:** 35 hours (includes 7 tests)

**What Students Learn:**
A newly expanded seven lesson block that provides the trainee with specific instruction for safe work practice in an industrial environment. The block contains an introductory unit that introduces safety philosophies and terminology as well as acquainting the student with OSHA policy and the “Right-to-Know” laws. New units specific to fire safety, pressurized gases and welding, chemical and electrical hazards, as well as safe machine usage have been added. An updated unit on material handling is included.

**Special Note:**
This new course replaces Industrial Safety, Block X03. Each study unit contains a progress exam.

**Components:**
- 186001 Trades Safety: Getting Started
- 186002 Working Safely with Chemicals
- 186003 Fire Safety
- 186004 Safe Handling of Pressurized Gases and Welding
- 186005 Electrical Safety for the Trades
- 186006 Material Handling Safety
- 186007 Machine Shop Safety

Block X03

**Industrial Safety**

**Duration:** 35 hours (includes 2 tests)

**What Students Learn:**
This five lesson block describes the need for safety awareness in the industrial workplace, then covers specific procedures for handling various materials, operating different kinds of machinery, and performing job tasks safely. The program presents an easy to understand explanation of how the human body is constructed and how it works, which parts are most frequently injured, and how to protect them. The course covers some of the regulations designed to improve industrial safety.

**Special Note:**
This course is replaced by Industrial Safety, Block X23. Contact your Training Consultant or Customer Service for availability.

186007

**Machine Shop Safety**

**Objectives:**
- Recognize the basic machine motions that can present a hazard to workers.
- Recognize the types of machinery most likely to be hazardous to workers.
- Understand the types of injuries caused by accidents commonly associated with unsafe machine operating procedures.
- Discuss the importance of machine guarding and how to incorporate methods of guarding to avoid physical injury.
- Recognize the four basic types of machine guards commonly used in industry.
- Control various forms of hazardous machine energy through the use of lockout / tagout procedures.
- Understand how and why to properly use personal protective equipment for added protection when using industrial equipment.
186006

**Material Handling Safety**

**Objectives:**
- Recognize the hazards associated with handling materials.
- Know the types of injuries that can be caused by these hazards.
- Understand how to effectively use safe material handling practices.
- Know how to avoid physical injury when handling loads.
- Know and follow the rules for safe operation of powered industrial material handling equipment.
- Understand and respect the limits and restrictions placed on powered material handling mechanisms.

186004

**Safe Handling of Pressurized Gases and Welding**

**Objectives:**
- Identify common welding gases and understand how they are used in welding operations.
- Point out the hazards associated with welding gases.
- Safely handle and store different types of gas cylinders.
- Safely operate a basic gas welding setup.
- Recognize the safety considerations involved in the setup and operation of electric arc welding equipment.
- Identify welding equipment malfunctions and take corrective action.
- Utilize fire prevention and protection methods specific to welding operations.
- Discuss the importance of the hot work permit program in your facility.
- Explain the correct use of protective clothing and equipment for welding.
- Utilize proper ventilation when welding.
- Effectively deal with confined spaces when performing welding operations.

186001

**Trade Safety: Getting Started**

**Objectives:**
- Name the agencies that make and enforce safety regulations and explain an employee's responsibilities under those regulations.
- List the hazards associated with chemicals and describe how to avoid those hazards.
- Name several electrical shock hazards and the techniques used to prevent shocks.
- List the steps in a lockout/tagout procedure.
- Explain the importance of machine guarding and name several types of machine guards.
- Name the four classes of fire and how to extinguish each of them.
- Describe the proper technique used to lift a heavy load.
- Explain how to avoid hand injuries when using hand and power tools.
- List some of the hazards involved in welding and hot cutting operations and how to prevent them.
- Explain how job analysis and the science of ergonomics are used to improve the workplace.
- Explain the importance of personal protective equipment and name several types of PPE.

186002

**Working Safety with Chemicals**

**Objectives:**
- Recognize the six different ways in which a chemical can cause physical injury.
- Name the routes or paths of entry by which chemicals can enter the body.
- Describe the types of injuries caused by chemicals.
- Identify potential chemical dangers in your workplace.
- Describe how to identify, store and label hazardous chemicals.
- List several methods used to prevent chemical accidents.
- Explain why proper training is important to chemical handling.
- Describe the types of personal protective equipment used and worn when handling chemicals.
- Explain the role of governmental agencies in enforcing chemical regulations.
General Safety & Health DVDs

V0000519EM
Sexual Harassment

Duration: 51 minutes

What Students Learn:
"Sexual Harassment in the Workplace Package" (all 3 DVD Programs) reminds employees to be aware of behaviors and actions that can constitute sexual harassment and what to do if they suspect that they or a coworker has been harassed. The DVD programs each come with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

V0000459EM3
Fire Prevention & Safety

Duration: 20 minutes

What Students Learn:
"Fire Prevention in Healthcare Facilities" DVD Program looks at how fires in healthcare facilities start, and what can be done to prevent them... as well as what employees should do in case of a fire emergency. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

V0000469EM
Fire Prevention & Safety

Duration: 18 minutes

What Students Learn:
"Using Fire Extinguishers” DVD Program looks at why things burn, reviews the types of fire extinguishers that are found in facilities today, and discusses how to use fire extinguishers to fight small fires. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

V0000479EM
Sexual Harassment

Duration: 16 minutes

Objectives:
"Sexual Harassment... for Employees” DVD Program discusses various forms of sexual harassment, explains how to avoid inadvertently sexually harassing someone and reviews the procedures employees should follow if they feel that they or a coworker are being sexually harassed. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

V0000489EM
Sexual Harassment

Duration: 15 minutes

Objectives:
"Sexual Harassment... for Managers and Supervisors” DVD Program looks at behaviors and actions that can constitute sexual harassment, discusses why managers and supervisors must pay particular attention to what they say and do, and examines how to recognize sexual harassment in the workplace. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

V0000499EM
Fire Safety

Duration: 20 minutes

Objectives:
"Handling a Sexual Harassment Investigation” DVD Program looks at a company’s legal responsibility to prevent and deal with sexual harassment incidents, examines policies and procedures that should be followed when investigating allegations of sexual harassment and discusses how to interview apparent victims, alleged harassers and potential witnesses. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.
<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Duration</th>
<th>Objectives</th>
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<tbody>
<tr>
<td>V0000319EM</td>
<td>Fire Prevention &amp; Safety</td>
<td>22 minutes</td>
<td>&quot;Industrial Fire Prevention&quot; DVD Program looks at what causes industrial fires, and what can be done to prevent them. It reviews steps that can be taken to help prevent fires, as well as what employees should do in case of a fire emergency. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling &amp; attendance form, employee quiz, training certificate and training log.</td>
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<tr>
<td>V0000199EM</td>
<td>Office Ergonomics</td>
<td>21 minutes</td>
<td>&quot;Office Ergonomics&quot; DVD Program addresses how to recognize ergonomic problems, the potential of adverse effects, and practical solutions employees can use to help deal with ergonomic problems in the office. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling &amp; attendance form, employee quiz, training certificate and training log.</td>
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<tr>
<td>V0000329EM</td>
<td>Electrical Safety for the Trades Fire Prevention &amp; Safety</td>
<td>16 minutes</td>
<td>&quot;Fire Prevention in the Office&quot; DVD Program looks at what causes office fires, and what can be done to prevent them. It reviews steps that can be taken to help prevent fires, as well as what employees should do in case of a fire emergency. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling &amp; attendance form, employee quiz, training certificate and training log.</td>
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<tr>
<td>V0000209EM</td>
<td>Office Safety</td>
<td>22 minutes</td>
<td>&quot;Office Safety&quot; DVD Program shows employees what hazards exist in office environments, and how important it is to use good safety practices as they go about their work. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling &amp; attendance form, employee quiz, training certificate and training log.</td>
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<tr>
<td>V0000219EM</td>
<td>Computer Workstation Safety</td>
<td>18 minutes</td>
<td>&quot;The objective of &quot;Computer Workstation Safety&quot; DVD Program is for employees to learn the safe use of computers, and to offer practical solutions to many potential problems.</td>
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<tr>
<td>V000AIN9EM</td>
<td>Accident Investigation</td>
<td>13 minutes</td>
<td>The objective of &quot;Accident Investigation&quot; DVD Program is for employees to understand the steps that are taken in an accident investigation, and how important it is for employees to fully cooperate with any inquiry.</td>
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<tr>
<td>V0000139EM</td>
<td>Hazardous Labeling</td>
<td>21 minutes</td>
<td>&quot;Hazardous Materials Labels&quot; DVD Program is designed to help employees understand the characteristics of different labeling systems and the ways that each convey information. By recognizing the differences and similarities of these systems, employees will be better prepared to work safely around hazardous materials. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling &amp; attendance form, employee quiz, training log and training certificate.</td>
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<tr>
<td>V0000439EM</td>
<td>Back Safety</td>
<td>21 minutes</td>
<td>&quot;Back Safety&quot; DVD Program emphasizes the importance of overall back care, both at work and at home, including exercises and weight control. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling &amp; attendance form, employee...</td>
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**Compressed Gas Cylinders**

*Duration:* 12 minutes  
*Objectives:*  
"Compressed Gas Cylinders" DVD Program provides the information employees need to handle and transport these potentially volatile storage containers. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**Crane Safety**

*Duration:* 17 minutes  
*Objectives:*  
"Crane Safety" DVD Program points out to employees that over 90% of crane-related accidents are caused by human error... and that they are the key to preventing these incidents. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**Driving Safety**

*Duration:* 16 minutes  
*Objectives:*  
"Driving Safety" DVD Program provides the information employees need to drive cars, vans and small trucks safely, both on and off the job. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**Electrical Safety**

*Duration:* 15 minutes  
*Objectives:*  
"Electrical Safety" DVD Program reminds employees about electrical hazards they may face in their jobs, and provides the information they need to work safely around low voltage electricity. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**Hand & Power Tool Safety**

*Duration:* 18 minutes  
*Objectives:*  
"Hand and Power Tool Safety" DVD Program shows how accidents can be significantly reduced by applying good general safety rules, and reviews what hazards are associated with the specific types of tools employees use. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**Hand, Wrist & Finger Safety**

*Duration:* 13 minutes  
*Objectives:*  
"Hand, Wrist and Finger Safety" DVD Program reviews hand, wrist and finger hazards and helps employees to take the steps necessary to avoid them. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.
Ladder Safety

Duration: 12 minutes

Objectives:
"Ladder Safety" DVD Program shows that because they are so common, many employees take ladders for granted, and don’t take the appropriate precautions when using ladders. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

Machine Guard Safety

Duration: 20 minutes

Objectives:
"Machine Guard Safety" DVD Program is designed to help employees understand the dangers of working with machinery... and how those risks can be minimized by proper installation and use of safety guards and devices. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

Materials Handling Safety

Duration: 15 minutes

Objectives:
"Materials Handling Safety" DVD Program provides the information employees need to work safely when handling various types of materials. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

Rigging Safety

Duration: 13 minutes

Objectives:
"Rigging Safety" DVD Program points out to employees that over 90 percent of rigging-related accidents are caused by human error... and that they are the key to preventing these incidents. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

Safety Audits

Duration: 15 minutes

Objectives:
"Safety Audits" DVD Program informs employees about the goals of a Safety Audit, and how all workers should become involved. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

Accident Prevention

Duration: 13 minutes

Objectives:
"Safety Housekeeping and Accident Prevention" DVD Program demonstrates to employees how to prevent workplace accidents by paying attention to safety housekeeping considerations. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

Slips, Trips & Falls

Duration: 17 minutes

Objectives:
"Slips, Trips and Falls" DVD Program shows employees the situations that can lead to slips, trips & falls, and what they can do to avoid or prevent these accidents. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

Safety Showers & Eye Washes

Duration: 13 minutes

Objectives:
"Safety Showers and Eye Washes" DVD Program reviews for employees situations where safety showers and eye washes should be used, as well as how to properly use them. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

Workplace Stress

Duration: 13 minutes

Objectives:
"Workplace Stress" DVD Program helps employees identify potentially stressful situations and learn how to cope with them. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.
**V000WIN9EM**

**Winter Safety**

**Duration:** 13 minutes

**Objectives:**

"Winter Safety" DVD Program shows employees how to plan ahead, look for potential hazards and avoid dangerous situations that occur during the winter holiday season. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**V000VIL9EM**

**Workplace Violence**

**Duration:** 14 minutes

**Objectives:**

"Workplace Violence" DVD Program shows employees how to recognize the warning signs of possible violent behavior, as well as how to avoid or defuse potentially dangerous situations. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**V000WLD9EM**

**Welding Safety**

**Duration:** 14 minutes

**Objectives:**

"Welding Safety" DVD Program reminds employees that there are indeed a number of hazards associated with welding, and provides the information that they need to work safely when involved with welding operations. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

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**V000HST9EM**

**Heat Stress**

**Duration:** 12 minutes

**Objectives:**

"Heat Stress" DVD Program reviews how heat effects the body, the steps that employees can take to prevent heat stress, and elementary first aid that can be given to a worker who has been affected by a heat-related illness.

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**V000WIN9EM**

**Winter Safety**

**Duration:** 13 minutes

**Objectives:**

"Winter Safety" DVD Program shows employees how to plan ahead, look for potential hazards and avoid dangerous situations that occur during the winter holiday season. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**K0000469EM**

**Fire Prevention & Safety**

**Duration:** 18 minutes

**Objectives:**

"Using Fire Extinguishers" Safety Meeting Kit looks at why things burn, reviews the types of fire extinguishers that are found in facilities today, and discusses how to use fire extinguishers to fight small fires. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

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**K0000479EM**

**Sexual Harassment**

**Duration:** 16 minutes

**Objectives:**

"Sexual Harassment... for Employees" Safety Meeting Kit discusses various forms of sexual harassment, explains how to avoid inadvertently sexually harassing someone and reviews the procedures employees should follow if they feel that they or a coworker are being sexually harassed. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.
Health and Safety

**K0000489EM**

**Sexual Harassment**

**Duration:** 15 minutes

**Objectives:**
"Sexual Harassment... for Managers and Supervisors" Safety Meeting Kit (DVD) looks at behaviors and actions that can constitute sexual harassment, discusses why managers and supervisors must pay particular attention to what they say and do, and examines how to recognize sexual harassment in the workplace. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

**K0000499EM**

**Sexual Harassment**

**Duration:** 20 minutes

**Objectives:**
"Handling a Sexual Harassment Investigation" Safety Meeting Kit (DVD) looks at a company’s legal responsibility to prevent and deal with sexual harassment incidents, examines policies and procedures that should be followed when investigating allegations of sexual harassment and discusses how to interview apparent victims, alleged harassers and potential witnesses. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

**K000MGDVEM**

**Machine Guard Safety**

**Duration:** 19 minutes

**Objectives:**
"Machine Guard Safety" Safety Meeting Kit™ is designed to help employees understand the dangers of working with machinery... and how those risks can be minimized by proper installation and use of safety guards and devices. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

**K000MHSVEM**

**Materials Handling Safety**

**Duration:** 15 minutes

**Objectives:**
"Materials Handling Safety" Safety Meeting Kit™ provides the information employees need to work safely when handling various types of materials. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

**K000EELCVEM**

**Electrical Safety**

**Duration:** 15 minutes

**Objectives:**
"Electrical Safety" Safety Meeting Kit™ reminds employees about electrical hazards they may face in their jobs, and provides the information they need to work safely around low voltage electricity. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

**K000FALVEM**

**Fall Protection**

**Duration:** 12 minutes

**Objectives:**
"Fall Protection" Safety Meeting Kit™ provides the information employees need to work safely when they are "off the ground", and help to satisfy the major training requirements in the OSHA Standard on Fall Protection. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.
**Driving Safety**

**Duration:** 16 minutes

**Objectives:**
"Driving Safety" Safety Meeting Kit™ provides the information employees need to drive cars, vans and small trucks safely, both on and off the job. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

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**Welding Safety**

**Duration:** 14 minutes

**Objectives:**
"Welding Safety" Safety Meeting Kit™ reminds employees that there are indeed a number of hazards associated with welding, and provides the information that they need to work safely when involved with welding operations. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

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**Workplace Violence**

**Duration:** 14 minutes

**Objectives:**
"Workplace Violence" Safety Meeting Kit™ shows employees how to recognize the warning signs of possible violent behavior, as well as how to avoid or defuse potentially dangerous situations. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

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**Accident Investigation**

**Duration:** 13 minutes

**Objectives:**
"Accident Investigation" Safety Meeting Kit™ shows employees steps that are taken in an accident investigation, and highlights how important it is for employees to fully cooperate with any inquiry. It also points out that while an investigation’s focus is to determine the cause of an accident, the overall goal is to prevent similar accidents from happening again. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

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**Safety Audits**

**Duration:** 15 minutes

**Objectives:**
"Safety Audits" Safety Meeting Kit™ informs employees about the goals of a Safety Audit, and how all workers should become involved. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

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**Crane Safety**

**Duration:** 17 minutes

**Objectives:**
"Crane Safety" Safety Meeting Kit™ points out to employees that over 90% of crane-related accidents are caused by human error... and that they are the key to preventing these incidents. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

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**Rigging Safety**

**Duration:** 19 minutes

**Objectives:**
"Rigging Safety" Safety Meeting Kit™ points out to employees that over 90 percent of rigging-related accidents are caused by human error... and that they are the key to preventing these incidents. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

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**Back Safety**

**Duration:** 21 minutes

**Objectives:**
"Back Safety" Safety Meeting Kit™ emphasizes the importance of overall back care, both at work and at home, including exercises and weight control. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

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**Slips, Trips & Falls**

**Duration:** 17 minutes

**Objectives:**
"Slips, Trips and Falls" Safety Meeting Kit™ shows employees the situations that can lead to slips, trips & falls, and what they can do to avoid or prevent these accidents. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.
Hand & Power Tool Safety

Duration: 18 minutes

Objectives:
"Hand and Power Tool Safety" Safety Meeting Kit™ shows how accidents can be significantly reduced by applying good general safety rules, and reviews what hazards are associated with the specific types of tools employees use. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

Accident Prevention

Duration: 13 minutes

Objectives:
"Safety Housekeeping and Accident Prevention" Safety Meeting Kit™ demonstrates to employees how to prevent workplace accidents by paying attention to safety housekeeping considerations. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

Office Safety

Duration: 22 minutes

Objectives:
"Office Safety" Safety Meeting Kit™ shows employees what hazards exist in office environments, and how important it is to use good safety practices as they go about their work. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

Fitness & Wellness

Duration: 13 minutes

Objectives:
"Wellness and Fitness" Safety Meeting Kit™ shows employees how small changes in lifestyles can produce big benefits. While wellness is a gradual process, eliminating negative lifestyle factors can help keep employees healthy. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

Ladder Safety

Duration: 12 minutes

Objectives:
"Ladder Safety" Safety Meeting Kit™ shows that because they are so common, many employees take ladders for granted, and don’t take the appropriate precautions when using ladders. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.
**Workplace Stress**

*Duration:* 13 minutes

*Objectives:*

“Workplace Stress” Safety Meeting Kit™ helps employees identify potentially stressful situations and learn how to cope with them. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

**Heat Stress**

*Duration:* 12 minutes

*Objectives:*

“Heat Stress” Safety Meeting Kit™ reviews how heat affects the body, the steps that employees can take to prevent Heat Stress, and elementary first aid that can be given to a worker who has been affected by a heat-related illness. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

**Computer Workstation Safety**

*Duration:* 18 minutes

*Objectives:*

“Computer Workstation Safety” Safety Meeting Kit™ reviews the safe use of computers and offers practical solutions to many potential problems. Materials in the kit include a video program, five motivational posters, and 30 booklets. The video program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

**Spill Cleanup**

*Duration:* 23 minutes

*Objectives:*

“Dealing With Hazardous Spills” Safety Meeting Kit™ is designed to help employees who seldom have to face the dangers of a hazardous spill deal with a cleanup situation. Materials in the kit include a video program, five motivational posters, and 30 employee booklets. The video program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

**Hazardous Labeling**

*Duration:* 22 minutes

*Objectives:*

“Hazardous Materials Labels” Safety Meeting Kit™ is designed to help employees understand the characteristics of different labeling systems and the ways that each convey information. By recognizing the differences and similarities of these systems, employees will be better prepared to work safely around hazardous materials. Materials in the kit include a video program, five motivational posters, and 30 employee booklets. The posters in the kit emphasize the importance of container labeling. The video program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.
Health and Safety

and the ways that each convey information. By recognizing the differences and similarities of these systems, employees will be better prepared to work safely around hazardous materials. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets. The posters in the kit emphasize the importance of container labeling. The DVD program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

**K0000199EM**

**Office Ergonomics**

**Duration:** 21 minutes

**Objectives:**
"Office Ergonomics” Safety Meeting Kit™ addresses how to recognize ergonomic problems, the potential of adverse effects, and practical solutions employees can use to help deal with ergonomic problems in the office. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

**K0000209EM**

**Office Safety**

**Duration:** 22 minutes

**Objectives:**
"Office Safety” Safety Meeting Kit™ shows employees what hazards exist in office environments, and how important it is to use good safety practices as they go about their work. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

**K0000219EM**

**Computer Workstation Safety**

**Duration:** 18 minutes

**Objectives:**
"Computer Workstation Safety” Safety Meeting Kit™ reviews the safe use of computers and offers practical solutions to many potential problems. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets. The DVD program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

**K000AIN9EM**

**Accident Investigation**

**Duration:** 13 minutes

**Objectives:**
"Accident Investigation” Safety Meeting Kit™ shows employees steps that are taken in an accident investigation, and highlights how important it is for employees to fully cooperate with any inquiry. It also points out that while an investigation’s focus is to determine the cause of an accident, the overall goal is to prevent similar accidents from happening again. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

**K000CGC9EM**

**Compressed Gas Cylinders**

**Duration:** 12 minutes

**Objectives:**
"Compressed Gas Cylinders” Safety Meeting Kit™ provides the information employees need to handle and transport these potentially volatile storage containers. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

**K000CST9EM**

**Crane Safety**

**Duration:** 17 minutes

**Objectives:**
"Crane Safety” Safety Meeting Kit™ points out to employees that over 90% of crane-related accidents are caused by human error... and that they are the key to preventing these incidents. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

**K000DRV9EM**

**Driving Safety**

**Duration:** 16 minutes

**Objectives:**
"Driving Safety” Safety Meeting Kit™ provides the information employees need to drive cars, vans and small trucks safely, both on and off the job. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

**K000ELC9EM**

**Electrical Safety**

**Duration:** 15 minutes

**Objectives:**
"Electrical Safety” Safety Meeting Kit™ reminds employees about electrical hazards they may face in their jobs, and provides the information they need to work safely around low voltage electricity. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

**K000ERG9EM**

**Industrial Ergonomics**

**Duration:** 13 minutes
Objectives: "Industrial Ergonomics" Safety Meeting Kit™ covers recognizing ergonomic problems, potential adverse effects and pragmatic solutions employees can use to address these problems. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000EYE9EM

Eye Safety

Duration: 13 minutes

Objectives: "Eye Safety" Safety Meeting Kit™ shows how many eye problems are caused by not paying attention to the work employees are doing, or by not wearing the appropriate protective equipment. It reminds employees that eye injuries can easily happen to them and shows them how to prevent these injuries. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000FAL9EM

Fall Protection

Duration: 12 minutes

Objectives: "Fall Protection" Safety Meeting Kit™ provides the information employees need to work safely when they are "off the ground", and satisfies the major training requirements in the OSHA Standard on Fall Protection. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K0000449EM

Hand & Power Tool Safety

Duration: 18 minutes

Objectives: "Hand and Power Tool Safety" Safety Meeting Kit™ shows how accidents can be significantly reduced by applying good general safety rules, and reviews what hazards are associated with the specific types of tools employees use. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000HST9EM

Heat Stress

Duration: 12 minutes

Objectives: "Heat Stress" Safety Meeting Kit™ reviews how heat affects the body, the steps that employees can take to prevent heat stress, and elementary first aid that can be given to a worker who has been affected by a heat-related illness. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000HWF9EM

Hand, Wrist & Finger Safety

Duration: 13 minutes

Objectives: "Hand, Wrist and Finger Safety" Safety Meeting Kit™ reviews hand, wrist and finger hazards and helps employees to take the steps necessary to avoid them. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000LAD9EM

Ladder Safety

Duration: 12 minutes

Objectives: "Ladder Safety" Safety Meeting Kit™ shows that because they are so common, many employees take ladders for granted, and don’t take the appropriate precautions when using ladders. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000MAS9EM

ANSI MSDS

Duration: 13 minutes

Objectives: "The ANSI Material Safety Data Sheet" Safety Meeting Kit™ has been specifically created to educate employees about the ANSI MSDS format. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000MGD9EM

Machine Guard Safety

Duration: 19 minutes

Objectives: "Machine Guard Safety" Safety Meeting Kit™ is designed to help employees understand the dangers of working with machinery... and how those risks can be minimized by proper installation and use of safety guards and devices. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000MHS9EM

Materials Handling Safety

Duration: 15 minutes

Objectives: "Materials Handling Safety" Safety Meeting Kit™ provides the information employees need to work safely when handling various types of materials. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.
**K000SHK9EM**  
*Accident Prevention*

**Duration:** 18 minutes  
**Objectives:**  
"Safety Housekeeping and Accident Prevention" Safety Meeting Kit™ demonstrates to employees how to prevent workplace accidents by paying attention to safety housekeeping considerations. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

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**K0000429EM**  
*Slips, Trips & Falls*

**Duration:** 17 minutes  
**Objectives:**  
"Slips, Trips and Falls" Safety Meeting Kit™ shows employees the situations that can lead to slips, trips & falls, and what they can do to avoid or prevent these accidents. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

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**K000SSE9EM**  
*Safety Showers & Eye Washes*

**Duration:** 13 minutes  
**Objectives:**  
"Safety Showers and Eye Washes" Safety Meeting Kit™ reviews for employees situations where safety showers and eye washes should be used, as well as how to properly use them. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

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**K000STR9EM**  
*Workplace Stress*

**Duration:** 13 minutes  
**Objectives:**  
"Workplace Stress" Safety Meeting Kit™ helps employees identify potentially stressful situations and learn how to cope with them. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

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**K000VIL9EM**  
*Workplace Violence*

**Duration:** 14 minutes  
**Objectives:**  
"Workplace Violence" Safety Meeting Kit™ shows employees how to recognize the warning signs of possible violent behavior, as well as how to avoid or defuse potentially dangerous situations. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.
K000032VEM

Fire Prevention & Safety

Duration: 22 minutes

Objectives:
"Fire Prevention in the Office" Safety Meeting Kit™ looks at what causes office fires, and what can be done to prevent them. It reviews steps that can be taken to help prevent fires, as well as what employees should do in case of a fire emergency. The materials in the kit include a videotape program, five motivational posters and 30 employee booklets.

K0000329EM

Fire Prevention & Safety

Duration: 22 minutes

Objectives:
"Fire Prevention in the Office" Safety Meeting Kit™ looks at what causes office fires, and what can be done to prevent them. It reviews steps that can be taken to help prevent fires, as well as what employees should do in case of a fire emergency. The materials in the kit include a DVD program, five motivational posters and 30 employee booklets.

Laboratory Safety DVDs

V000SSE9EL

Safety Showers & Eye Washes

Duration: 8 minutes

Objectives:
"Safety Showers and Eye Washes in the Laboratory" DVD Program reviews the correct ways to use this equipment, and emphasizes the need for quick action after a chemical splash or spill in a laboratory. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log. This DVD program is one of 12 in the Laboratory Safety Training Series.

V000OLER9EL

Laboratory Ergonomics

Duration: 12 minutes

Objectives:
"Laboratory Ergonomics” DVD Program discusses the need to set up work areas correctly, as well as how to minimize the strain of using laboratory equipment, tools and instruments. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log. This DVD program is one of 12 in the Laboratory Safety Training Series.

V000OLS9EL

Laboratory Safety Orientation

Duration: 11 minutes

Objectives:
"Orientation to Laboratory Safety” DVD Program shows both new employees and "seasoned veterans" the importance of safety in the laboratory... as well as reviews the OSHA regulations and good safety practices that apply to laboratory environments. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log. This DVD program is one of 12 in the Laboratory Safety Training Series.

V000MAT9EL

ANSI MSDS

Duration: 15 minutes

Objectives:
"Material Safety Data Sheets in the Laboratory” DVD Program reviews the various sections of the MSDS, what information can be found in each section and most importantly, how this information can help employees to work safely in their laboratory. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log. This DVD Program is one of 12 in the Laboratory Safety Training Series.

V000PCN9EL

Preventing Contamination

Duration: 10 minutes

Objectives:
"Preventing Contamination in the Laboratory" Program emphasizes the need to recognize situations that could led to contamination, and discusses what can be done to prevent contamination from occurring.

K000SHK9EM

Accident Prevention

Duration: 18 minutes

The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log. This DVD program is one of 12 in the Laboratory Safety Training Series.
Objectives:
“Safety Housekeeping and Accident Prevention” Safety Meeting Kit™ demonstrates to employees how to prevent workplace accidents by paying attention to safety housekeeping considerations. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K0000429EM
Slips, Trips & Falls
Duration: 17 minutes
Objectives:
“Slips, Trips and Falls” Safety Meeting Kit™ shows employees the situations that can lead to slips, trips & falls, and what they can do to avoid or prevent these accidents. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000SSE9EM
Safety Showers & Eye Washes
Duration: 13 minutes
Objectives:
“Safety Showers and Eye Washes” Safety Meeting Kit™ reviews for employees situations where safety showers and eye washes should be used, as well as how to properly use them. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000STR9EM
Workplace Stress
Duration: 13 minutes
Objectives:
“Workplace Stress” Safety Meeting Kit™ helps employees identify potentially stressful situations and learn how to cope with them. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000VIL9EM
Workplace Violence
Duration: 14 minutes
Objectives:
“Materials Handling Safety” Safety Meeting Kit™ provides the information employees need to work safely when handling various types of materials. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

V000LEM9EL
Laboratory Emergencies
Duration: 15 minutes
Objectives:
“Planning for Laboratory Emergencies” DVD Program discusses how to minimize damage and prevent injuries if a laboratory emergency should occur. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log. This DVD program is one of 12 in the Laboratory Safety Training Series.

V000GLS9EL
Laboratory Glassware
Duration: 13 minutes
Objectives:
“Safe Handling of Laboratory Glassware” DVD Program discusses the nature of various types of glassware, and the problems it can cause... as well as the need for employees to use and maintain laboratory glassware safely. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log. This DVD program is one of 12 in the Laboratory Safety Training Series.

V000FOR9EL
Formaldehyde Standard
Duration: 13 minutes
Objectives:
“The OSHA Formaldehyde Standard” DVD Program provides training that is required by this standard, focusing on the rules and procedures that the standard establishes for working with this potentially dangerous chemical. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log. This DVD program is one of 12 in the Laboratory Safety Training Series.

V000FEX9EL
Flammables & Explosives
Duration: 12 minutes
Objectives:
“Flammables and Explosives in the Laboratory” DVD Program discusses the nature of flammable and explosive materials, as well as hazards associated with their use. It also reviews the proper handling procedures and personal protective equipment that should be used when working with these substances. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log. This DVD program is one of 12 in the Laboratory Safety Training Series.
### Electrical Safety

**Duration:** 12 minutes

**Objectives:**
"Electrical Safety in the Laboratory" DVD Program emphasizes the need for safety when using electricity, and discusses how to reduce the potential for accidents involving electrical shock, fire and explosions. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log. This DVD program is one of 12 in the Laboratory Safety Training Series.

### Laboratory Safety

**Duration:** 147 minutes

**Objectives:**
“Elements of Safety” Laboratory Safety DVD Training Series contains 12 DVD programs covering a wide range of safety methods, practices and tools that are needed in today’s laboratory environments. Each DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

### Compressed Gas Cylinders

**Duration:** 13 minutes

**Objectives:**
"Handling Compressed Gas Cylinders in the Laboratory" DVD Program examines how gas cylinders "work", the hazards that are associated with them and the need for caution when using or storing a cylinder. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log. This DVD program is one of 12 in the Laboratory Safety Training Series.

### Laboratory Hoods

**Duration:** 13 minutes

**Objectives:**
"Laboratory Hoods" DVD Program emphasizes how to properly use laboratory hoods and how to test them to ensure correct functioning... as well as discusses how hoods can protect an experiment, the facility, and most importantly, the employee. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log. This DVD program is one of 12 in the Laboratory Safety Training Series.

### DOT General Awareness

**Duration:** 17 minutes

**Objectives:**
"DOT HAZMAT General Awareness" DVD Program focuses on employees who handle hazardous materials. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

### DOT Safety Training

**Duration:** 18 minutes

**Objectives:**
"DOT HAZMAT Safety Training" DVD Program focuses on employees who handle hazardous materials. The program makes employees aware of the hazards associated with the materials they handle... and shows them how to work with these materials safely. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

### DOT Security Awareness

**Duration:** 13 minutes

**Objectives:**
"DOT HAZMAT Security Awareness" DVD Program focuses on employees who handle hazardous materials and making them aware of the security risks associated with transporting hazardous materials.

### DOT In-Depth Security

**Duration:** 16 minutes

**Objectives:**
"DOT HAZMAT In-Depth Security" DVD Program focuses on employees who handle hazardous materials and making them aware of the risks associated with transporting hazardous materials, giving them a good understanding of what is addressed in their facility’s HAZMAT Security Plan.
**OSHA Recordkeeping**

**Duration:** 20 minutes

**Objectives:**
"OSHA Recordkeeping for Managers and Supervisors” DVD Program helps facilities comply with OSHA’s Recordkeeping regulation (29 CFR Part 1904). It covers the details of the regulation’s requirements and shows actual workplace incidents that demonstrate what a manager’s responsibilities are in documenting and reporting recordable accidents. The program can be used in conjunction with the MARCOM’s DVD program “OSHA Recordkeeping for Employees” to train workers at all levels, and provide them with a common base of understanding about OSHA’s Recordkeeping requirements. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

**Asbestos Awareness**

**Duration:** 14 minutes

**Objectives:**
"Asbestos Awareness” DVD Program has been created specifically to educate employees about the dangers of working with materials that may contain asbestos. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Bloodborne Pathogens**

**Duration:** 24 minutes

**Objectives:**
"Bloodborne Pathogens in Commercial and Light Industrial Facilities" DVD Program has been specifically created to assist facilities in fulfilling the OSHA Bloodborne Pathogens Standard’s (29 CFR Part 1910.1030) training requirements. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Bloodborne Pathogens Retraining**

**Duration:** 17 minutes

**Objectives:**
"Bloodborne Pathogens” DVD Retraining Program gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Bloodborne Pathogens in Heavy Industry**

**Duration:** 24 minutes

**Objectives:**
"Bloodborne Pathogens in Heavy Industry” DVD Program has been specifically created to assist companies in fulfilling the OSHA Bloodborne Pathogens Standard’s (29 CFR Part 1910.1030) training requirements. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Indoor Air Quality**

**Duration:** 13 minutes

**Objectives:**
"Indoor Air Quality” DVD Program shows employees the potentially harmful effects of poor air quality, and will help them prevent, identify and correct air quality problems. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.
**V000B3F9EO**

**Bloodborne Pathogens**

**Duration:** 26 minutes

**Objectives:**

"Bloodborne Pathogens in First Response Environments" DVD Program has been specifically created to assist facilities in fulfilling the OSHA Bloodborne Pathogens Standard’s (29 CFR Part 1910.1030) training requirements. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**V000B3H9EO**

**Bloodborne Pathogens**

**Duration:** 27 minutes

**Objectives:**

"Bloodborne Pathogens in Healthcare Facilities" DVD Program has been specifically created to assist facilities in fulfilling the OSHA Bloodborne Pathogens Standard’s (29 CFR Part 1910.1030) training requirements. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**V000CFS9ER**

**Confined Space Entry**

**Duration:** 15 minutes

**Objectives:**

"Confined Space Entry" DVD Retraining Program gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**V000CHM9ER**

**Right-To-Know**

**Duration:** 17 minutes

**Objectives:**

"Right-To-Know" DVD Retraining Program gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The program reviews highlights of the OSHA regulation and reminds employees of the importance of compliance. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**V000CSE9EC**

**Confined Space Entry**

**Duration:** 19 minutes

**Objectives:**

"Confined Space Entry" DVD Program addresses the major areas of employee training required by the regulation. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**V000EPL9EX**

**Emergency Planning**

**Duration:** 13 minutes

**Objectives:**

Emergency Planning” DVD Program assists facilities in complying with various federal and state regulations and helps them prepare for potential emergency situations. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**V000FOD9EO**

**Right-To-Know**

**Duration:** 34 minutes

**Objectives:**

"Right-To-Know for the Food Retailing Industry” DVD Program both introduces employees to the "Right-To-Know” regulations and provides training on various groups of chemicals found in the food retailers environment. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

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**V000HES9EO**

**Hearing Conservation**

**Duration:** 17 minutes

**Objectives:**

"Hearing Conservation and Safety” DVD Program has been created specifically to involve employees in the process of understanding noise hazards and to help facilities in fulfilling the OSHA Occupational Noise Exposure and Hearing Protection Standard (29 CFR.1910.95) training requirements. The DVD program reviews why employees should pay attention to “noise” hazards, and how they can protect themselves from hearing injuries. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.
**V000K2S9EO**

**Forklift/Powered Industrial Truck Safety**

**Duration:** 25 minutes

**Objectives:**
"Forklift/Powered Industrial 'Truck Safety' DVD Program has been specifically created to involve employees in the process of understanding forklift operation and to help facilities in fulfilling the OSHA Powered Industrial Truck Standard (29 CFR,1910.178) training requirements. The DVD program reviews how to inspect forklifts and other powered industrial truck equipment prior to operation, safe operating procedures, forklift stability, and how to recognize potential problem situations. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**V000LDS9ER**

**Lead Standard**

**Duration:** 15 minutes

**Objectives:**
"OSHA Lead Standards” DVD Retraining Program gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**V000LAS9EO**

**Laboratory Standard**

**Duration:** 22 minutes

**Objectives:**
"The OSHA Laboratory Standard” DVD Program addresses the three major areas needed to comply with the standard... general information about the standard itself, commonly used chemicals and safe chemical handling. The DVD comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**V000LDS9ER**

**Lead Standard**

**Duration:** 13 minutes

**Objectives:**
"OSHA Laboratory Standard” DVD Retraining Program gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**V000LDR9EO**

**Lock-Out/Tag-Out**

**Duration:** 22 minutes

**Objectives:**
"Lock-Out/Tag-Out" DVD Program has been created specifically to assist facilities in complying with the employee training requirements of OSHA’s "Lock-Out/Tag-Out” regulation. This program discusses the OSHA Lock-Out/Tag-Out Standard, including the Energy Control Plan. The program uses environments which are familiar to employees working with both electric and hydraulic/pneumatic equipment and points out specifically where lock-out/tag-out procedures should be applied. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**V000LTR9ER**

**Lock-Out/Tag-Out**

**Duration:** 14 minutes

**Objectives:**
"Lock-Out/Tag-Out” DVD Retraining Program gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The program reviews highlights of the OSHA regulation and reminds employees of the importance of compliance. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.
**Suspended Scaffolding**

**Duration:** 20 minutes

**Objectives:**
"Suspended Scaffolding Safety" DVD Program assists facilities of all types in complying with OSHA's Scaffolding regulation (29 CFR 1926.451), and helps employees understand the dangers of working with scaffolds, and how these risks can be minimized by knowing the correct ways to erect, maintain and use scaffolding equipment. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Personal Protective Equipment**

**Duration:** 25 minutes

**Objectives:**
"Personal Protective Equipment" DVD Program has been created specifically to involve employees in the process of understanding the proper use of personal protective equipment and to help facilities in fulfilling OSHA's Personal Protective Equipment Standards (29 CFR,1910. 132, 133, 134,135,136,137,138) training requirements. The DVD program looks at why personal protective equipment is so important and reminds employees of what is available. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Right-To-Know**

**Duration:** 21 minutes

**Objectives:**
"Right-To-Know for Auto Service Facilities" DVD Program has been created specifically to assist auto service facilities of all types in complying with Federal, state and municipal "Right-To-Know" regulations. This DVD program also addresses the major education and training requirements in these "chemical hazard" laws. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Right-To-Know**

**Duration:** 21 minutes

**Objectives:**
"Right-To-Know for Building and Construction Companies" DVD Program has been created specifically to assist building and construction companies of all types in complying with Federal, state and municipal "Right-To-Know" regulations, this program also addresses the major education and training requirements in these "chemical hazard" laws. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Right-To-Know**

**Duration:** 21 minutes

**Objectives:**
"Right-To-Know for Cleaning and Maintenance Operations" DVD Program has been created specifically to assist cleaning and maintenance operations of all types in complying with Federal, state and municipal "Right-To-Know" regulations. This program also addresses the major education and training requirements in these "chemical hazard" laws. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Right-To-Know**

**Duration:** 21 minutes

**Objectives:**
"Right-To-Know for Healthcare Facilities" DVD Program has been created specifically to assist industrial facilities of all types in complying with Federal, state and municipal "Right-To-Know" regulations. This program also addresses the major education and training requirements in these "chemical hazard" laws. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Right-To-Know**

**Duration:** 21 minutes

**Objectives:**
"Right-To-Know for the Hospitality Industry" DVD Program both introduces employees to "Right-To-Know" regulations and provides training on the various types of chemicals found in hospitality environments. Created specifically to assist industrial facilities of all types in complying with Federal, state and municipal "Right-To-Know" regulations. This program also addresses the major education and training requirements in these "chemical hazard" laws.
Right-To-Know

Duration: 21 minutes

Objectives:
"Right-To-Know for Industrial Facilities" DVD Program has been created specifically to assist industrial facilities of all types in complying with Federal, state and municipal "Right-To-Know" regulations. This program also addresses the major education and training requirements in these "chemical hazard" laws.

Supported Scaffolding

Duration: 23 minutes

Objectives:
"Supported Scaffolding Safety" DVD Program assists facilities of all types in complying with OSHA’s Scaffolding regulation (29 CFR 1926.451), and helps employees understand the dangers of working with scaffolds, and how these risks can be minimized by knowing the correct ways to erect, maintain and use scaffolding equipment. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

Tuberculosis

Duration: 18 minutes

Objectives:
"Tuberculosis in the First Responder Environment" DVD Program includes recent changes in respiratory protection requirements. The program is designed to assist facilities and operations whose employees have a risk of exposure to tuberculosis. The DVD program also helps employees understand the nature of the disease, as well as what they can do to protect themselves from infection. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

Accidental Release Measures & Spill Cleanup Procedures

Duration: 20 minutes

Objectives:
"Accidental Release Measures and Spill Cleanup Procedures" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees understand the plans and procedures necessary to safely contain and cleanup a hazardous materials spill. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.

Personal Protective Equipment

Duration: 18 minutes

Objectives:
"Personal Protective Equipment" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps instruct employees on the selection and use of personal protective equipment (such as chemical protective clothing and respirators) in environments where hazardous materials are present. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.
**Confined Space Entry**

**Duration:** 21 minutes

**Objectives:**
"Confined Space Entry" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees understand how to reduce or eliminate potential exposure to hazardous materials in their confined space work environments. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. This program can be used as the basis for approximately two hours of classroom training.

**Dealing with the Media**

**Duration:** 14 minutes

**Objectives:**
"Dealing With the Media in Emergency Situations" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and instructs employees on the proper ways of interacting with the media during an emergency situation. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. This program can be used as the basis for approximately two hours of classroom training.

**Decontamination Procedures**

**Duration:** 18 minutes

**Objectives:**
"Decontamination Procedures" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and instructs employees on the proper ways of interacting with the media during an emergency situation. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. This program can be used as the basis for approximately two hours of classroom training.

**Emergency Response**

**Duration:** 15 minutes

**Objectives:**
"The Emergency Response Plan" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and instructs employees who deal with hazardous materials why planning for emergencies is critical for their safety. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. This program can be used as the basis for approximately two hours of classroom training.

**Work Practices and Engineering Controls**

**Duration:** 18 minutes

**Objectives:**
"Work Practices and Engineering Controls" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees understand the nature and the "behavior" of hazardous chemicals, and reduce or eliminate potential exposure to hazardous materials in their work environments. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. This program can be used as the basis for approximately two hours of classroom training.
program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. This program can be used as the basis for approximately two hours of classroom training.

**V000FPS9EW**

**Fire Prevention & Safety**

*Duration:* 21 minutes  
*Objectives:*  
"Fire Prevention" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees understand the hazards of fire when combined with hazardous materials. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.

**V000HAL9EW**

**HAZMAT Labeling**

*Duration:* 21 minutes  
*Objectives:*  
"HAZMAT Labeling" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and instructs employees who deal with hazardous materials that they can reduce the risk of accidental exposure by using the correct labels and placards on each chemical container. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.

**V000HST9EW**

**Heat Stress**

*Duration:* 19 minutes  
*Objectives:*  
"Heat Stress" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees understand the need to guard against heat-related illnesses and what steps they can take to protect themselves in their work environments. The DVD program comes with a comprehensive leader's guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.

**V000HZ19EW**

**HAZWOPER 8 Hour Annual Retraining Package**

*Duration:* 85 minutes  
*Objectives:*  
"HAZWOPER Annual Retraining Package" assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees avoid exposure to hazardous materials. The package of four "refresher" DVD programs is designed to provide the core content for OSHA’s 8 Hour "annual retraining" requirement. The programs include "Introduction to HAZWOPER Retraining”, "Personal Protective Equipment and Decontamination Procedures”, "Understanding Chemical Hazards”, and “Exposure Monitoring and Medical Surveillance.” Each DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. Each Program can be used as the basis for approximately two hours of classroom training.

**V000HZ29EW**

**HAZWOPER General Training Package**

*Duration:* 252 minutes  
*Objectives:*  
"HAZWOPER General Training Package" assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees avoid exposure to hazardous chemicals. The package of twelve DVD programs provides the basis for the 24 Hour training required by OSHA for HAZMAT employees who are unlikely to be exposed to hazards in excess of permissible exposure limits. The programs include "Decontamination Procedures", "Understanding Chemical Hazards", "The Emergency Response Plan", "Understanding HAZWOPER”, "HAZMAT Labeling”, "Personal Protective Equipment”, "Medical Surveillance Programs”, "Confined Space Entry", "Monitoring Procedures and Equipment”, "Accidental Release Measures and Spill Cleanup Procedures", "Handling Hazardous Materials", and "Work Practices and Engineering Controls." Each DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. Each Program can be used as the basis for approximately two hours of classroom training.

**V000HZ39EW**

**HAZWOPER Complete 40 Hour Training Package**

*Duration:* 387 minutes  
*Objectives:*  
"HAZWOPER Complete 40 Hour Training Package" assists facilities in complying with the employee training requirements of OSHA’s
HAZWOPER regulation (29 CFR 1910.120), and helps employees avoid exposure to hazardous materials. The package of 20 DVD programs provides the comprehensive information needed by employees who are exposed to hazardous substances as a routine part of their jobs, the people who supervise and manage them, as well as HAZMAT "Incident Commanders". The programs include "Understanding HAZWOPER", "Understanding Chemical Hazards", "The Emergency Response Plan", "The Site Safety and Health Plan", "HAZWOPER Labeling", "Confined Space Entry", "Personal Protective Equipment", "Medical Surveillance Programs", "Monitoring Procedures and Equipment", "Accidental Release Measures and Spill Cleanup Procedures", "ANSI MSDS", "Handling Hazardous Materials", "Work Practices and Engineering Controls", "Respiratory Protection", "Fire Prevention", "Dealing with the Media in Emergency Situations", "Safety Orientation", "Electrical Safety in HAZMAT Environments", "Heat Stress", and "Decontamination Procedures." Each DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. Each program can be used as the basis for approximately two hours of classroom training.

**V000HZ49EW**

**HAZWOPER All 23 Programs**

**Duration:** 451 minutes

**Objectives:**

"All 23 HAZWOPER DVD Programs" assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees avoid exposure to hazardous materials. The package of 23 DVD programs provides the comprehensive information needed by employees who are exposed to hazardous substances as a routine part of their jobs, the people who supervise and manage them, as well as HAZMAT "Incident Commanders". The programs include "Introduction to HAZWOPER Retraining", "Personal Protective Equipment and Decontamination Procedures", "Exposure Monitoring and Medical Surveillance", "Understanding HAZWOPER", "Understanding Chemical Hazards", "The Emergency Response Plan", "The Site Safety and Health Plan", "HAZWOPER Labeling", "Confined Space Entry", "Personal Protective Equipment", "Medical Surveillance Programs", "Monitoring Procedures and Equipment", "Accidental Release Measures and Spill Cleanup Procedures", "ANSI MSDS", "Handling Hazardous Materials", "Work Practices and Engineering Controls", "Respiratory Protection", "Fire Prevention", "Dealing with the Media in Emergency Situations", "Safety Orientation", "Electrical Safety in HAZMAT Environments", "Heat Stress", and "Decontamination Procedures." Each DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. Each program can be used as the basis for approximately two hours of classroom training.

**V000HZ69EW**

**HAZWOPER Emergency Response: Awareness Package**

**Duration:** 41 minutes

**Objectives:**

"HAZWOPER Emergency Response" Awareness Package assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees avoid exposure to hazardous materials. The package of two DVD programs thoroughly covers information that every HAZMAT worker should know. The Programs include "Understanding HAZWOPER", and "The Emergency Response Plan." Each DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. Each program can be used as the basis for approximately two hours of classroom training.

**V000HZ79EW**

**HAZWOPER Emergency Response: Operations Package**

**Duration:** 80 minutes

**Objectives:**

"HAZWOPER Emergency Response: Operations Package" assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees avoid exposure to hazardous materials. The package of four DVD programs is aimed at workers who contain HAZMAT releases. The programs include "Understanding HAZWOPER", "Personal Protective Equipment", "The Emergency Response Plan", and "Accidental Release Measures and Spill Cleanup Procedures." Each DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. Each program can be used as the basis for approximately two hours of classroom training.
HAZWOPER Supplemental Training Package

**Duration:** 154 minutes

**Objectives:**
"HAZWOPER Supplemental Training Package" assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees avoid exposure to hazardous materials. The package of eight DVD programs provides the basis for the 16-hours of additional training needed by workers who must wear respirators in their jobs, or who already had general 24-hour training and are moving to jobs requiring complete 40-hour training. The programs include "Safety Orientation", "ANSI MSDS", "Heat Stress", "Fire Prevention", "The Emergency Response Plan", "The Site Safety and Health Plan", "Dealing with the Media in Emergency Situations", and "Electrical Safety in HAZMAT Environments." Each DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. Each program can be used as the basis for approximately two hours of classroom training.

Understanding HAZWOPER

**Duration:** 26 minutes

**Objectives:**
"Understanding HAZWOPER" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), explains the regulations, and helps employees reduce or eliminate potential exposure to hazardous materials in their work environments. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.

HAZWOPER Retraining

**Duration:** 24 minutes

**Objectives:**
"Introduction to HAZWOPER Retraining" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and reminds employees who deal with hazardous materials of the importance of identifying, evaluating and controlling chemical hazards. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.

ANSI MSDS

**Duration:** 22 minutes

**Objectives:**
"The ANSI Material Safety Data Sheet” HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps instruct employees about the ANSI MSDS format and reviews how the information in an MSDS can help them work safely with potentially hazardous chemicals. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.

Medical Surveillance Programs

**Duration:** 11 minutes

**Objectives:**
"Medical Surveillance Program" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and discusses various types of "medical surveillance" and how it is used to evaluate the health of anyone who regularly works around hazardous materials. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.

Handling Hazardous Materials

**Duration:** 23 minutes

**Objectives:**
"Handling Hazardous Materials" HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and instructs employees on how to work safely with the chemicals that they encounter in their jobs. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.
Monitoring Procedures & Equipment

**Duration:** 18 minutes

**Objectives:**
"Monitoring Procedures and Equipment“ HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and discusses the importance of detecting hazardous materials, as well as the equipment and procedures used in the process. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.

PPE & Decontamination Procedures

**Duration:** 21 minutes

**Objectives:**
"Personal Protective Equipment and Decontamination Procedures“ HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and instructs employees on the appropriate use of personal protective equipment (such as chemical protective clothing) as well as how to remove contaminants that accumulate on clothing and equipment. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.

Respiratory Safety

**Duration:** 19 minutes

**Objectives:**
"Respiratory Protection“ HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees avoid exposure to hazardous materials. The program instructs employees who deal with hazardous materials about how to protect themselves from respiratory hazards. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.

Understanding Chemical Hazards

**Duration:** 21 minutes

**Objectives:**
"Understanding Chemical Hazards“ HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and introduces employees to chemical hazard regulations and provides training on the various types of hazardous chemicals found in industrial environments. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.

Safety Orientation

**Duration:** 17 minutes

**Objectives:**
"Safety Orientation“ HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees avoid exposure to hazardous materials. The program instructs employees about how to reduce or eliminate potential exposure to hazardous materials in their work environments. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate. The program can be used as the basis for approximately two hours of classroom training.

The Site Safety & Health Plan

**Duration:** 20 minutes

**Objectives:**
"The Site Safety and Health Plan“ HAZWOPER DVD Program assists facilities in complying with the employee training requirements of OSHA’s HAZWOPER regulation (29 CFR 1910.120), and helps employees avoid exposure to hazardous materials. The program summarizes the various aspects of the Plan which is used in a hazardous materials facility or operation, and how the Plan helps to protect the health of anyone who regularly works around hazardous materials. The DVD program comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log. The program can be used as the basis for approximately two hours of classroom training.
Regulatory Compliance Kits

**K000LTRVEO**

**Lock-Out/Tag-Out**

**Duration:** 22 minutes

**Objectives:**
"Lock-Out/Tag-Out" Regulatory Compliance Kit™ has been created specifically to assist facilities in complying with the employee training requirements of OSHA’s "Lock-Out/Tag-Out" regulation. This kit discusses the OSHA Lock-Out/Tag-Out Standard, including the Energy Control Plan. The program uses environments which are familiar to employees working with both electric and hydraulic/pneumatic equipment and points out specifically where Lock-Out/Tag-Out procedures should be applied. Materials in the kit include a video program, a compliance manual, five motivational posters, and 30 employee booklets.

**K000LASVEO**

**Laboratory Standard**

**Duration:** 22 minutes

**Objectives:**
"The OSHA Laboratory Standard” Regulatory Compliance Kit™ addresses the three major areas needed to comply with the standard... general information about the standard itself, commonly used chemicals and safe chemical handling. Materials in the kit include a video program, a compliance manual, five motivational posters, and 30 employee booklets.

**K000LDSVEO**

**Lead Standard**

**Duration:** 22 minutes

**Objectives:**
"OSHA Lead Standards” Regulatory Compliance Kit™ addresses the major areas of employee training required by the regulations. Because of the widespread historical use of lead-based paints, as well as other materials containing lead, this program is useful to a number of different groups including building/ construction companies, manufacturers, recyclers and many others. Created specifically for OSHA’s Lead Standards (both the General Industrial Standard as well as the Interim Final Rule for Construction), the Regulatory Compliance Kit™ is designed for employees in general industry and construction environments where lead and lead-based materials are found. Materials in the kit include a video program, a compliance manual, five motivational posters, and 30 employee booklets.

**K000TSFVEX**

**Tuberculosis**

**Duration:** 18 minutes

**Objectives:**
"Tuberculosis in the First Responder Environment” Regulatory Compliance Kit™ includes recent changes in respiratory protection requirements. The kit is designed to assist facilities and operations whose employees have a risk of exposure to tuberculosis. The kit also helps employees understand the nature of the disease, as well as what they can do to protect themselves from infection. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

**K000TSHVEX**

**Tuberculosis**

**Duration:** 22 minutes

**Objectives:**
"Tuberculosis in the Healthcare Environment” Regulatory Compliance Kit™ includes the changes in respiratory protection requirements. The kit is designed to assist facilities and operations whose employees have a risk of exposure to tuberculosis. The kit also helps employees understand the nature of the disease, as well as what they can do to protect themselves from infection. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

**K000TSIVEX**

**Tuberculosis**

**Duration:** 21 minutes

**Objectives:**
"Tuberculosis in the Institutional Environment” Regulatory Compliance Kit™ includes the changes in respiratory protection requirements. The kit is designed to assist facilities and operations whose employees have a risk of exposure to tuberculosis. The kit also helps employees understand the nature of the disease, as well as what they can do to protect themselves from infection. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.

**K000ASBVEO**

**Asbestos Awareness**

**Duration:** 14 minutes

**Objectives:**
"Asbestos Awareness” Regulatory Compliance Kit™ has been created specifically to educate employees about the dangers of working with materials that may contain asbestos. Materials in the kit include a video program, five motivational posters, and 30 employee booklets.
**K000SPSVEO**

**Supported Scaffolding**

**Duration:** 20 minutes

**Objectives:**
"Supported Scaffolding Safety" Regulatory Compliance Kit™ assists facilities of all types in complying with OSHA’s Scaffolding regulation (29 CFR 1926.451), and helps employees understand the dangers of working with scaffolds, and how these risks can be minimized by knowing the correct ways to erect, maintain and use scaffolding equipment. Materials in the kit include a video program, five motivational posters, and 30 employee booklets. The video program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

**K000B3FVEO**

**Bloodborne Pathogens**

**Duration:** 26 minutes

**Objectives:**
"Bloodborne Pathogens in First Response Environments” Regulatory Compliance Kit™... updated to incorporate the latest medical language and needlestick guidelines... has been specifically created to assist First Responders in fulfilling the OSHA Bloodborne Pathogens Standard’s (29 CFR Part 1910.1030) training requirements. Materials in the kit include a video program, a compliance manual, five motivational posters, and 30 employee booklets.

**K000CSEVEC**

**Confined Space Entry**

**Duration:** 19 minutes

**Objectives:**
"Confined Space Entry” Regulatory Compliance Kit™ addresses the major areas of employee training required by the regulation. Materials in the kit include a video program, a compliance manual, five motivational posters, and 30 employee booklets.

**K000033VEX**

**DOT General Awareness**

**Duration:** 17 minutes

**Objectives:**
"DOT HAZMAT General Awareness” Regulatory Compliance Kit™. focuses on employees who handle hazardous materials. Materials in the kit include a videotape program, five motivational posters, and 30 employee booklets.

**K000035VEX**

**DOT Safety Training**

**Duration:** 18 minutes

**Objectives:**
"DOT HAZMAT Safety Training” Regulatory Compliance Kit™ focuses on employees who handle hazardous materials. The program makes employees aware of the hazards associated with the materials they handle... and shows them how to work with these materials safely. Materials in the kit include a videotape program, five motivational posters, and 30 employee booklets.
### Emergency Planning

**Duration:** 13 minutes  
**Objectives:**  
"Emergency Planning" Regulatory Compliance Kit™ assists facilities in complying with various federal and state regulations and helps them prepare for potential emergency situations. Materials in the kit include a DVD program, a compliance manual, five motivational posters, and 30 employee booklets.

### Lead Standard

**Duration:** 15 minutes  
**Objectives:**  
"OSHA Lead Standards" Regulatory Retraining Kit gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The kit contains a short videotape training program, five posters and 30 employee booklets. The videotape program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

### Right-To-Know

#### Right-To-Know for Industrial Facilities

**Duration:** 21 minutes  
**Objectives:**  
"Right-To-Know for Industrial Facilities" Regulatory Compliance Kit™ has been created specifically to assist industrial facilities of all types in complying with federal, state and municipal “Right-To-Know” regulations, this kit also addresses the major education and training requirements in these “chemical hazard” laws. Materials in the kit include a video program, a compliance manual, a container labeling system, five motivational posters, and 30 employee booklets.

#### Right-To-Know for Building and Construction Companies

**Duration:** 21 minutes  
**Objectives:**  
"Right-To-Know for Building and Construction Companies" Regulatory Compliance Kit™ has been created specifically to assist building and construction companies of all types in complying with federal, state and municipal “Right-To-Know” regulations, this kit also addresses the major education and training requirements in these “chemical hazard” laws. Materials in the kit include a video program, a compliance manual, a container labeling system, five motivational posters, and 30 employee booklets.

#### Right-To-Know for Cleaning and Maintenance Operations

**Duration:** 21 minutes  
**Objectives:**  
"Right-To-Know for Cleaning and Maintenance Operations" Regulatory Compliance Kit™ has been created specifically to assist cleaning and maintenance operations of all types in complying with federal, state and municipal “Right-To-Know” regulations, this kit also addresses the major education and training requirements in these “chemical hazard” laws. Materials in the kit include a video program, a compliance manual, a container labeling system, five motivational posters, and 30 employee booklets.

#### Right-To-Know for the Hospitality Industry

**Duration:** 21 minutes  
**Objectives:**  
"Right-To-Know for the Hospitality Industry" Regulatory Compliance Kit™ has been created specifically to assist industrial facilities of all types in complying with federal, state and municipal “Right-To-Know” regulations, this kit also addresses the major education and training requirements in these “chemical hazard” laws. Materials in the kit include a video program, a compliance manual, a container labeling system, five motivational posters, and 30 employee booklets.

#### Right-To-Know for the Food Retailing Industry

**Duration:** 34 minutes  
**Objectives:**  
"Right-To-Know for the Food Retailing Industry" Regulatory Compliance Kit™ both introduces employees to the “Right-To-Know” regulations and provides training on various groups of chemicals found in the food retailers environment. The kit contains a Video Program, a Compliance Manual, a Container Labeling System, five posters and 30 employee booklets. The video program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

### Right-To-Know for Healthcare Facilities

**Duration:** 21 minutes  
**Objectives:**  
"Right-To-Know for Healthcare Facilities" Regulatory Compliance Kit™ has been created specifically to assist industrial facilities of all types in complying with federal, state and municipal “Right-To-Know” regulations, this kit also addresses the major education and training requirements in these “chemical hazard” laws. Materials in the kit include a video program, a compliance manual, a container labeling system, five motivational posters, and 30 employee booklets.

### Right-To-Know for the Retail Industry

**Duration:** 34 minutes  
**Objectives:**  
"Right-To-Know for the Retail Industry" Regulatory Compliance Kit™ both introduces employees to the “Right-To-Know” regulations and provides training on various groups of chemicals found in the retail environment. The kit contains a Video Program, a Compliance Manual, a Container Labeling System, five posters and 30 employee booklets. The video program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.
**Right-To-Know**

**Duration:** 17 minutes

**Objectives:**
“Right-To-Know” Regulatory Retraining Kit gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The kit contains a short videotape training program, five posters and 30 employee booklets. The videotape program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Bloodborne Pathogens**

**Duration:** 17 minutes

**Objectives:**
“Bloodborne Pathogens” Regulatory Retraining Kit gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The kit contains a short videotape training program, five posters and 30 employee booklets. The videotape program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Confined Space Entry**

**Duration:** 15 minutes

**Objectives:**
“Confined Space Entry” Regulatory Retraining Kit gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The kit contains a short videotape training program, five posters and 30 employee booklets. The videotape program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Lock-Out/Tag-Out**

**Duration:** 14 minutes

**Objectives:**
“Lock-Out/Tag-Out” Regulatory Retraining Kit gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The kit contains a short videotape training program, five posters and 30 employee booklets. The videotape program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Laboratory Standard**

**Duration:** 14 minutes

**Objectives:**
“OSHA Laboratory Standard” Regulatory Retraining Kit gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The kit contains a short videotape training program, five posters and 30 employee booklets. The video program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**OSHA Recordkeeping**

**Duration:** 38 minutes

**Objectives:**
"OSHA Recordkeeping for Managers, Supervisors, and Other Employees” Regulatory Compliance Kit™ helps facilities comply with OSHA’s Recordkeeping regulation (29 CFR Part 1904). Materials in the kit include a two DVD programs, a compliance manual, five motivational posters, and 30 employee booklets. The compliance manual contains a "fill-in-the-blank" written compliance program. The posters in the kit emphasize the importance of complying with the regulation. The two DVDs in the kit can be used to train all levels of personnel and provide them with a common base of understanding about recordkeeping requirements. They show all employees actual workplace incidents that demonstrate how to report accidents and what information they need to furnish.

**Emergency Planning**

**Duration:** 13 minutes

**Objectives:**
"Emergency Planning” Regulatory Compliance Kit™ assists facilities in complying with various federal and state regulations and helps them prepare for potential emergency situations. Materials in the kit include a videotape program, a compliance manual, five motivational posters, and 30 employee booklets.

**Forklift/Powered Industrial Truck Safety**

**Duration:** 28 minutes

**Objectives:**
"Forklift/Powered Industrial Truck Safety” Regulatory Compliance Kit™ has been specifically created to involve employees in the process of understanding forklift operation and to help facilities in fulfilling the OSHA Powered Industrial Truck Standard (29 CFR,1910.178)
training requirements. Materials in the kit include a video program, a compliance manual, 5 motivational posters, and 30 employee booklets. The video program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**K000PNSVEO**

**Suspended Scaffolding**

**Duration:** 20 minutes

**Objectives:**

“Suspended Scaffolding Safety” Regulatory Compliance Kit™ assists facilities of all types in complying with OSHA’s Scaffolding regulation (29 CFR 1926.451), and helps employees understand the dangers of working with scaffolds, and how these risks can be minimized by knowing the correct ways to erect, maintain and use scaffolding equipment. Materials in the kit include a video program, five motivational posters, and 30 employee booklets. The video program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**K000PPSVEO**

**Personal Protective Equipment**

**Duration:** 27 minutes

**Objectives:**

“Personal Protective Equipment” Regulatory Compliance Kit™ has been created specifically to involve employees in the process of understanding the proper use of Personal Protective Equipment and to help facilities in fulfilling OSHA’s Personal Protective Equipment Standards (29 CFR, 1910.132, 133, 134, 135, 136, 137, 138) training requirements. Materials in the kit include a video program, a compliance manual, five motivational posters, and 30 employee booklets. The video program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**K000HESVEO**

**Hearing Conservation**

**Duration:** 25 minutes

**Objectives:**

The objective of “Hearing Conservation and Safety” Regulatory Compliance Kit™ is to involve employees in the process of understanding noise hazards and to help facilities in fulfilling the OSHA Occupational Noise Exposure and Hearing Protection Standard (29 CFR, 1910.95) training requirements.

**K000015VEO**

**OSHA Recordkeeping**

**Duration:** 20 minutes

**Objectives:**

“OSHA Recordkeeping for Managers and Supervisors” Regulatory Compliance Kit™ helps facilities comply with OSHA’s Recordkeeping regulation (29 CFR Part 1904). It covers the details of the regulation’s requirements and highlights actual workplace incidents that demonstrate what managers’ responsibilities are in documenting and reporting recordable accidents. Materials in the kit include a video program, a compliance manual, five motivational posters, and 30 Booklets. The video program in the kit can be used in conjunction with the MARCOM’s Video Program "OSHA Recordkeeping for Employees” to train workers at all levels, and provide them with a common base of understanding about OSHA’s recordkeeping requirements. The video program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

**K000017VEO**

**OSHA Recordkeeping**

**Duration:** 17 minutes

**Objectives:**

“OSHA Recordkeeping for Employees” Regulatory Compliance Kit™ helps facilities comply with OSHA’s Recordkeeping regulation (29 CFR Part 1904). It shows employees actual workplace incidents that demonstrate how to report accidents and what information they need to furnish. Materials in the kit include a video program, a compliance manual, five motivational posters, and 30 Booklets. The Compliance Manual contains a “fill-in-the-blank” Written Compliance Program. The posters in the kit emphasize the importance of complying with the regulation. This program can be used in conjunction with the MARCOM’s “OSHA Recordkeeping for Managers and Supervisors” Video Program to train all levels of personnel and provide them with a common base of understanding about recordkeeping requirements. The video program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

**K000019VEO**

**OSHA Recordkeeping**

**Duration:** 20 minutes

**Objectives:**

“OSHA Recordkeeping for Managers and Supervisors” Regulatory Compliance Kit™ helps facilities comply with OSHA’s Recordkeeping regulation (29 CFR Part 1904). It covers the details of the regulation’s requirements and highlights actual workplace incidents that demonstrate what managers’ responsibilities are in documenting and reporting recordable accidents. Materials in the kit include a DVD
program, a compliance manual, five motivational posters, and 30 employee booklets. The DVD program in the kit can be used in conjunction with the MARCOM’s DVD program "OSHA Recordkeeping for Employees” to train workers at all levels, and provide them with a common base of understanding about OSHA’s recordkeeping requirements. The DVD program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

K0000179EO

OSHA Recordkeeping

Duration: 17 minutes

Objectives:
"OSHA Recordkeeping for Employees” Regulatory Compliance Kit™ helps facilities comply with OSHA’s Recordkeeping regulation (29 CFR Part 1904). It shows employees actual workplace incidents that demonstrate how to report accidents and what information they need to furnish. Materials in the kit include a DVD program, a compliance manual, five motivational posters, and 30 employee booklets. The compliance manual contains a "fill-in-the-blank" written compliance program. The posters in the kit emphasize the importance of complying with the regulation. This program can be used in conjunction with the MARCOM’s “OSHA Recordkeeping for Managers and Supervisors’” DVD program to train all levels of personnel and provide them with a common base of understanding about recordkeeping requirements. The DVD program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

K000AQI9EO

Indoor Air Quality

Duration: 13 minutes

Objectives:
"Indoor Air Quality” Regulatory Compliance Kit™ shows employees the potentially harmful effects of poor air quality, and will help them prevent, identify and correct air quality problems. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000ASB9EO

Asbestos Awareness

Duration: 14 minutes

Objectives:
"Asbestos Awareness” Regulatory Compliance Kit™ has been created specifically to educate employees about the dangers of working with materials that may contain asbestos. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000B2I9EO

Bloodborne Pathogens

Duration: 24 minutes

Objectives:
"Bloodborne Pathogens in Commercial and Light Industrial Facilities” Regulatory Compliance Kit™ has been specifically created to assist facilities in fulfilling the OSHA Bloodborne Pathogens Standard’s (29 CFR Part 1910.1030) training requirements. Materials in the kit include a DVD program, a compliance manual, five motivational posters, and 30 employee booklets.

K000B2P9ER

Bloodborne Pathogens

Duration: 17 minutes

Objectives:
“Bloodborne Pathogens” Regulatory Retraining Kit gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The kit contains a short DVD program, five posters and 30 employee booklets. The DVD program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

K000B2Y9EO

Bloodborne Pathogens

Duration: 24 minutes

Objectives:
"Bloodborne Pathogens in Heavy Industry” Regulatory Compliance Kit™ ... updated to incorporate the latest medical language and guidelines... has been specifically created to assist facilities in fulfilling the OSHA Bloodborne Pathogens Standard’s (29 CFR Part 1910.1030) training requirements. Materials in the kit include a DVD program, a compliance manual, five motivational posters, and 30 employee booklets.

K000B3H9EO

Bloodborne Pathogens

Duration: 26 minutes

Objectives:
"Bloodborne Pathogens in Healthcare Facilities” Regulatory Compliance Kit™... updated to incorporate the latest medical language and needlestick guidelines... has been specifically created to assist facilities in fulfilling the OSHA Bloodborne Pathogens Standard’s (29 CFR Part 1910.1030) training requirements. Materials in the kit include a DVD program, a compliance manual, five motivational posters, and 30 employee booklets.
**Confined Space Entry**

Duration: 15 minutes

Objectives:
“Confined Space Entry” Regulatory Retraining Kit gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The kit contains a short DVD program, five posters and 30 employee booklets. The DVD program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Right-To-Know**

Duration: 17 minutes

Objectives:
“Right-To-Know” Regulatory Retraining Kit gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The kit contains a short DVD program, five posters and 30 employee booklets. The DVD program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Confined Space Entry**

Duration: 19 minutes

Objectives:
“Confined Space Entry” Regulatory Compliance Kit™ addresses the major areas of employee training required by the regulation. Materials in the kit include a DVD program, a compliance manual, five motivational posters, and 30 employee booklets.

**Forklift/Powered Industrial Truck Safety**

Duration: 28 minutes

Objectives:
"Forklift/Powered Industrial Truck Safety” Regulatory Compliance Kit™ has been specifically created to involve employees in the process of understanding forklift operation and to help facilities in fulfilling the OSHA Powered Industrial Truck Standard (29 CFR, 1910.178) training requirements. Materials in the kit include a DVD program, a compliance manual, 5 motivational posters, and 30 employee booklets. The DVD program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Laboratory Standard**

Duration: 14 minutes

Objectives:
"The OSHA Laboratory Standard” Regulatory Compliance Kit™ addresses the three major areas needed to comply with the standard... general information about the standard itself, commonly used chemicals and safe chemical handling. Materials in the kit include a DVD program, a compliance manual, five motivational posters, and 30 employee booklets.

**Hearing Conservation**

Duration: 25 minutes

Objectives:
"Hearing Conservation and Safety” Regulatory Compliance Kit™ has been created specifically to involve employees in the process of understanding noise hazards and to help facilities in fulfilling the OSHA Occupational Noise Exposure and Hearing Protection Standard (29 CFR, 1910.95) training requirements. Materials is the kit include a DVD program, a compliance manual, five motivational posters, and 30 employee booklets. The DVD program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**Right-To-Know for the Food Retailing Industry**

Duration: 34 minutes

Objectives:
"Right-To-Know for the Food Retailing Industry” Regulatory Compliance Kit™ both introduces employees to the "Right-To-Know” regulations and provides training on various groups of chemicals found in the food retailers environment. The kit contains a DVD program, a compliance manual, a container labeling system, five posters and 30 employee booklets. The DVD program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**OSHA Lead Standards**

Duration: 15 minutes

Objectives:
“OSHA Lead Standards” Regulatory Retraining Kit gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The kit contains a short DVD program, five posters and 30 employee booklets. The DVD program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.
program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**K000LTR9EO**

**Lock-Out/Tag-Out**

**Duration:** 22 minutes

**Objectives:**

“Lock-Out/Tag-Out” Regulatory Compliance Kit™ has been created specifically to assist facilities in complying with the employee training requirements of OSHA’s Lock-Out/Tag-Out regulation. This kit discusses the OSHA Lock-Out/Tag-Out Standard, including the Energy Control Plan. The program uses environments which are familiar to employees working with both electric and hydraulic/pneumatic equipment and points out specifically where lock-out/tag-out procedures should be applied. Materials in the kit include a DVD program, a compliance manual, five motivational posters, and 30 employee booklets.

**K000LTR9ER**

**Lock-Out/Tag-Out**

**Duration:** 14 minutes

**Objectives:**

“Lock-Out/Tag-Out” Regulatory Retraining Kit gives employees the information they need to refresh their knowledge of OSHA regulations... as cost effectively as possible. The kit contains a short DVD program, five posters and 30 employee booklets. The DVD program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training certificate and training log.

**K000PNS9EO**

**Suspended Scaffolding**

**Duration:** 20 minutes

**Objectives:**

“Suspended Scaffolding Safety” Regulatory Compliance Kit™ assists facilities of all types in complying with OSHA’s Scaffolding regulation (29 CFR 1926.451), and helps employees understand the dangers of working with scaffolds, and how these risks can be minimized by knowing the correct ways to erect, maintain and use scaffolding equipment. Materials in the kit include a DVD program, a compliance manual, five motivational posters, and 30 employee booklets.

**K000PPS9EO**

**Personal Protective Equipment**

**Duration:** 27 minutes

**Objectives:**

“Personal Protective Equipment” Regulatory Compliance Kit™ has been created specifically to involve employees in the process of understanding the proper use of personal protective equipment and to help facilities in fulfilling the OSHA Personal Protective Equipment Standards (29 CFR,1910. 132,133,134,135,136,137,138) training requirements. Materials in the kit include a DVD program, a compliance manual, five motivational posters, and 30 employee booklets.

**K000RAU9EO**

**Right-To-Know**

**Duration:** 21 minutes

**Objectives:**

“Right-To-Know for Auto Service Facilities” Regulatory Compliance Kit™ has been created specifically to assist auto service facilities of all types in complying with Federal, state and municipal “Right-To-Know” regulations. This kit also addresses the major education and training requirements in these “chemical hazard” laws. Materials in the kit include a DVD program, a compliance manual, a container labeling system, five motivational posters, and 30 employee booklets.

**K000RBL9EO**

**Right-To-Know**

**Duration:** 24 minutes

**Objectives:**

“Right-To-Know for Building and Construction Companies” Regulatory Compliance Kit™ has been created specifically to assist building and construction companies of all types in complying with Federal, state and municipal “Right-To-Know” regulations, this kit also addresses the major education and training requirements in these “chemical hazard” laws. Materials in the kit include a DVD program, a compliance manual, a container labeling system, five motivational posters, and 30 employee booklets.

**K000RCM9EO**

**Right-To-Know**

**Duration:** 21 minutes

**Objectives:**

“Right-To-Know for Cleaning and Maintenance Operations” Regulatory Compliance Kit™ has been created specifically to assist cleaning and maintenance operations of all types in complying with Federal, state and municipal “Right-To-Know” regulations, this kit also addresses the major education and training requirements in these “chemical hazard” laws. Materials in the kit include a DVD program, a compliance manual, five motivational posters, and 30 employee booklets.
Right-To-Know Compliance Manual, a container labeling system, five motivational posters, and 30 employee booklets.

K000RHC9EO
Right-To-Know
Duration: 15 minutes
Objectives:
“Right-To-Know for Healthcare Facilities” Regulatory Compliance Kit™ has been created specifically to assist industrial facilities of all types in complying with Federal, state and municipal “Right-To-Know” regulations, this kit also addresses the major education and training requirements in these "chemical hazard" laws. Materials in the kit include a DVD program, a compliance manual, a container labeling system, five motivational posters, and 30 employee booklets.

K000RHS9EO
Right-To-Know
Duration: 21 minutes
Objectives:
“Right-To-Know for the Hospitality Industry” Regulatory Compliance Kit™ has been created specifically to assist industrial facilities of all types in complying with Federal, state and municipal “Right-To-Know” regulations, this kit also addresses the major education and training requirements in these "chemical hazard" laws. Materials in the kit include a DVD program, a compliance manual, a container labeling system, five motivational posters, and 30 employee booklets.

K000RIN9EO
Right-To-Know
Duration: 21 minutes
Objectives:
“Right-To-Know for Industrial Facilities” Regulatory Compliance Kit™ has been created specifically to assist industrial facilities of all types in complying with Federal, state and municipal “Right-To-Know” regulations, this kit also addresses the major education and training requirements in these "chemical hazard" laws. Materials in the kit include a DVD program, a compliance manual, a container labeling system, five motivational posters, and 30 employee booklets.

K000SPS9EO
Supported Scaffolding
Duration: 21 minutes
Objectives:
“Supported Scaffolding Safety” Regulatory Compliance Kit™ assists facilities of all types in complying with OSHA’s Scaffolding regulation (29 CFR 1926.451), and helps employees understand the dangers of working with scaffolds, and how these risks can be minimized by knowing the correct ways to erect, maintain and use scaffolding equipment. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets. The DVD program in the kit comes with a comprehensive leader’s guide, reproducible scheduling & attendance form, employee quiz, training log and training certificate.

K000TSF9EX
Tuberculosis
Duration: 18 minutes
Objectives:
“Tuberculosis in the First Responder Environment” Regulatory Compliance Kit™ includes recent changes in respiratory protection requirements. The kit is designed to assist facilities and operations whose employees have a risk of exposure to tuberculosis. The kit also helps employees understand the nature of the disease, as well as what they can do to protect themselves from infection. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000TSH9EX
Tuberculosis
Duration: 18 minutes
Objectives:
“Tuberculosis in the Healthcare Environment” Regulatory Compliance Kit™ includes the changes in respiratory protection requirements. The kit is designed to assist facilities and operations whose employees have a risk of exposure to tuberculosis. The kit also helps employees understand the nature of the disease, as well as what they can do to protect themselves from infection. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K000TSI9EX
Tuberculosis
Duration: 21 minutes
Objectives:
“Tuberculosis in the Institutional Environment” Regulatory Compliance Kit™ includes the changes in respiratory protection requirements. The kit is designed to assist facilities and operations whose employees have a risk of exposure to tuberculosis. The kit also helps employees understand the nature of the disease, as well as what they can do to protect themselves from infection. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

K0000339EX
DOT General Awareness
Duration: 17 minutes
Objectives:
“DOT HAZMAT General Awareness” Regulatory Compliance Kit™ focuses on employees who handle hazardous materials. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.
**K0000359EX**

**DOT Safety Training**

**Duration:** 18 minutes

**Objectives:**

“DOT HAZMAT Safety Training” Regulatory Compliance Kit™ focuses on employees who handle hazardous materials. The program makes employees aware of the hazards associated with the materials they handle... and shows them how to work with these materials safely. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

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**K000037VEX**

**DOT Security Awareness**

**Duration:** 13 minutes

**Objectives:**

“DOT HAZMAT Security Awareness” Regulatory Compliance Kit™ focuses on employees who handle hazardous materials. Materials in the kit include a videotape program, five motivational posters, and 30 employee booklets.

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**K0000379EX**

**DOT Security Awareness**

**Duration:** 13 minutes

**Objectives:**

“DOT HAZMAT Security Awareness” Regulatory Compliance Kit™ focuses on employees who handle hazardous materials. Materials in the kit include a DVD program, five motivational posters, and 30 employee booklets.

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**K000039VEX**

**DOT In-Depth Security**

**Duration:** 16 minutes

**Objectives:**

“DOT HAZMAT In-Depth Security” Regulatory Compliance Kit™ focuses on employees who handle hazardous materials. Materials in the kit include a DVD program, a security manual, five motivational posters, and 30 employee booklets.
AC/DC Fundamentals
AC/DC Motors and Motor Controllers
Cable/Telecommunications Industry
Components – Basic Electrical and Electronic Components – Fittings, Conduits, Fuses, and Batteries
Digital/Electronic Circuits
Electrical/Electronics – Instruments, Measurements, Electronic Systems, Testing and Troubleshooting
Industrial Control/PLCs
Lighting and Heating
Microprocessors
Print Reading and Schematic Diagrams
Transformers
# Electrical and Electronics

## Subject Index

### AC/DC Fundamentals

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Principles (Block A22)</td>
<td>152</td>
</tr>
<tr>
<td>Alternating Current (086007)</td>
<td>152</td>
</tr>
<tr>
<td>Circuit Analysis and Ohm’s Law (086002)</td>
<td>151</td>
</tr>
<tr>
<td>DC Principles (Block A21)</td>
<td>151</td>
</tr>
<tr>
<td>Electrical Safety for the Trades (186005)</td>
<td>70</td>
</tr>
<tr>
<td>Electricity (4210A-C)</td>
<td>145</td>
</tr>
<tr>
<td>Electricity and Magnetism (4010A-C)</td>
<td>142</td>
</tr>
<tr>
<td>Experiments with Basic AC Theory – Lab Manual (086088)</td>
<td>135</td>
</tr>
<tr>
<td>Experiments with Basic DC Theory – Lab Manual (086087)</td>
<td>135</td>
</tr>
<tr>
<td>Electronics Workbench®</td>
<td>143</td>
</tr>
<tr>
<td>Getting Started as an Electrician (006025)</td>
<td>131</td>
</tr>
<tr>
<td>Inductance and Capacitance (6617)</td>
<td>149</td>
</tr>
<tr>
<td>Inductors in AC Circuits (086009)</td>
<td>152</td>
</tr>
<tr>
<td>Industrial Electron Tubes (2080)</td>
<td>141</td>
</tr>
<tr>
<td>Modulation and Detection Circuits (086044)</td>
<td>171</td>
</tr>
<tr>
<td>National Electrical Code (5177EM)</td>
<td>269</td>
</tr>
<tr>
<td>Optoelectronic and Fiber Optic Components (086024)</td>
<td>170</td>
</tr>
<tr>
<td>Principles of AC Circuits (4018A-D)</td>
<td>143</td>
</tr>
<tr>
<td>Protective Relay (6538A-B)</td>
<td>148</td>
</tr>
<tr>
<td>Reactance and Impedance (086037)</td>
<td>168</td>
</tr>
<tr>
<td>Rectification and Basic Electronic Devices (086014)</td>
<td>153</td>
</tr>
<tr>
<td>Rectifiers and Power Supplies (086041)</td>
<td>170</td>
</tr>
<tr>
<td>Resonant Circuits (086038)</td>
<td>168</td>
</tr>
<tr>
<td>Resonant Circuits (3306)</td>
<td>142</td>
</tr>
<tr>
<td>Special Rectifiers: Electron Tubes (086023)</td>
<td>170</td>
</tr>
<tr>
<td>Switchgear (6613)</td>
<td>148</td>
</tr>
<tr>
<td>Switching Circuits (086054)</td>
<td>171</td>
</tr>
<tr>
<td>Switching Devices (086021)</td>
<td>169</td>
</tr>
<tr>
<td>Troubleshooting Sensing Devises and Systems (086066)</td>
<td>173</td>
</tr>
<tr>
<td>Vacuum Tube Fundamentals (2010)</td>
<td>140</td>
</tr>
<tr>
<td>Wiring Electrical Components, Part 1 (006027)</td>
<td>131</td>
</tr>
<tr>
<td>Wiring Electrical Components, Part 2 (006028)</td>
<td>132</td>
</tr>
<tr>
<td>Wiring Electrical Circuits (006037)</td>
<td>134</td>
</tr>
</tbody>
</table>

### AC/DC Motors and Motor Controllers

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Motor Repair (6631A-B)</td>
<td>149</td>
</tr>
<tr>
<td>AC Motors, Generators, and Rectifiers (6698)</td>
<td>149</td>
</tr>
<tr>
<td>Alternating Current Motors (4032)</td>
<td>144</td>
</tr>
<tr>
<td>Controlling Industrial Motors (086053)</td>
<td>134</td>
</tr>
<tr>
<td>DC Generators and Motors (6687)</td>
<td>149</td>
</tr>
<tr>
<td>DC Machines (4030A-B)</td>
<td>143</td>
</tr>
<tr>
<td>DC Motors and Generator Theory (086006)</td>
<td>152</td>
</tr>
<tr>
<td>Design of Alternating Current Machines (2727A-C)</td>
<td>142</td>
</tr>
<tr>
<td>Design of DC Machines (2720A-C)</td>
<td>142</td>
</tr>
<tr>
<td>Electronic Troubleshooting of Industrial</td>
<td>173</td>
</tr>
<tr>
<td>Motor Controllers (086065)</td>
<td>144</td>
</tr>
<tr>
<td>Fractional Horsepower Motors (4033)</td>
<td>144</td>
</tr>
<tr>
<td>Industrial AC Motors (086052)</td>
<td>134</td>
</tr>
<tr>
<td>Industrial DC Motors (086051)</td>
<td>134</td>
</tr>
<tr>
<td>Industrial Motor Applications (4341)</td>
<td>146</td>
</tr>
<tr>
<td>Industrial Motor Control (6699A-C)</td>
<td>149</td>
</tr>
<tr>
<td>Industrial Motor Control (for Programmable Logic Controllers),</td>
<td>129</td>
</tr>
<tr>
<td>Part 1 (006011)</td>
<td></td>
</tr>
<tr>
<td>Industrial Motor Control (for Programmable Logic Controllers),</td>
<td>129</td>
</tr>
<tr>
<td>Part 2 (006012)</td>
<td></td>
</tr>
<tr>
<td>Motor Control Fundamentals (for Programmable Logic Controllers),</td>
<td>129</td>
</tr>
<tr>
<td>(006010)</td>
<td></td>
</tr>
<tr>
<td>Reconnecting Induction Motors (6585)</td>
<td>148</td>
</tr>
<tr>
<td>Repairing DC Motors and Generators (4220A-B)</td>
<td>145</td>
</tr>
<tr>
<td>Repairing Fractional/Horsepower Motors (4034)</td>
<td>144</td>
</tr>
</tbody>
</table>

### Basic Electrical and Electronic Components

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternating Current Circuits (086008)</td>
<td>152</td>
</tr>
<tr>
<td>Alternators (086012)</td>
<td>153</td>
</tr>
<tr>
<td>Alternators (4031)</td>
<td>144</td>
</tr>
<tr>
<td>Analog Electronic Components (Block B23)</td>
<td>169</td>
</tr>
<tr>
<td>Applications and Troubleshooting of Resonant Circuits (086039)</td>
<td>168</td>
</tr>
<tr>
<td>Basic Electronic Components and Schematic Symbols (2020)</td>
<td>140</td>
</tr>
<tr>
<td>Basic Semiconductor Components: Diodes (086019)</td>
<td>169</td>
</tr>
<tr>
<td>Basic Semiconductor Components: Transistors (086020)</td>
<td>169</td>
</tr>
<tr>
<td>Capacitors and Inductors (086003)</td>
<td>151</td>
</tr>
<tr>
<td>Capacitors in AC Circuits (086010)</td>
<td>153</td>
</tr>
<tr>
<td>Digital Electronics (086E18)</td>
<td>139</td>
</tr>
<tr>
<td>Efficiency Tests (4342)</td>
<td>146</td>
</tr>
<tr>
<td>Electrical Equipment, Part 1 (006027)</td>
<td>131</td>
</tr>
<tr>
<td>Electrical Equipment, Part 2 (006028)</td>
<td>132</td>
</tr>
<tr>
<td>Electrical Equipment (Block A24)</td>
<td>154</td>
</tr>
<tr>
<td>Electrical Grounding (086E01)</td>
<td>136</td>
</tr>
<tr>
<td>Electronic Sensors (086022)</td>
<td>169</td>
</tr>
<tr>
<td>Electronics Hardware (086040)</td>
<td>170</td>
</tr>
<tr>
<td>How to Solder and Desolder (SLD1)</td>
<td>174</td>
</tr>
<tr>
<td>Inductive and Capacitive (6617)</td>
<td>149</td>
</tr>
<tr>
<td>Inductors in AC Circuits (086009)</td>
<td>152</td>
</tr>
<tr>
<td>Industrial Electron Tubes (2080)</td>
<td>141</td>
</tr>
<tr>
<td>Modulation and Detection Circuits (086044)</td>
<td>171</td>
</tr>
<tr>
<td>National Electrical Code (5177EM)</td>
<td>269</td>
</tr>
<tr>
<td>Opto-Electronic and Fiber Optic Components (086024)</td>
<td>170</td>
</tr>
<tr>
<td>Principles of AC Circuits (4018A-D)</td>
<td>143</td>
</tr>
<tr>
<td>Protective Relay (6538A-B)</td>
<td>148</td>
</tr>
<tr>
<td>Reactance and Impedance (086037)</td>
<td>168</td>
</tr>
<tr>
<td>Rectification and Basic Electronic Devices (086014)</td>
<td>153</td>
</tr>
<tr>
<td>Rectifiers and Power Supplies (086041)</td>
<td>170</td>
</tr>
<tr>
<td>Resonant Circuits (086038)</td>
<td>168</td>
</tr>
<tr>
<td>Resonant Circuits (3306)</td>
<td>142</td>
</tr>
<tr>
<td>Special Rectifiers: Electron Tubes (086023)</td>
<td>170</td>
</tr>
<tr>
<td>Switchgear (6613)</td>
<td>148</td>
</tr>
<tr>
<td>Switching Circuits (086054)</td>
<td>171</td>
</tr>
<tr>
<td>Switching Devices (086021)</td>
<td>169</td>
</tr>
<tr>
<td>Troubleshooting Sensing Devises and Systems (086066)</td>
<td>173</td>
</tr>
<tr>
<td>Vacuum Tube Fundamentals (2010)</td>
<td>140</td>
</tr>
<tr>
<td>Wiring Electrical Components, Part 1 (006027)</td>
<td>132</td>
</tr>
<tr>
<td>Wiring Electrical Components, Part 2 (006030)</td>
<td>132</td>
</tr>
<tr>
<td>Wiring Electrical Circuits (006037)</td>
<td>134</td>
</tr>
</tbody>
</table>

### Digital/Electronic Circuits

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Solid State Circuits (2008A-B)</td>
<td>140</td>
</tr>
<tr>
<td>Amplifiers (086042)</td>
<td>170</td>
</tr>
<tr>
<td>Analog Systems (2133)</td>
<td>141</td>
</tr>
<tr>
<td>Applications and Troubleshooting of Resonant Circuits (086039)</td>
<td>168</td>
</tr>
<tr>
<td>Audio and RF Circuits (086046)</td>
<td>172</td>
</tr>
<tr>
<td>Basic Electronic Circuits (Block B24)</td>
<td>170</td>
</tr>
<tr>
<td>Basic Industrial Computer Systems (Block B10)</td>
<td>162</td>
</tr>
<tr>
<td>Digital Methods and Components (2131A-B)</td>
<td>141</td>
</tr>
<tr>
<td>Digital Trainer (NK-200)</td>
<td>174</td>
</tr>
<tr>
<td>Electronic Control Circuits and Applications (6580)</td>
<td>148</td>
</tr>
<tr>
<td>Electronic Power Supply Systems (086048)</td>
<td>172</td>
</tr>
<tr>
<td>Electronics for Numerical Control (2148A-B)</td>
<td>141</td>
</tr>
<tr>
<td>Experiments with Resonant Circuits – Lab Manual (086090)</td>
<td>136</td>
</tr>
<tr>
<td>Gating and Counting Circuits (086056)</td>
<td>171</td>
</tr>
<tr>
<td>Industrial Amplification Systems (086058)</td>
<td>172</td>
</tr>
<tr>
<td>Linear and Digital Integrated Circuits (Block B09)</td>
<td>161</td>
</tr>
<tr>
<td>Logic Circuits (086055)</td>
<td>171</td>
</tr>
<tr>
<td>Logic Circuits (Block B08)</td>
<td>160</td>
</tr>
<tr>
<td>Modulation and Detection Circuits (086044)</td>
<td>171</td>
</tr>
<tr>
<td>Organization of Digital Computers (2132)</td>
<td>141</td>
</tr>
<tr>
<td>Oscillators (086043)</td>
<td>170</td>
</tr>
<tr>
<td>Oscillators, Feedback, and Waveforms (086047)</td>
<td>172</td>
</tr>
</tbody>
</table>
### Electrical and Electronic Instruments, Measurements

- Amplifiers (086042) ......................................................... 170
- Analog Circuit Measurement (Block A23) ......................... 153
- Basic Test Equipment (086025) ........................................ 153
- Component Testers (086062) ........................................... 134
- Digital Test Equipment (086063) .................................... 135
- Electric Power Measurements (4019A-B) .......................... 143
- Electrical Measuring Instruments (4146A-C) ..................... 145
- Electronic Devices and Amplification (086045) .................. 171
- Electronic Instrumentation Methods and Circuits (6526) .... 147
- Electronic Test Instruments (6531A-B) .............................. 147
- Electronics (2002A-D) .................................................... 139
- Experiments in Electrical Measurements – Lab Manual (086089) .......................... 135
- Full Function Digital Multimeter Kit (086801) ..................... 157
- Fundamentals of Electronic Instrumentation and Control (6525) .......................... 147
- Measurements Trainer (XK-100) ...................................... 174
- Oscillators (086043) ......................................................... 171
- Symmetrical Components (6728) ....................................... 170
- Troubleshooting with Volt-Ohm-Milliammeter Meters (VOMs) (086026) .......................... 154
- Ultrasonics (6520A-B) ..................................................... 147
- Using Basic Oscilloscopes (086027) ................................. 154
- Working with Multimeters (006021) ................................. 131

### Electrical and Electronic Systems

- Audio and RF Circuits (086046) ....................................... 172
- Digital Electronics (086E18) .......................................... 139
- Electronic Devices and Amplification (086045) .................. 171
- Electronic Power Supply Systems (086048) ....................... 172
- Electronic Systems (Block B25) ....................................... 171
- Industrial Amplification Systems (086058) ......................... 172
- Oscillators, Feedback, and Waveforms (086047) ................. 172
- Programmable Controllers and Microprocessors (086061) .... 172
- Pulse and Logic Circuits (086060) .................................... 172
- Servo and Control Systems (086059) ............................... 172
- Telemetering (4048) ....................................................... 145

### Electronics Testing and Troubleshooting

- Advanced Troubleshooting Techniques (Block B16) .......... 167
- Electricians’ Tools (006026) .......................................... 131
- Electronic Troubleshooting of
  - Industrial Motor Controllers (086065) ......................... 173
- Industrial Computer Networks (086069) ......................... 174
- Industrial Electronic Troubleshooting (086064) ................ 173
- Troubleshooting Electrical Systems (006018) ................... 130
- Troubleshooting Electronic Equipment and Systems (Block B06) ......................................................... 157
- Troubleshooting Industrial Control Systems and Output Devices (086067) ......................................................... 173
- Troubleshooting Industrial Computer Systems and Software (086068) ......................................................... 174
- Troubleshooting Industrial Electrical, Electronic, and Computer Systems (Block B26) ......................................................... 173
- Troubleshooting Sensing Devices and Systems (086066) .... 173

### Fittings, Conduits, Fuses, and Batteries

- Batteries and Electronic Power Supplies (6598) .................. 148
- Conductors and Fittings (006014) .................................... 129
- Conductors, Insulators, and Batteries (086005) ................. 151
- Data, Voice, and Video Cabling (086E16) ......................... 139
- Electrical Wiring Practices (086E02) ............................... 137
- Fiber Optics (086E03) ..................................................... 137
- Fiber Optics Training Kit (086803) .................................... 136
- Storage Batteries (4343) ................................................ 146
- Working with Conduit (006015) ....................................... 130

### Industrial Control/PLCs

- Basic Industrial Electronic System Applications (Block B15) ......................................................... 166
- Distributed Control Systems, Part 1 (086084) ................... 135
- Distributed Control Systems, Part 2 (086085) .................. 135
- Distributed Control Systems, Part 3 (086086) ................. 135
- Electronic Instrumentation and Control (Block B13) ....... 165
- Electronic Process Control (086E17) .............................. 139
- Industrial Electronic Circuit Applications (Block B14) ....... 165
- Industrial Microprocessors (086E05) ............................. 137
- Industrial Motor Control (for Programmable Logic Controllers), Part 1 (006011) ......................... 129
- Industrial Motor Control (for Programmable Logic Controllers), Part 2 (006012) ......................... 129
- Introduction to Microprocessors (Block B11) ..................... 164
- Motor Control Fundamentals (for Programmable Logic Controllers) (006010) ......................... 129
- Number Systems and Logic (2130A-B) .......................... 141
- Programmable Controllers and Microprocessors (086061) .... 172
- Servo and Control Systems (086059) .............................. 172
- Troubleshooting Industrial Control Systems and Output Devices (086067) ......................................................... 173

### Lighting and Heating

- Electric Furnaces (4420A-B) ............................................ 146
- Electric Heating (006034) .............................................. 133
- Electric Lamps, Part 1 (006031) ....................................... 132
- Electric Lamps, Part 2 (006032) ....................................... 133
- Illumination Principles (6646) ....................................... 149
- Interior and Exterior Lighting Practices (006016) .............. 130
- Lighting Control (006033) .............................................. 133
**Microprocessors**

- 8085 Microprocessor Trainer (086802) .............................................. 136
- Basic Industrial Computer Systems (Block B10) ............................ 114
- Electronic Process Control (086E17) .................................................... 139
- Industrial Microprocessors (086E05) .................................................... 137
- Introduction to Microprocessors (Block B11) ..................................... 164
- Programmable Controllers and Microprocessors (086061) ............... 172

**Transformers**

- Design of Transformers (4415) .............................................................. 146
- Distribution and Power Transformers (4042) ....................................... 145
- Electrical Energy Distribution (086013) ............................................. 153
- Electrical Power Distribution
  - and Transmission for the Technician (786E01) ................................ 290
- Instrument Transformers (6793) ............................................................ 150
- Local Distribution of Electrical Power (006038) .................................. 284
- Transformer Operation (4041) .............................................................. 144
- Transformers (086011) ......................................................................... 153
- Transformation for Lineworkers (786E05) .......................................... 291
- Transformers (4040) ........................................................................... 144
- Underground Power Systems (006039) ............................................. 284

**Cable/Telecommunications Industry**

- Cable: Introduction to Transmission and Measurement (786001) .... 150
- Cable: Performance Characteristics (786002) .................................... 150
- Fiber Optics (086E03) .......................................................................... 137
- Fiber Optics Training Kit (086803) .................................................. 136
- Data, Voice, and Video Cabling (086E16) ........................................ 139

**Residential and Commercial Electricians**

- The Business of Electrical Contracting (006020) ............................... 130
- Electrical Estimating (086E04) ............................................................ 137
- Electricians’ Tools (006026) ................................................................. 131
Recommended Career/Apprentice Curricula

- Electrical Maintenance/Plant Electrician Apprentice
  - Electronics Maintenance Technician
  - Multicraft Electronics Technician
- Instrumentation and Process Control Technician/Automated Equipment Engineer/Technician (Electro-Mechanical)

Recommended Topical Programs

- Basic Skills for the Electrician
- Basic Electrician/Electrical Technican/Industrial Maintenance Electrician
- Electric Motor and Generator Repair Mechanic
  - Basic Soldering Skills
  - Basic Industrial Electronics
  - Electronics Troubleshooter
- Microprocessor Technology: Concepts, Uses, and Applications
- Industrial Instrumentation and Process Control Technician
  - Electrical Distributor: Knowledge and Skills Training
- Field Service Technician: Electrical Knowledge and Skills Training
- Field Service Technician: Electronics Knowledge and Skills Training
  - Electrician: Residential and Commercial Building Trades
Electrical and Electronics

Curricula

Electrical Maintenance/Plant Electrician Apprentice

The Electrical Maintenance Apprentice/Career Skills curriculum provides trainees with the courseware materials required to enable them to perform the tasks associated with a Plant Electrician. This print-based curriculum has been developed to meet the subject requirements set forth in the standards established by the Bureau of Apprenticeship and Training (BAT). When combined with on-the-job training, this program will provide apprentices/trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

The recommended Electrical Maintenance curriculum starts with pre-technical foundation skills courses. It progresses through electrical principles, electrical equipment and components, electrical motors and motor controllers, and the skills needed by a Plant Electrician. Operations, maintenance, and troubleshooting procedures are emphasized.

Upon completion of this curriculum, students will be able to:

- Perform arithmetic calculations and work with fractions, decimals, ratios, and conversion factors.
- Explain how voltage, current, and resistance are related by Ohm’s Law.
- Identify basic schematic symbols and read electrical drawings.
- Use electrical measuring instruments for troubleshooting.
- Explain the construction and operation of motors, generators, and transformers.
- Perform the important steps for general maintenance and troubleshooting techniques using the required tools.
- Use the National Electrical Code Handbook effectively.

Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Technical Foundation Skills</td>
<td></td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186023</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
</tr>
<tr>
<td>Fluid Measurement</td>
<td>186025</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
<tr>
<td>Trades Safety; Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
<tr>
<td>Material Handling Safety</td>
<td>186006</td>
</tr>
<tr>
<td>Working Safely with Electricity</td>
<td>4400</td>
</tr>
<tr>
<td>Hand and Power Tools</td>
<td>Block X24</td>
</tr>
<tr>
<td>Common Hand Tools, Part 1</td>
<td>18052</td>
</tr>
<tr>
<td>Common Hand Tools, Part 2</td>
<td>18053</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 1</td>
<td>18068</td>
</tr>
<tr>
<td>Electric Drilling and Grinding Tools</td>
<td>18054</td>
</tr>
<tr>
<td>Power Cutting Tools</td>
<td>18055</td>
</tr>
<tr>
<td>Pneumatic Hand Tools</td>
<td>18056</td>
</tr>
<tr>
<td>Plumbing and Pipefitting Tools</td>
<td>28042</td>
</tr>
<tr>
<td>Electricians’ Tools</td>
<td>00602</td>
</tr>
<tr>
<td>Tool Grinding and Sharpening</td>
<td>18057</td>
</tr>
<tr>
<td>Woodworking Hand Tools</td>
<td>18058</td>
</tr>
<tr>
<td>Routers, Power Planers, and Sanders</td>
<td>18059</td>
</tr>
<tr>
<td>Jacks, Hoists, and Pulleys</td>
<td>18060</td>
</tr>
<tr>
<td>Applied Geometry</td>
<td>Block X25</td>
</tr>
<tr>
<td>Practical Trigonometry</td>
<td>X0212</td>
</tr>
<tr>
<td>Reading Prints and Schematics</td>
<td>Block X25</td>
</tr>
<tr>
<td>Introduction to Print Reading</td>
<td>186080</td>
</tr>
<tr>
<td>Print Reading Symbols and Abbreviations</td>
<td>186081</td>
</tr>
<tr>
<td>Dimensioning and Tolerancing</td>
<td>186082</td>
</tr>
<tr>
<td>Print Reading Applications</td>
<td>186083</td>
</tr>
<tr>
<td>Building Drawings</td>
<td>186043</td>
</tr>
<tr>
<td>Electrical Drawings and Circuits</td>
<td>186044</td>
</tr>
<tr>
<td>Electronic Drawings</td>
<td>186045</td>
</tr>
<tr>
<td>Hydraulic and Pneumatic Drawings</td>
<td>186046</td>
</tr>
<tr>
<td>Piping: Drawings, Materials, and Parts</td>
<td>186047</td>
</tr>
<tr>
<td>Welding Symbols</td>
<td>186048</td>
</tr>
<tr>
<td>Sheet Metal Basics</td>
<td>186049</td>
</tr>
<tr>
<td>Sketching</td>
<td>186050</td>
</tr>
</tbody>
</table>

AC/DC and Electrical Fundamentals

DC Principles                                      | Block A21     |
Nature of Electricity                              | 086001        |
Circuit Analysis and Ohm’s Law                     | 086002        |
Capacitors and Inductors                          | 086003        |
Magnetism and Electromagnetism                    | 086004        |
Conductors, Insulators, and Batteries             | 086005        |
DC Motors and Generator Theory                    | 086006        |

Optional Laboratory Experiments:

Electronic Simulation Software                     | 086800        |
Experiments with Basic DC Theory – Lab Manual      | 086087        |
AC Principles                                     | Block A22     |
Alternating Current                               | 086007        |
Alternating Current Circuits                       | 086008        |
Inductors in AC Circuits                          | 086009        |
Capacitors in AC Circuits                         | 086010        |
Transformers                                       | 086011        |
Alternators                                       | 086012        |
Electrical Energy Distribution                    | 086013        |
Rectification and Basic Electronic Devices        | 086014        |
Experiments with Basic AC Theory – Lab Manual      | 086088        |
Analog Circuit Measurement                        | Block A23     |
Basic Test Equipment                              | 086025        |
Troubleshooting with Voltage-Ohm-Milliamp Meters (VOMs) | 086026        |
Using Basic Oscilloscopes                         | 086027        |
Experiments in Electrical Measurements – Lab Manual | 086089        |
Electrical Safety for the Trades                  | 180005        |
Electrical Equipment                              | Block A24     |
Functional Skills Used by a Plant Electrician

Reading Electrical Schematic Diagrams .................................................. 006022
Electrical Blueprint Reading ................................................................. 006036
Electrical Wiring Practices ................................................................ 086E01
Electric Lamps, Part 1 ...................................................................... 006031
Electric Lamps, Part 2 ...................................................................... 006032
Lighting Control .............................................................................. 006033
National Electrical Code (NEC Code and Textbook Course) ............. 5177EM
Preventive Maintenance .................................................................. 286085
Preventive Maintenance Techniques .................................................. 286086
Electrical Grounding ....................................................................... 086E01
Wiring Electrical Circuits ................................................................. 006037

Electrical Components – Operations and Maintenance

Storage Batteries .............................................................................. 4343
Alternators ...................................................................................... 4031
Transformers ................................................................................... 4040
Transformer Operation ..................................................................... 4041
Distribution and Power Transformers ............................................. 4042
Local Distribution of Electrical Power ............................................ 006038
Underground Power Systems .......................................................... 006039
Efficiency Tests .............................................................................. 4342

AC/DC Motors and Motor Controllers – Operations and Maintenance

Industrial Motor Applications .......................................................... 4344
Industrial DC Motors ..................................................................... 086051
Industrial AC Motors .................................................................... 086052
Controlling Industrial Motors ......................................................... 086053
Fractional Horsepower Motors ...................................................... 4033
Motor Control Fundamentals (for Programmable Logic Controllers) .................................................. 006010
Industrial Motor Control (for Programmable Logic Controllers), Part 1 .................................................... 006011
Industrial Motor Control (for Programmable Logic Controllers), Part 2 .................................................... 006012
Repairing DC Motors and Generators ......................................... 4220A-B
AC Motor Repair ........................................................................... 6631A-B
Repairing Fractional Horsepower Motors ................................... 4034
Reconnecting Induction Motors ...................................................... 6585
Electric Heating ............................................................................. 006034
Controls for Air Conditioning .......................................................... 006035

Industrial Applications and Troubleshooting

Analog Electronic Components ......................................................... Block B23
Basic Semiconductor Components: Diodes .................................. 086019
Basic Semiconductor Components: Transistors ......................... 086020
Switching Devices ......................................................................... 086021
Electronic Sensors ......................................................................... 086022
Special Rectifiers .......................................................................... 086023
Optoelectronic and Fiber Optic Components ............................ 086024
Electronics Hardware ................................................................... 086040

Electronics Maintenance Technician

This Apprentice/Career Skills curriculum provides trainees with the courseware materials required to enable them to perform the tasks associated with an Electronics Maintenance Technician. This print-based curriculum has been developed to meet the subject requirements set forth in the standards established by the Bureau of Apprenticeship and Training (BAT). When combined with on-the-job training, this program will provide apprentices/trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

Trainees should either complete or demonstrate mastery of the Electrical Maintenance/Plant Electrician curriculum courses as a prerequisite. The Electronics Maintenance Technician training will cover electronic components, circuits, microprocessors, industrial computer systems, and troubleshooting applications.

Upon completion of this curriculum, students will be able to:

- Work with electrical quantities such as voltage, current, and resistance as they apply to electronic circuits.
- Work with electronic measurement components such as multimeters, oscilloscopes, bridge-type instruments, and digital test equipment.
- Discuss the operation of power supplies, amplifiers, oscillators, detectors, switching circuits, and pulse and logic circuits.
- Explain the operation of electronic equipment and systems such as servo and control systems, numerical control systems, computers, programmable controllers, and microprocessors used in industry.
- Show how linear and digital integrated circuits are used as the building blocks in industrial electronics applications.
- Describe the functions and applications of microprocessor chips and support architecture.
- Locate causes of trouble in electronic circuits using a logical procedure.
- Utilize and explain the block diagram approach to system analysis and troubleshooting.
# Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic Electronics</strong></td>
<td></td>
</tr>
<tr>
<td>Analog Circuit Measurement</td>
<td>Block A23</td>
</tr>
<tr>
<td>Basic Test Equipment</td>
<td>086025</td>
</tr>
<tr>
<td>Troubleshooting with Volt-Ohm-Milliamp Meters (VOMs)</td>
<td>086026</td>
</tr>
<tr>
<td>Using Basic Oscilloscopes</td>
<td>086027</td>
</tr>
<tr>
<td><strong>Optional Laboratory Experiment:</strong></td>
<td></td>
</tr>
<tr>
<td>Electronic Simulation Software</td>
<td>086800</td>
</tr>
<tr>
<td>Experiments in Electrical Measurements – Lab Manual</td>
<td>086089</td>
</tr>
<tr>
<td>Analog Electronic Components</td>
<td>Block B23</td>
</tr>
<tr>
<td>Basic Semiconductor Components: Diodes</td>
<td>086019</td>
</tr>
<tr>
<td>Basic Semiconductor Components: Transistors</td>
<td>086020</td>
</tr>
<tr>
<td>Switching Devices</td>
<td>086021</td>
</tr>
<tr>
<td>Electronic Sensors</td>
<td>086022</td>
</tr>
<tr>
<td>Special Rectifiers: Electron Tubes</td>
<td>086023</td>
</tr>
<tr>
<td>Optoelectronic and Fiber-Optic Components</td>
<td>086024</td>
</tr>
<tr>
<td>Electronics Hardware</td>
<td>086040</td>
</tr>
<tr>
<td>Electronic Systems</td>
<td>Block B25</td>
</tr>
<tr>
<td>Electronic Devices and Amplification</td>
<td>086045</td>
</tr>
<tr>
<td>Audio and RF Circuits</td>
<td>086046</td>
</tr>
<tr>
<td>Oscillators, Feedback, and Waveforms</td>
<td>086047</td>
</tr>
<tr>
<td>Electronic Power Supply Systems</td>
<td>086048</td>
</tr>
<tr>
<td>Industrial Amplification Systems</td>
<td>086058</td>
</tr>
<tr>
<td>Servo and Control Systems</td>
<td>086059</td>
</tr>
<tr>
<td>Pulse and Logic Circuits</td>
<td>086060</td>
</tr>
<tr>
<td>Programmable Controllers and Microprocessors</td>
<td>086061</td>
</tr>
<tr>
<td>Fiber Optics</td>
<td>086E03</td>
</tr>
<tr>
<td>How to Solder and Desolder</td>
<td>SLD1</td>
</tr>
<tr>
<td><strong>Electronics Testing and Troubleshooting</strong></td>
<td></td>
</tr>
<tr>
<td>Troubleshooting Industrial Electronic and Computer Systems</td>
<td>Block B26</td>
</tr>
<tr>
<td>Industrial Electronic Troubleshooting</td>
<td>086064</td>
</tr>
<tr>
<td>Electronic Troubleshooting of Industrial Motor Controls</td>
<td>086065</td>
</tr>
<tr>
<td>Troubleshooting Sensing Devices and Systems</td>
<td>086066</td>
</tr>
<tr>
<td>Troubleshooting Industrial Control Systems and Output Devices</td>
<td>086067</td>
</tr>
<tr>
<td>Troubleshooting Industrial Computer Systems and Software</td>
<td>086068</td>
</tr>
<tr>
<td>Industrial Computer Networks</td>
<td>086069</td>
</tr>
<tr>
<td><strong>Advanced Troubleshooting Techniques</strong></td>
<td>Block B16</td>
</tr>
<tr>
<td>Approach to Troubleshooting</td>
<td>B1601</td>
</tr>
<tr>
<td>Analysis of Systems</td>
<td>B1602</td>
</tr>
<tr>
<td>Test Equipment Applications</td>
<td>B1603</td>
</tr>
<tr>
<td>Safe Troubleshooting Practices</td>
<td>B1604</td>
</tr>
<tr>
<td>Troubleshooting Industrial Systems, Part 1</td>
<td>B1605</td>
</tr>
<tr>
<td>Troubleshooting Industrial Systems, Part 2</td>
<td>B1606</td>
</tr>
<tr>
<td>Data, Voice, and Video Cabling</td>
<td>086E16</td>
</tr>
<tr>
<td><strong>Digital/Electronic Circuits</strong></td>
<td></td>
</tr>
<tr>
<td>Reactive Circuits</td>
<td>Block B22</td>
</tr>
<tr>
<td>Reactance and Impedance</td>
<td>086037</td>
</tr>
<tr>
<td>Resonant Circuits</td>
<td>086038</td>
</tr>
<tr>
<td>Applications and Troubleshooting of Resonant Circuits</td>
<td>086039</td>
</tr>
<tr>
<td>Experiments with Resonant Circuits – Lab Manual</td>
<td>086090</td>
</tr>
<tr>
<td><strong>Basic Electronic Circuits</strong></td>
<td>Block B24</td>
</tr>
<tr>
<td>Rectifiers and Power Supplies</td>
<td>086041</td>
</tr>
<tr>
<td>Amplifiers</td>
<td>086042</td>
</tr>
<tr>
<td>Oscillators</td>
<td>086043</td>
</tr>
<tr>
<td>Modulation and Detection Circuits</td>
<td>086044</td>
</tr>
<tr>
<td>Switching Circuits</td>
<td>086054</td>
</tr>
<tr>
<td>Logic Circuits</td>
<td>086055</td>
</tr>
<tr>
<td>Gating and Counting Circuits</td>
<td>086056</td>
</tr>
<tr>
<td>Pulse and Digital Circuits</td>
<td>086057</td>
</tr>
<tr>
<td>Digital Electronics</td>
<td>086E18</td>
</tr>
<tr>
<td><strong>Basic Industrial Computer Systems</strong></td>
<td>Block B10</td>
</tr>
<tr>
<td>Industrial Computer Fundamentals</td>
<td></td>
</tr>
<tr>
<td>Digital and Analog Systems</td>
<td>B1001</td>
</tr>
<tr>
<td>Software and Programming</td>
<td>B1002</td>
</tr>
<tr>
<td>Computer-Aided Control Systems</td>
<td>B1003</td>
</tr>
<tr>
<td>Interfacing Principles</td>
<td>B1004</td>
</tr>
<tr>
<td><strong>Microprocessors</strong></td>
<td></td>
</tr>
<tr>
<td>Introduction to Microprocessors</td>
<td>Block B11</td>
</tr>
<tr>
<td>Introduction to Computers</td>
<td>B1101</td>
</tr>
<tr>
<td>Introduction to Microprocessor Applications</td>
<td>B1102</td>
</tr>
<tr>
<td>Microprocessor Basics, Part 1</td>
<td>B1103</td>
</tr>
<tr>
<td>Microprocessor Basics, Part 2</td>
<td></td>
</tr>
<tr>
<td>Overview of What’s in a Microprocessor</td>
<td>B1104</td>
</tr>
<tr>
<td>Motor Control Fundamentals (for Programmable Logic Controllers)</td>
<td>006010</td>
</tr>
<tr>
<td>Industrial Motor Control (for Programmable Logic Controllers), Part 1</td>
<td>006011</td>
</tr>
<tr>
<td>Industrial Motor Control (for Programmable Logic Controllers), Part 2</td>
<td>006012</td>
</tr>
<tr>
<td>Industrial Microprocessors</td>
<td>086E05</td>
</tr>
<tr>
<td><strong>Industrial Controllers</strong></td>
<td></td>
</tr>
<tr>
<td>Electronic Process Control</td>
<td>086E17</td>
</tr>
<tr>
<td>Industrial Electronic Circuit Applications</td>
<td>Block B14</td>
</tr>
<tr>
<td>Interfacing Process Variables</td>
<td>B1401</td>
</tr>
<tr>
<td>Motor Control and Servo Systems</td>
<td>B1402</td>
</tr>
<tr>
<td>Numerical Control Systems</td>
<td>B1403</td>
</tr>
<tr>
<td>Programmable Controllers</td>
<td>B1402</td>
</tr>
<tr>
<td>Industrial Robots</td>
<td>B1405</td>
</tr>
<tr>
<td>Basic Industrial Electronic System Applications</td>
<td>Block B15</td>
</tr>
<tr>
<td>Voltage and Frequency Controllers</td>
<td>B1501</td>
</tr>
<tr>
<td>Nondestructive Test Equipment</td>
<td>B1502</td>
</tr>
<tr>
<td>Resistance Welding Equipment</td>
<td>B1503</td>
</tr>
<tr>
<td>Dielectric and Induction Heating</td>
<td>B1504</td>
</tr>
<tr>
<td>Cranes, Scales, and Materials Handling</td>
<td>B1505</td>
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Estimated Curriculum Duration: 662 hours (excluding optional lab experiments).

Number of Exams: 78.

**Optional Laboratory Experiments:**

- Measurements Trainer : XK-100
- Digital Trainer : XK-200
- Full Function Digital Multimeter Kit : 086801
- 8085 Microprocessor Trainer : 086802
- Fiber Optics Training Kit : 086803
Multicraft Electronics Technician

This skills curricula is designed for the Electronics Technician who also has Mechanical and Electrical (multicraft) duties.

Trainees will progress from a comprehensive foundation in safety, math and measurements to the electrical and electronics principles and applications needed to be effective on-the-job. The courses focus on the components and circuits used in PLC systems.

Upon completion of this program, students will be able to:

- Understand DC and AC principles.
- Use electrical testing and troubleshooting measurement instruments such as multimeters, VOMs, and oscilloscopes.
- Identify electronic components by sight, function, and operating characteristic, and describe how they are used in electronic circuits.
- Learn the principles of Boolean logic – how computer-driven industrial systems make decisions, route parts and sort data.
- Understand, evaluate, and troubleshoot integrated circuits, microprocessors, and PLC operations and programming.

### Base Program

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Technical Foundation Skills</strong></td>
<td></td>
</tr>
<tr>
<td>Industrial Safety</td>
<td>186001</td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186002</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186003</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186004</td>
</tr>
<tr>
<td>Safe Handling of Pressurized Gases and Welding</td>
<td>186005</td>
</tr>
<tr>
<td>Electrical Safety for the Trades</td>
<td>186006</td>
</tr>
<tr>
<td>Material Handling Safety</td>
<td>186007</td>
</tr>
<tr>
<td>Machine Shop Safety</td>
<td>186008</td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>186009</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186010</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186011</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186012</td>
</tr>
<tr>
<td>Metric System</td>
<td>186013</td>
</tr>
<tr>
<td>Formulas</td>
<td></td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td></td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>186014</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186015</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186016</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186017</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186018</td>
</tr>
<tr>
<td>Fluid Measurement</td>
<td>186019</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186020</td>
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<td>Bench Work</td>
<td>5004A-C</td>
</tr>
<tr>
<td>Practical Trigonometry</td>
<td>X0212</td>
</tr>
<tr>
<td><strong>AC/DC Principles, Testing, and Troubleshooting</strong></td>
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<td>DC Principles</td>
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<tr>
<td>Nature of Electricity</td>
<td></td>
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<tr>
<td>Circuit Analysis and Ohm’s Law</td>
<td>086002</td>
</tr>
<tr>
<td>Capacitors and Inductors</td>
<td>086003</td>
</tr>
<tr>
<td>Magnetism and Electromagnetism</td>
<td>086004</td>
</tr>
<tr>
<td>Conductors, Insulators, and Batteries</td>
<td>086005</td>
</tr>
<tr>
<td>DC Motors and Generator Theory</td>
<td>086006</td>
</tr>
<tr>
<td><strong>Optional Laboratory Experiment:</strong></td>
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<tr>
<td>Electronic Simulation Software</td>
<td>086800</td>
</tr>
<tr>
<td>Experiments with Basic DC Theory – Lab Manual</td>
<td>086087</td>
</tr>
<tr>
<td>AC Principles</td>
<td>Block A22</td>
</tr>
<tr>
<td>Alternating Current</td>
<td>086007</td>
</tr>
<tr>
<td>Alternating Current Circuits</td>
<td>086008</td>
</tr>
<tr>
<td>Inductors in AC Circuits</td>
<td>086009</td>
</tr>
<tr>
<td>Capacitors in AC Circuits</td>
<td>086010</td>
</tr>
<tr>
<td>Transformers</td>
<td>086011</td>
</tr>
<tr>
<td>Alternators</td>
<td>086012</td>
</tr>
<tr>
<td>Electrical Energy Distribution</td>
<td>086013</td>
</tr>
<tr>
<td>Rectification and Basic Electronic Devices</td>
<td>086014</td>
</tr>
<tr>
<td>Experiments with Basic AC Theory – Lab Manual</td>
<td>086088</td>
</tr>
<tr>
<td>Analog Circuit Measurement</td>
<td>Block A23</td>
</tr>
<tr>
<td>Basic Test Equipment</td>
<td>086025</td>
</tr>
<tr>
<td>Troubleshooting with</td>
<td></td>
</tr>
<tr>
<td>Volt-Ohm-Milliamp Meters (VOMs)</td>
<td>086026</td>
</tr>
<tr>
<td>Using Basic Oscilloscopes</td>
<td>086027</td>
</tr>
<tr>
<td>Experiments in Electrical Measurements – Lab Manual</td>
<td>086089</td>
</tr>
<tr>
<td>Component Testers</td>
<td>086062</td>
</tr>
<tr>
<td>Digital Test Equipment</td>
<td>086063</td>
</tr>
<tr>
<td>Preventive Maintenance</td>
<td>286085</td>
</tr>
<tr>
<td>Preventive Maintenance Techniques</td>
<td>286086</td>
</tr>
<tr>
<td>Reading Electrical Schematic Diagrams</td>
<td>086022</td>
</tr>
<tr>
<td>Industrial Fuses</td>
<td>086076</td>
</tr>
<tr>
<td><strong>Mechanical Maintenance</strong></td>
<td></td>
</tr>
<tr>
<td>Lubrication, Part 1</td>
<td>286091</td>
</tr>
<tr>
<td>Lubrication, Part 2</td>
<td>286092</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 1</td>
<td>186006</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 2</td>
<td>186007</td>
</tr>
<tr>
<td>Bearings and Seals, Part 1</td>
<td>286093</td>
</tr>
<tr>
<td>Bearings and Seals, Part 2</td>
<td>286094</td>
</tr>
<tr>
<td>Pumps, Part 1</td>
<td>286001</td>
</tr>
<tr>
<td>Pumps, Part 2</td>
<td>286002</td>
</tr>
<tr>
<td>Pumps, Part 3</td>
<td>286003</td>
</tr>
<tr>
<td>Mechanical Power Transmission Part 1</td>
<td>286101</td>
</tr>
<tr>
<td>Mechanical Power Transmission Part 2</td>
<td>286102</td>
</tr>
<tr>
<td>Mechanical Power Transmission Part 3</td>
<td>286103</td>
</tr>
<tr>
<td>Hydraulic Power Basics</td>
<td>286060</td>
</tr>
<tr>
<td>Hydraulic Components</td>
<td></td>
</tr>
<tr>
<td>Actuators, Pumps, and Motors</td>
<td>286061</td>
</tr>
<tr>
<td>Hydraulic Components</td>
<td></td>
</tr>
<tr>
<td>Conductors, Conditioners, and Fluids</td>
<td>286062</td>
</tr>
<tr>
<td>Hydraulic Power System Control</td>
<td>286063</td>
</tr>
<tr>
<td>Hydraulic Power System Troubleshooting</td>
<td>286065</td>
</tr>
<tr>
<td>Interpreting Hydraulic System Schematics</td>
<td>286064</td>
</tr>
<tr>
<td>Predictive Maintenance</td>
<td>286087</td>
</tr>
<tr>
<td>Predictive Maintenance: Vibration Analysis</td>
<td>286088</td>
</tr>
<tr>
<td>Predictive Maintenance: Advanced Topics</td>
<td>286089</td>
</tr>
<tr>
<td><strong>Electronic Circuits and Controllers</strong></td>
<td></td>
</tr>
<tr>
<td>Analog Electronic Components</td>
<td>Block B23</td>
</tr>
<tr>
<td>Basic Semiconductor Components: Diodes</td>
<td>086019</td>
</tr>
<tr>
<td>Basic Semiconductor Components: Transistors</td>
<td>086020</td>
</tr>
<tr>
<td>Switching Devices</td>
<td>086021</td>
</tr>
<tr>
<td>Electronic Sensors</td>
<td>086022</td>
</tr>
<tr>
<td>Special Rectifiers: Electron Tubes</td>
<td>086023</td>
</tr>
<tr>
<td>Optoelectronic and Fiber Optic Components</td>
<td>086024</td>
</tr>
<tr>
<td>Electronics Hardware</td>
<td>086040</td>
</tr>
<tr>
<td>Reactive Circuits</td>
<td>Block B22</td>
</tr>
<tr>
<td>Reactance and Impedance</td>
<td>086037</td>
</tr>
<tr>
<td>Resonant Circuits</td>
<td>086038</td>
</tr>
<tr>
<td>Applications and Troubleshooting of Resonant Circuits</td>
<td>086039</td>
</tr>
<tr>
<td>Experiments with Resonant Circuits – Lab Manual</td>
<td>086090</td>
</tr>
</tbody>
</table>
Basic Electronic Circuits .............................................. Block B24
Rectifiers and Power Supplies ........................................ 086041
Amplifiers ...................................................................... 086042
Oscillators ...................................................................... 086043
Modulation and Detection Circuits ................................. 086044
Switching Circuits ......................................................... 086054
Logic Circuits .................................................................. 086055
Gating and Counting Circuits ......................................... 086056
Pulse and Digital Circuits ................................................ 086057
Distributed Control Systems, Part 1 .............................. 086084
Distributed Control Systems, Part 2 .............................. 086085
Distributed Control Systems, Part 3 .............................. 086086
Electronic Process Control ............................................. 086E17
Industrial DC Motors ..................................................... 086051
Industrial AC Motors ..................................................... 086052
Controlling Industrial Motors ........................................... 086053
Motor Control Fundamentals ........................................... 086054
(Conditioned Cold Start) .............................................. 086054
(Conditioned Cold Start) .............................................. 086055
Safe Troubleshooting Practices ...................................... B1604
Test Equipment Applications ......................................... B1605
Approach to Troubleshooting ........................................ B1606
Microprocessor Trainer ................................................. 086802
Estimated Curriculum Duration: 976 hours
(excluding optional lab experiments).
Number of Exams: 121.

Optional Laboratory Experiment:

Instrumentation and Process Control Technician
Automated Equipment Engineer/Technician
(Electro-Mechanical)

This skills curricula provides trainees with the courseware materials required to enable them to perform the tasks associated with either an Instrumentation and Process Control Technician or an Automated Equipment Engineer/Technician. This print-based curriculum has been developed to meet the subject requirements set forth in the standards established by the Bureau of Apprenticeship and Training (BAT). The Automated Equipment Engineer/Technician curriculum targets the service and maintenance requirements for an automated, technology-based facility that uses instrumentation and process control systems. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

The training programs for both industrial positions start with pre-technical foundation skills courses. They progress to AC/DC fundamentals, electric motors, basic electronics, electronics testing and troubleshooting, digital circuits/microprocessors, industrial controllers and process control instrumentation, and mechanical systems courses.

As referenced in the sequential course outline, it is recommended that the Automated Equipment Engineer/Technician receive supplemental technical training in electrical equipment, troubleshooting electronic components and circuits, and power transmission systems.

Upon completion of this curriculum, students will be able to:

- Use the related principles and application – appropriate to the electrical, electronic, mechanical, hydraulic, and pneumatic skill areas – in the installation, operation and maintenance of instrumentation and process control systems.
- Maintain the common types of electrical motors and motor controllers, generators, and transformers.
- Demonstrate use of the main types of measuring instruments.
- Describe the major control systems found in industry.
- Identify electronic logic, pulse, linear, and digital integrated circuits.
- Use test instruments for troubleshooting electro-mechanical instrumentation and process control systems.
- Isolate and correct problems interfacing with microprocessor/computer control systems.
- Apply troubleshooting techniques to complex electronic components and systems.
- Use the skills required for the maintaining and operating the components found in a basic mechanical power transmission system.
## Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Technical Foundation Skills</strong></td>
<td></td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
<tr>
<td>Material Handling Safety</td>
<td>186006</td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td><strong>Practical Measurements</strong></td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186023</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
</tr>
<tr>
<td>Fluid Measurement</td>
<td>186025</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
<tr>
<td>Working Safely with Electricity</td>
<td>186076</td>
</tr>
<tr>
<td><strong>Hand and Power Tools</strong></td>
<td>Block X24</td>
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<td>Reading Prints and Schematics</td>
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<td>Introduction to Print Reading</td>
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<td>Print Reading Symbols and Applications</td>
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<td>Dimensioning and Tolerancing</td>
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<td>Print Reading Applications</td>
<td>186083</td>
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<td>Building Drawings</td>
<td>186043</td>
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<td>Electrical Drawings and Circuits</td>
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<td>Electronic Drawings</td>
<td>186045</td>
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<tr>
<td>Hydraulic and Pneumatic Drawings</td>
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<td>Piping: Drawings, Materials, and Parts</td>
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<td>Quality Concepts: Tools and Applications</td>
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## AC/DC and Electrical Motor Fundamentals

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<td>DC Principles</td>
<td>Block A21</td>
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<tr>
<td>Nature of Electricity</td>
<td>086001</td>
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<td>Circuit Analysis and Ohm’s Law</td>
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<td>Conductors, Insulators, and Batteries</td>
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## Optional Laboratory Experiment:

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<tr>
<td>Electronic Simulation Software</td>
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<tr>
<td>Experiments with Basic DC Theory – Lab Manual</td>
<td>086807</td>
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**Basic Electronics**

- Analog Electronic Components ........................................... Block B23
- Basic Semiconductor Components: Diodes ................................ 086019
- Basic Semiconductor Components: Transistors ......................... 086020
- Switching Devices ................................................................. 086021
- Electronic Sensors ................................................................... 086022
- Special Rectifiers: Electron Tubes ........................................... 086023
- Optoelectronic and Fiber Optic Components .............................. 086024
- Electronics Hardware ............................................................... 086040
- How to Solder and Desolder ..................................................... SLD1

**Electronic Circuits**

- Reactive Circuits ..................................................................... Block B22
- Reactance and Impedance ......................................................... 086037
- Resonant Circuits ................................................................. 086038
- Applications and Troubleshooting of Resonant Circuits .......... 086039
- Experiments with Resonant Circuits – Lab Manual ................. 086090
- Basic Electronic Circuits ......................................................... Block B24
  - Rectifiers and Power Supplies ............................................... 086041
  - Amplifiers ............................................................................ 086042
  - Oscillators .......................................................................... 086043
  - Modulation and Detection Circuits ...................................... 086044
  - Switching Circuits ................................................................ 086054
  - Logic Circuits ....................................................................... 086055
  - Gating and Counting Circuits .............................................. 086056
- Pulse and Digital Circuits .......................................................... 086057
- Electronic Systems ................................................................... Block B25
  - Electronic Devices and Amplification ..................................... 086045
  - Audio and RF Circuits .......................................................... 086046
  - Oscillators, Feedback, and Waveforms ................................ 086047
  - Electronic Power Supply Systems ....................................... 086048
  - Industrial Amplification Systems ....................................... 086058
  - Servo and Control Systems ............................................... 086059
  - Pulse and Logic Circuits ...................................................... 086060
  - Programmable Controllers and Microprocessors ............... 086061

**Electronics Testing and Troubleshooting**

- Troubleshooting Industrial Electronic and Computer Systems .......... Block B26
- Industrial Electronic Troubleshooting .................................... 086064
- Electronic Troubleshooting of Industrial Motor Controls .......... 086065
- Troubleshooting Sensing Devices and Systems ............................. 086066
- Troubleshooting Industrial Control Systems and Output Devices ......................................................... 086067
- Troubleshooting Industrial Computer Systems and Software .......... 086068
- Industrial Computer Networks ................................................. 086069

**Digital Circuits/Microprocessors**

- Digital Electronics ............................................................. 086E18
- Basic Industrial Computer Systems ................................... Block B10
  - Industrial Computer Fundamentals ................................... 81001
  - Digital and Analog Systems ............................................. 81002
  - Software and Programming .............................................. 81003
  - Computer-Aided Control Systems .................................... 81004
  - Interfacing Principles ...................................................... 81005
- Introduction to Microprocessors ........................................ Block B11
- Introduction to Computers .................................................. B1101
- Introduction to Microprocessor Applications .......................... B1102
- Microprocessor Basics, Part 2: Overview of What’s in a Microprocessor ......................................................... B1104
- Industrial Microprocessors .................................................. 086E05
- Industrial Electronic Circuit Applications ................................ Block B14
  - Interfacing Process Variables ........................................... B1401
  - Motor Control and Servo Systems ..................................... B1402
  - Numerical Control Systems ................................................ B1403
  - Programmable Controllers .............................................. B1404

**Industrial Controllers and Process Control**

- Instrumentation .................................................................. 086011
- Heat, Part 1 ........................................................................... 086001
- Heat, Part 2 ........................................................................... 086002
- Pneumatic Instrumentation for the Technician .......................... 286M01
- Control Technology for Technicians ...................................... 286M04
- Distributed Control Systems, Part 1 ...................................... 086084
- Distributed Control Systems, Part 2 ...................................... 086085
- Distributed Control Systems, Part 3 ...................................... 086086
- Process Control ...................................................................... 086E17
- Automatic Process Control Valves ........................................... 6307
- Fluid Flow Measuring and Control Instruments ...................... 6308A-B
- Temperature Measuring and Control Instruments .................. 6306A-B

**Mechanical Systems Used in Process Control**

- Principles of Mechanics, Part 1 ............................................ 286007
- Principles of Mechanics, Part 2 ............................................ 286008
- Bearings and Seals, Part 1 .................................................... 286093
- Bearings and Seals, Part 2 .................................................... 286094
- Mechanical Power Transmission Part 1 .................................. 286101
- Mechanical Power Transmission Part 2 .................................. 286102
- Mechanical Power Transmission Part 3 .................................. 286103
- Belt Power Transmission ...................................................... 2607A-B
- Link Mechanisms ................................................................... 2603
- Gearing ................................................................................. 2446
- Gearing ................................................................................. 2505
- Cam ..................................................................................... 2505
- Lubrication, Part 1 ............................................................... 286091
- Lubrication, Part 2 ............................................................... 286092
- Lubrication, Part 3 ............................................................... 286093
- Mechanical Power Transmission ............................................ 286101
- Mechanical Power Transmission ............................................ 286102
- Mechanical Power Transmission ............................................ 286103
- Belt Power Transmission ...................................................... 2607A-B
- Link Mechanisms ................................................................... 2603
- Gearing ................................................................................. 2446
- Gearing ................................................................................. 2505
- Cam ..................................................................................... 2505
- Lubrication, Part 1 ............................................................... 286091
- Lubrication, Part 2 ............................................................... 286092
- Lubrication, Part 3 ............................................................... 286093
- Mechanical Power Transmission ............................................ 286101
- Mechanical Power Transmission ............................................ 286102
- Mechanical Power Transmission ............................................ 286103
- Belt Power Transmission ...................................................... 2607A-B
- Link Mechanisms ................................................................... 2603
- Gearing ................................................................................. 2446
- Gearing ................................................................................. 2505
- Cam ..................................................................................... 2505
- Lubrication, Part 1 ............................................................... 286091
- Lubrication, Part 2 ............................................................... 286092
- Lubrication, Part 3 ............................................................... 286093

**Advanced Troubleshooting Techniques**

- Basic Industrial Electronic System Applications .................. Block B15
- Voltage and Frequency Controllers ...................................... B1501
- Nondestructive Test Equipment ............................................ B1502
- Resistance Welding Equipment ............................................. B1503
- Dielectric and Induction Heating .......................................... B1504
- Cranes, Scales, and Materials Handling ................................. B1505
- Advanced Troubleshooting Techniques ................................ Block B16
- Approach to Troubleshooting ............................................. B1601
- Analysis of Systems .......................................................... B1602
- Test Equipment Applications ............................................... B1603
- Safe Troubleshooting Practices ............................................ B1604
- Troubleshooting Industrial Systems, Part 1 ......................... B1605
- Troubleshooting Industrial Systems, Part 2 ......................... B1606

**Optional Laboratory Experiment:**

- Microprocessor Trainer ........................................................ 086820
Basic Skills for the Electrician

This topical program provides trainees with the courseware materials that prepare them for the trade of Electrical Technology. Trainees will receive a comprehensive foundation in math and measurement skills, and in electrical principles and measurements.

In addition to the conceptual coverage in the courses, trainees can gain practical experience through a series of “hands-on” experiments they can perform on the XK-100 Measurements Trainer. (The trainer and associated experiment manual are available on an optional basis.)

Upon completion of this program, students will be able to:

• Demonstrate the correct and safe use of the following hand tools: hammers, screwdrivers, chisels, files, knives, wrenches, and hand saws.
• State the correct practice to avoid electric shock when using electric tools and describe a procedure for the treatment of electrical shock.
• Work with fractions, decimals, ratios, and conversion factors.
• Perform the basic arithmetic operations with signed numbers and terms.
• Explain how voltage, current, and resistance are related.
• Use Ohm’s law to solve electrical calculations.
• Identify basic schematic symbols.
• Explain the concept of generator action and motor action.
• Explain how alternators operate.
• Discuss how transformers are constructed.
• Discuss how ohmmeters, voltmeters, and ammeters are used.
• Describe how to use electrical measuring instruments for troubleshooting.

Base Program

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<tr>
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<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
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<td>Working Safely with Chemicals</td>
<td>186002</td>
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<td>Fire Safety</td>
<td>186003</td>
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<td>Material Handling Safety</td>
<td>186006</td>
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<td>Working Safely with Electricity</td>
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<td>Basic Industrial Math</td>
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<td>Addition and Subtraction</td>
<td>186008</td>
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<td>Multiplication and Division</td>
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<td>Fractions, Percents, Proportions, and Angles</td>
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<td>Metric System</td>
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<td>Introduction to Algebra</td>
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<td>Linear and Distance Measurement</td>
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<td>Bulk Measurement</td>
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<td>Temperature Measurement</td>
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<td>Fluid Measurement</td>
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<td>DC Motors and Generator Theory</td>
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Optional Laboratory Experiments:

Electronic Simulation Software ................................................. 086800
Experiments with Basic DC Theory – Lab Manual ......................... 086087
AC Principles ................................................................. Block A22
Alternating Current ........................................................... 086007
Alternating Current Circuits ................................................ 086008
Inductors in AC Circuits ..................................................... 086009
Capacitors in AC Circuits .................................................... 086010
Transformers ........................................................................ 086011
Alternators ........................................................................... 086012
Electrical Energy Distribution ............................................... 086013
Rectification and Basic Electronic Devices ............................. 086014
Experiments with Basic AC Theory – Lab Manual ......................... 086088
Analog Circuit Measurement .................................................. 086025
Basic Test Equipment ............................................................ 086025
Troubleshooting with Volt-Ohm-Milliamp Meters (VOMs) .............. 086026
Using Basic Oscilloscopes .................................................... 086027
Experiments in Electrical Measurements – Lab Manual ............... 086089
Electrical Safety for the Trades ........................................... 186005

Estimated Program Duration: 285 hours
(Number of Exams: 50.)


**Basic Electrician/ Electrical Technician/ Industrial Maintenance Electrician**

The Basic Electrician topical program provides trainees with the related courseware covering a practical working knowledge of electrical wiring used for lighting, equipment, motors, and heating. The program covers the instructional skills regarding the installation, maintenance, and repair of electrical equipment. Trainees should enter the program with the knowledge of the courses covered in the Basic Skills for the Electrician program.

The Basic Electrician program can be used as a stepping stone for those trainees who are going to continue their studies and specialize in electrical maintenance, construction, or enter an apprentice program. When combined with on-the-job training, this program will provide trainees with the skills and knowledge they will need to perform those tasks associated with the Electrician’s trade.

Upon completion of this program, students will be able to:
- Recognize the basic electrical symbols used on electrical schematics and wiring plans.
- Describe how to bend and install conduit.
- Explain the operation and construction of motors, generators, and transformers.
- Use the National Electrical Code handbook effectively.
- Select the correct type of lamp needed for a given application.
- Size and select conductors for a given installation.
- Calculate electrical equipment ratings based on electrical loads.
- Test for opens, shorts, and grounds.

**Base Program**

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<tr>
<td>Reading Electrical Schematic Diagrams</td>
<td>006022</td>
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<td>Electrical Equipment</td>
<td>Block A24</td>
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<td>Conductors and Insulators in Industry</td>
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<td>Working with Conduit</td>
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<td>Electrical Boxes</td>
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<td>Industrial Enclosures and Raceways</td>
<td>086073</td>
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<td>Connecting Electrical Equipment, Part 1</td>
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<td>Connecting Electrical Equipment, Part 2</td>
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<td>Industrial Fuses</td>
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<td>Industrial Circuit Breakers</td>
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<td>Plugs, Receptacles, and Lampholders</td>
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<td>Industrial Switches</td>
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<td>Industrial Relay Ladder Logic</td>
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<td>Electrical Wiring Practices</td>
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<td>Lighting Control</td>
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<td>Storage Batteries</td>
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<td>Electrical Grounding</td>
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<td>Transformers</td>
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<td>Industrial DC Motors</td>
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<td>Industrial AC Motors</td>
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<td>Controlling Industrial Motors</td>
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<td>Fractional Horsepower Motors</td>
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<td>Industrial Motor Applications</td>
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<td>Industrial Motor Control (for Programmable Logic Controls), Part 1</td>
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<td>Data, Voice, and Video Cabling</td>
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<td>Controls for Air Conditioning</td>
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<td>Distribution and Power Transformers</td>
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Estimated Program Duration: 509 hours.  
Number of Exams: 67.
Electric Motor and Generator Repair Mechanic

This topical program provides trainees with the concepts and techniques used for the repair of electric motors, motor controllers, and generators. The program is designed for both entry-level and experienced electricians who have a background in machine operation and mathematics. Specialized training covers AC/DC machinery, industrial motor control equipment and applications, transformers, and storage batteries.

Upon completion of this program, students will be able to:

- Recognize the basic electrical symbols used on electrical schematics and wiring plans.
- Explain the operation and construction of motors, generators, and transformers.
- Use the National Electrical Code handbook effectively.
- Describe the operation of industrial motor controls.
- Prescribe testing procedures for motors and generators.
- Explain how to reconnect induction motors for changes in voltage, number of phases, number of poles, frequency, and output.
- Relate how to test and troubleshoot motors and generators for mechanical and electrical faults.

### Base Program

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<td>Industrial Circuit Breakers</td>
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<td>Plugs, Receptacles, and Lampholders</td>
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<td>Industrial Switches</td>
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<td>Industrial Relay Ladder Logic</td>
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<td>Industrial Relays, Contractors, and Solenoids</td>
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<td>Electrical Wiring Practices</td>
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<td>Transformers</td>
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<td>Reading Electrical Schematic Diagrams</td>
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<td>Repairing DC Motors and Generators</td>
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<td>Predictive Maintenance: Vibration Analysis</td>
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<td>Predictive Maintenance: Advanced Topics</td>
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</table>

Estimated Program Duration: 448 hours.
Number of Exams: 63.

### Basic Soldering Skills

This topical program provides trainees with the basic techniques for soldering and desoldering. It includes a "hands-on" lesson, using a soldering kit.

Upon completion of this program, students will be able to:

- Select the appropriate soldering iron and solder.
- Tin a soldering iron.
- Solder an electronic component to a PC board.
- Desolder with a solder braid or desoldering pump on a PC board.
- Use a heat sink or long-nose pliers when soldering and desoldering.
- Assemble and solder the practice kit.

### Base Program

<table>
<thead>
<tr>
<th>Course Title</th>
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<td>How to Solder and Desolder</td>
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Estimated Program Duration: 3 hours.
Number of Exams: 1.

### Basic Industrial Electronics

This topical program provides trainees with the related courseware that prepares them for career opportunities in Electronics Technology. These positions include Electronics Technician, Industrial Electronics Specialist, Electronic Systems Electrician, Electrician, and Electronics Troubleshooter. The program can also be used to upgrade Industrial Maintenance Electricians by providing them with the skills and knowledge to understand electronic equipment and systems. Trainees will study the following subjects: electronic instruments and measurements, reactive circuits, electronic components, basic electronic circuits, and electronic systems.

In addition to the conceptual coverage of the courses, trainees can gain practical experience through a series of "hands-on" experiments they can perform on the XK-100 Measurements Trainer. (The trainer and associated experiment manual are available on an optional basis.)
Upon completion of this program, students will be able to:

- Work with electrical quantities such as voltage, current, and resistance as they apply to electronic circuits.
- Select the proper type of test equipment for a particular electronic application.
- Interpret and work with specifications and tables used to identify component parts such as resistors, capacitors, inductors, and semiconductors.
- Discuss the operation of basic electronic circuits including power supplies, amplifiers, oscillators, detection circuits, switching circuits, and pulse and logic circuits.
- Discuss the operation of electronic equipment and systems such as servo and control systems, programmable controllers, and microprocessors as used in industry.
- Locate causes of trouble in basic electronic circuits by a logical process.
- Demonstrate how to use a meter to make both out-of-circuit and in-circuit tests on common electronic components.

**Base Program**

<table>
<thead>
<tr>
<th>Course Title</th>
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<tr>
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<td>Basic Test Equipment</td>
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<td>Volt-Ohm-Millamp Meters (VOMs)</td>
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<tr>
<td>Using Basic Oscilloscopes</td>
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<td><strong>Optional Laboratory Experiment:</strong></td>
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<td>Electronic Simulation Software</td>
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<td>Experiments in Electrical Measurements – Lab Manual</td>
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<td>Component Testers</td>
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<td>Digital Test Equipment</td>
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<td>Reactive Circuits</td>
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<td>Applications and Troubleshooting of Resonant Circuits</td>
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<td>Experiments with Resonant Circuits – Lab Manual</td>
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<td>Electronic Troubleshooting of Industrial Motor Controls</td>
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<td>Distributed Control Systems, Part 2</td>
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<td>Distributed Control Systems, Part 3</td>
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<tr>
<td>Fiber Optics Training Kit</td>
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Estimated Program Duration: 294 hours
(excluding optional lab experiments).
Number of Exams: 48.

**Optional Laboratory Experiments:**

- Measurements Trainer – XK-100
- Fiber Optics Training Kit – 086803

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**Electronics Troubleshooter**

The **Electronics Troubleshooter** topical program provides experienced employees with the related courseware they will need to advance their troubleshooting skills. These trade positions include Foremen, Production Testers, Testing Technicians, Customer Service Technicians, Field Service Technicians and Engineers, and Quality Control Technicians.

The program covers maintenance and troubleshooting methods and techniques, electronic testing and measuring instruments, and safe troubleshooting practices. Case histories of problems in industrial systems illustrate correct troubleshooting procedures.

Employees entering this program should have working experience and knowledge covering electrical and electronic circuits and instruments; pulse, linear, digital, and logic circuits; industrial control systems and microprocessors.

In addition, trainees can gain practical experience through a series of “hands-on” experiments they can perform on the Microprocessor Trainer. (The trainer and associated experiment manual are available on an optional basis.)

Upon completion of this program, students will be able to:

- List the important steps in preparing for general maintenance and troubleshooting, and name the basic tools required.
- Explain the importance of maintaining minimum downtime in an industrial operation.
- Use a systematic and safe procedure when troubleshooting.
- Locate causes of trouble in basic electronic circuits by a logical process.
- Identify the proper electronic test instruments for troubleshooting different problems in electronic circuits.
- Demonstrate how to narrow a difficult problem in a piece of electronic equipment to a section, then to a stage, then to a circuit, and finally to the faulty component.
- Show how to use triggered oscilloscopes, DVMs, time/frequency meters, logic probes, and precision test equipment to locate faults and determine proper performance in industrial electronic systems.
- Describe effective ways of handling hard-to-find and intermittent problems.
Microprocessor Technology: Concepts, Uses, and Applications

This topical program provides trainees with the related courseware that prepares them for advanced skills assignments using Microprocessor Technology. The training provides a conceptual understanding of how microprocessors function within programmable controllers, industrial control, and electronic instrumentation equipment. Operations, maintenance, and troubleshooting techniques are emphasized.

The Microprocessor Technology program is ideal for electricians, maintenance personnel, technicians, engineers, managers, and others who work with microprocessors and programmable/industrial controllers. In addition, trainees will gain practical experience through a series of “hands-on” experiments they will perform using the Microprocessor Trainer.

Trainees entering this program should have knowledge of practical mathematics, electricity, and electronics.

Upon completion of this program, students will be able to:

- Convert back and forth among decimal, binary, octal, and hexadecimal number systems.
- Write, enter, and run basic microprocessor programs.
- Use a dual-trace oscilloscope, DMM, logic probe, and logic pulser to troubleshoot hardware faults.
- Measure AC and DC system voltages.
- Use breakpoints and single-step operation to debug programs.
- Describe the functions of microprocessor chips and support architecture.
- Troubleshoot software and hardware faults using diagnostics.
- Understand the operations of motor controllers, numerical control systems, programmable controllers, and industrial robots.
- Discuss the principles of electronic servomechanism equipment and systems.
- Identify applications for numerical control systems: milling, drilling, and boring.

Base Program

<table>
<thead>
<tr>
<th>Course Title</th>
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<tr>
<td>Troubleshooting Industrial Electrical, Electronic, and Computer Systems</td>
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<tr>
<td>Troubleshooting Industrial Electronic Troubleshooting</td>
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<td>Troubleshooting Industrial Motor Controllers</td>
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<td>Troubleshooting Sensing Devices and Systems</td>
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<td>Troubleshooting Industrial Computer Systems and Software</td>
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<td>Data, Voice, and Video Cabling</td>
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<td>Advanced Troubleshooting Techniques</td>
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<td>Approach to Troubleshooting</td>
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<td>Analysis of Systems</td>
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<td>Test Equipment Applications</td>
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<td>Safe Troubleshooting Practices</td>
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<td>Microprocessor Trainer</td>
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</table>

Estimated Duration: 282 hours (excluding optional lab experiments).
Number of Exams: 37.

Optional Laboratory Experiment: Full Function Digital Multimeter Kit
Industrial Instrumentation and Process Control Technician

This topical program provides trainees with an understanding of the components that comprise a process control system. It covers systems operation, and how to perform maintenance and troubleshooting functions. The program is designed for electronic and instrumentation technicians, and electricians working with process control equipment who need to upgrade their skills. Trainees entering this program should be proficient in mathematics through algebraic equations, and have a working knowledge of the principles of electricity, test equipment, electronic components, circuits, and troubleshooting.

Upon completion of this program, students will be able to:

- Relate the role of the controller in a process control system.
- Describe how the various solid state logic systems are used in industrial control applications.
- Describe temperature, pressure, flow, humidity, weight and level applications, measurement and control techniques.
- Discuss the operation of a numerical control system, motor control systems, programmable controllers, and their relationship to computers and robots.

### Base Program

<table>
<thead>
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<td>Elements of Chemistry</td>
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<td>Heat, Part 1</td>
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<td>Heat, Part 2</td>
<td>686002</td>
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<td>Pneumatic Instrument for the Technician</td>
<td>286M01</td>
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<td>Control Technology for Technicians</td>
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<td>Principles of Automatic Process Control Instruments</td>
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<td>6307</td>
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<td>Process Pressure Measuring and Control Instruments</td>
<td>6309A-B</td>
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<td>Fluid Flow Measuring and Control Instruments</td>
<td>6308A-B</td>
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<td>Temperature Measuring and Control Instruments</td>
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<td>Liquid Level Measuring and Control Instruments</td>
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<td>Predictive Maintenance: Advanced Topics</td>
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<td>Motor Control Fundamentals</td>
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</table>

Estimated Program Duration: 484 hours.
Number of Exams: 69.

### Electrical Distributor: Knowledge and Skills Training

This topical program provides people employed in the Electrical Distribution industry with the technical knowledge needed to understand the principles, components and equipment used by your customers. It is recommended that students learn the business knowledge provided in the Distribution Industry: Core Knowledge and Skills program described in Resource 2, Foundation Skills, before starting the electrical training. Supplemental video based courses are suggested to reinforce the independent study units.

Upon completion of this program, students will be able to:

- Understand important principles and applications such as voltage, current, resistance and Ohm's Law.
- Identify all types of components and test equipment including oscilloscopes, meters, boxes, conduit, fittings, switches, circuits and fuses.
- Explain the operation and use of motors, generators and transformers.
- Refer to the National Electrical Code handbook effectively.

### Base Program

<table>
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<th>Course Title</th>
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<td>Circuit Analysis and Ohm's Law</td>
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<td>Capacitors and Inductors</td>
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<td>Magnetism and Electromagnetism</td>
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<td>Conductors, Insulators, and Batteries</td>
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<td>DC Motors and Generator Theory</td>
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<td>Alternating Current</td>
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Field Service Technician: Electrical Knowledge and Skills Training

This topical program provides people employed as a field service technician with the technical knowledge needed to understand the principles, components and equipment used by your customers. The training builds upon the pre-technical and business knowledge learned in the Field Service Technician Core Knowledge and Skills program described in Resource 2, Foundation Skills. Supplemental video-based courses are suggested to reinforce the independent study units.

Upon completion of this program, students will be able to:
- Understand important principles and applications such as voltage, current, resistance and Ohm’s Law.
- Identify test equipment and components including oscilloscopes, meters, circuits, switches and fuses.
- Describe the operation of industrial motor controls, relating how to test and troubleshoot motors and generators for mechanical and electrical faults.

Base Program

**Course Title** | **Course Number**
--- | ---
DC Principles | Block A21
Nature of Electricity | 086001
Circuit Analysis and Ohm’s Law | 086002
Capacitors and Inductors | 086003
Magnetism and Electromagnetism | 086004
Capacitors, Insulators and Batteries | 086005
DC Motors and Generator Theory | 086006

Optional Laboratory Experiments:
- Electronic Simulation Software | 086800
- Experiments with Basic DC Theory – Lab Manual | 086087
- AC Principles | Block A22
- Alternating Current | 086007
- Alternating Current Circuits | 086008
- Inductors in AC Circuits | 086009
- Capacitors in AC Circuits | 086010
- Transformers | 086011
- Alternators | 086012
- Electrical Energy Distribution | 086013
- Rectification and Basic Electronic Devices | 086014
- Experiments with Basic AC Theory – Lab Manual | 086088
- Analog Circuit Measurement | Block A23
- Basic Test Equipment | 086025
- Troubleshooting with Volt-Ohm-Millamp Meters (VOMs) | 086026
- Using Basic Oscilloscopes | 086027
- Using Basic Oscilloscopes | 086028
- Experiments in Electrical Measurements – Lab Manual | 086089
- Component Testers | 086062
- Digital Test Equipment | 086063
- Transformers | 4040
- Industrial DC Motors | 086051
- Industrial AC Motors | 086052
- Controlling Industrial Motors | 086053
- Motor Control Fundamentals (for Programmable Logic Controllers) | 006010
- Industrial Motor Control (for Programmable Logic Controllers), Part 1 | 006011
- Industrial Motor Control (for Programmable Logic Controllers), Part 2 | 006012
- Alternators | 4031
- Fractional Horsepower Motors | 4033
- Repairing Fractional Horsepower Motors | 4034
- Repairing DC Motors and Generators | A220A-B
- AC Motor Repair | 6631A-B
- Reconnecting Induction Motors | 6585
- National Electrical Code (NEC Code and Textbook Course) | 5177EM

Estimated Program Duration: 483 hours.
Number of Exams: 67.
Field Service Technician: Electronics Knowledge and Skills Training

This topical program provides experienced field service technicians with both the technical concepts and skills techniques to troubleshoot electronic circuits, microprocessors and control systems. It is recommended that the student complete both the Field Service Technician Core program described in Resource 2, Foundation Skills, and the Electrical program described in Resource 4, Electrical and Electronics, before starting the electronics training.

Upon completion of this program, students will be able to:

• Discuss the operation of basic electronic circuits including power supplies, amplifiers, oscillators, detection circuits, switching circuits, pulse circuits and logic circuits.
• Demonstrate how to narrow a difficult problem in a piece of electronic equipment to a section, then to a stage, then to a circuit, and finally to the faulty circuit.
• Show how to use triggered oscilloscopes, DVMs, time / frequency meters, logic probes, and precision test equipment to locate faults and determ ine proper performance in industrial electronic systems.

Estimated Program Duration: 378 hours (excluding optional lab experiments).
Number of Exams: 63.

Optional Laboratory Experiment:
Microprocessor Trainer .......................................................... 086502

Estimated Program Duration: 400 hours.
Number of Exams: 40.
Electrician: Residential and Commercial Building Trades

This topical program specifically focuses on the knowledge and skills needed by an Electrician working in the residential and commercial building trades. The custom assembled program consists of many additional study units than included in the Education Direct Electrician personal improvement program. It is also a different program than that required by an electrician working in a manufacturing plant.

Trainees will receive a comprehensive foundation covering all aspects of safety, tools, print reading, electrical principles and measurements, functions of components, equipment and motors, wiring and understanding the National Electrical Code.

Upon completion of this program, students will be able to:
• Select the correct practice to avoid shock when using electric tools and working with electricity.
• Recognize the basic electrical symbols used in electrical schematic diagrams and wiring plans.
• Explain how voltage, current, and resistance are related.
• Use Ohm’s law to solve electrical calculations.
• Describe how to bend and install conduit, wiring, and cables in residential circuits.
• Identify and learn to install various types of control devices, including hand operated switches, automatic switches, magnetically controlled devices, and remote control systems.
• Identify and learn to install various types of protective devices, including fuses, circuit breakers, and ground fault circuit interrupters.
• Explain when and where cable, conductor fittings, and conduit fittings are used in electrical installations.

Base Program

<table>
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</tr>
<tr>
<td>Working Safely with Electricity</td>
<td>4400</td>
</tr>
<tr>
<td>Getting Started as an Electrician</td>
<td>006025</td>
</tr>
<tr>
<td>Electricians’ Tools</td>
<td>006026</td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186023</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
</tr>
<tr>
<td>Fluid Measurement</td>
<td>186025</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
<tr>
<td>Common Hand Tools, Part 1</td>
<td>186052</td>
</tr>
<tr>
<td>Common Hand Tools, Part 2</td>
<td>186053</td>
</tr>
<tr>
<td>Electric Drilling and Grinding Tools</td>
<td>186054</td>
</tr>
<tr>
<td>AC/DC and Electrical Fundamentals</td>
<td></td>
</tr>
<tr>
<td>Electrical Equipment, Part 1</td>
<td>006027</td>
</tr>
<tr>
<td>Electrical Equipment, Part 2</td>
<td>006028</td>
</tr>
<tr>
<td>Conductors</td>
<td>006014</td>
</tr>
<tr>
<td>Working With Conduit</td>
<td>006015</td>
</tr>
<tr>
<td>Wiring Electrical Components, Part 1</td>
<td>006029</td>
</tr>
<tr>
<td>Wiring Electrical Components, Part 2</td>
<td>006030</td>
</tr>
<tr>
<td>Working with Multimeters</td>
<td>006021</td>
</tr>
<tr>
<td>DC Principles</td>
<td>Block A21</td>
</tr>
<tr>
<td>Nature of Electricity</td>
<td>086001</td>
</tr>
<tr>
<td>Circuit Analysis and Ohm’s Law</td>
<td>086002</td>
</tr>
<tr>
<td>Capacitors and Inductors</td>
<td>086003</td>
</tr>
<tr>
<td>Magnetism and Electromagnetism</td>
<td>086004</td>
</tr>
<tr>
<td>Conductors, Insulators, and Batteries</td>
<td>086005</td>
</tr>
<tr>
<td>DC Motors and Generator Theory</td>
<td>086006</td>
</tr>
<tr>
<td>AC Principles</td>
<td>Block A22</td>
</tr>
<tr>
<td>Alternating Current</td>
<td>086007</td>
</tr>
<tr>
<td>Alternating Current Circuits</td>
<td>086008</td>
</tr>
<tr>
<td>Inductors in AC Circuits</td>
<td>086009</td>
</tr>
<tr>
<td>Capacitors in AC Circuits</td>
<td>086010</td>
</tr>
<tr>
<td>Transformers</td>
<td>086011</td>
</tr>
<tr>
<td>Alternators</td>
<td>086012</td>
</tr>
<tr>
<td>Electrical Energy Distribution</td>
<td>086013</td>
</tr>
<tr>
<td>Rectification and Basic Electronic Devices</td>
<td>086014</td>
</tr>
</tbody>
</table>

Functional Skills Used by a Residential / Commercial Electrician

Introduction to Print Reading                        | 186080        |
Print Reading Symbols and Abbreviations              | 186081        |
Dimensioning and Tolerancing                         | 186082        |
Print Reading Applications                           | 186083        |
Building Drawings                                    | 186043        |
Electrical Drawings and Circuits                     | 186044        |
Reading Electrical Schematic Diagrams                | 006022        |
Electrical Blueprint Reading                         | 006036        |
Analog Circuit Measurement                           | Block A23     |
Basic Test Equipment                                 | 086025        |
Troubleshooting with Volt-Ohm-Milliamp Meters (VOMs)| 086026        |
Using Basic Oscilloscopes                            | 086027        |
Electrical Safety for the Trades                     | 186005        |

Electrical Components - Operations and Maintenance

Electrical Equipment                                  | Block A24     |
Conductors and Insulators in Industry                 | 086070        |
Working with Conduit                                 | 086071        |
Electrical Boxes                                     | 086072        |
Industrial Enclosures and Raceways                   | 086073        |
Connecting Electrical Equipment, Part 1              | 086074        |
Connecting Electrical Equipment, Part 2              | 086075        |
Industrial Fuses                                      | 086076        |
Industrial Circuit Breakers                          | 086077        |
Plugs, Receptacles, and Lampholders                   | 086078        |
Industrial Switches                                  | 086079        |
Industrial Relay Ladder Logic                        | 086080        |
Industrial Relays, Contractors, and Solenoids        | 086081        |
Electric Lamps, Part 1                               | 006031        |
Electric Lamps, Part 2                               | 006032        |
Lighting Control                                    | 006033        |
Interior and Exterior Lighting Practices              | 006016        |
Electric Heating                                     | 006034        |
Controls for Air Conditioning                        | 006035        |
Wiring Electrical Circuits                            | 006037        |
Transformers                                         | 4040          |
Local Distribution of Electrical Power               | 006038        |
Underground Power Systems                            | 006039        |
Troubleshooting Electrical Systems                   | 006018        |
National Electrical Code (NEC Code and Textbook Course) | 5177EM       |

AC/DC Motors and Motor Controllers

Industrial DC Motors                                  | 086051        |
Industrial AC Motors                                  | 086052        |
Controlling Industrial Motors                        | 086053        |
Motor Control Fundamentals                            | 006010        |
(for Programmable Logic Controllers)
Industrial Motor Control  
(for Programmable Logic Controllers), Part 1 .........................006011  
Industrial Motor Control  
(for Programmable Logic Controllers), Part 2 .........................006012

**Essential Functional Skills Needed**

- Electrical Wiring Practices ...........................................................086E02
- Data, Voice, and Video Cabling ..................................................086E16
- Electrical Grounding ....................................................................086E01
- Electrical Estimating ....................................................................086E04
- The Business of Electrical Contracting .........................................006020

Estimated Curriculum Duration: 726 hours.  
Number of Exams: 101.
006010
Motor Control Fundamentals (for Programmable Logic Controllers)

Duration: 10 hours (includes 1 test)

Course Prerequisites:
- Basic Industrial Math (Block X21)
- AC Principles (Block A22)
- Industrial AC Motors (086052)

What Students Learn:
- Motor Control Standards: Operating Characteristics of Motors – motor starters, NEMA and IEC Starters, reversing and multi-speed starters;

Special Note:
- This new series of Motor Control study units (006010-11-12) provides current electronics technology not covered in Industrial Motor Control (6699A-C).

006012
Industrial Motor Control (for Programmable Logic Controllers), Part 2

Duration: 10 hours (includes 1 test)

Course Prerequisite:
- Industrial Motor Control (for Programmable Logic Controllers), Part 1 (006011)

What Students Learn:
- Programmable Logic Controllers (PLCs) Fundamentals – contacts, coils, ladder logic terminology and symbology; scanning and solving ladder logic programs; Application/Troubleshooting Exercise One: The Pick-and-Place Robot; Application/Troubleshooting Exercise Two: The Mixing Vat; Application/Troubleshooting Exercise Three: The Paper Roll Stand; Troubleshooting Skills using LED indicators and programming console procedures; PLCs in Motor Speed Control; PLC System Troubleshooting and Repair.

Special Note:
- This new series of Motor Control study units (006010-11-12) provides current electronics technology not covered in Industrial Motor Control (6699A-C).

006011
Industrial Motor Control (for Programmable Logic Controllers), Part 1

Duration: 10 hours (includes 1 test)

Course Prerequisite:
- Motor Control Fundamentals (for Programmable Logic Controllers) (006010)

What Students Learn:
- History and Concepts of Programmable Logic Controllers (PLCs); Number Systems; The Central Processing Unit (CPU) – CPU scan, analog and discrete signals, types of PLC memory; The Input/Output System (I/O); Special Function I/O; Elements of a Relay Ladder Logic Program; Operation of Timers and Counters.

Special Note:
- This new series of Motor Control study units (006010-11-12) provides current electronics technology not covered in Industrial Motor Control (6699A-C).

006014
Conductors

Duration: 10 hours (includes 1 test)

What Students Learn:
- Electrical circuits rely on conductors to carry current from one point to another. All electricians deal with some form of conductors every day. In this study unit you’ll learn about conductor characteristics that are important to the electrician. Understanding how to select the appropriate conductors for a job and how to install conductors properly is described in this study unit.

Students will be able to:
- Identify the physical properties and characteristics of conductors.
- Identify electrical properties and characteristics.
- Work with tables that define conductor characteristics.
- Install and connect wires and cables in residential circuits.
- Size conductors to match circuit requirements.

Special Notes:
- This updated course replaces, Conductors, course 4402B.
- This study unit is primarily appropriate for residential and commercial electronics.
006015

Working With Conduit

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Conductors (006014)

What Students Learn:
This study unit focuses on what the electrician needs to know about conduit. It begins by explaining the characteristics of commonly used types of conduit. Next, the study unit covers conduit installation, including fittings, supports, and conduit sizing considerations. When installing conduit, you frequently have to make bends in the conduit. These bends must be made with the proper tools using specific techniques which are described in this study unit. The study unit concludes with a discussion on why and how specific conductors are installed in conduit.

Students will be able to:
- Identify and define the types and characteristics of conduit.
- Describe and install various types of conduit fittings and supports.
- Identify the tools needed to bend conduit and use those tools correctly.
- Determine conductor and conduit sizing when given a particular wiring job.

Special Notes:
- This updated course replaces, Conduit, course 4402A.
- This study unit is primarily appropriate for residential and commercial electricians or electrical contractors.

006018

Troubleshooting Electrical Systems

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Analog Circuit Measurement (Block A23)

What Students Learn:
Electricians must deal with the problems and failures that occur in residential, commercial and industrial electrical systems. While faults do not occur in every system, they must be quickly and properly addressed. In this study unit, students will learn about the types of problems that often occur in electrical systems. Students will also learn the basic steps followed by all effective troubleshooters, and will be exposed to several real world troubleshooting situations.

Special Note:
- This study unit is primarily appropriate for residential and commercial electricians or electrical contractors.

006016

Interior and Exterior Lighting Practices

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Electric Lamps, Part 1 (006031)
Electric Lamps, Part 2 (006032)

What Students Learn:
The purpose of this study unit is to familiarize yourself with lighting fixtures, known as luminaires, and their applications. It is important to understand the relationship of the components in lighting fixtures and their enhancements and limitations. Knowing the terminology used to describe the fixtures will expedite your work and enable you to communicate effectively with your associates.
The electrical codes are also a notable interest in the installation of lighting fixtures. Many of the codes have been established to prevent fires or electric shock. An electrician should be familiar with all codes before attempting to install any fixture.

Students will be able to:
- Describe a lighting fixture in detail and where they are used.
- Know any precautions to take while installing them.
- Know the effects of temperature on recessed lighting.
- Know the difference between prewired and non-prewired fixtures.
- Know the difference between a “wet niche” and a “dry niche” pool light.

Special Notes:
- This updated course replaces, Interior Lighting Practice, course 6685, and Exterior Lighting Practice, course 5513.
- This study unit is primarily appropriate for residential and commercial electricians or electrical contractors.

006020

The Business of Electrical Contracting

Duration: 10 hours (includes 1 test)

What Students Learn:
Some working electricians often consider starting an electrical contracting business. This study unit is written for electricians who want to own and manage their own electrical contracting business. The course is not intended to provide a complete guideline to starting and managing a successful electrical contracting business, but it will provide helpful information for electricians contemplating a career in electrical contracting.

Students will be able to:
- Recognize the important considerations of starting an electrical contracting business, including the advantages, disadvantages, skills required, and finances.
- Describe the very basic requirements and some suggested actions one might take when opening a business.
- Understand some of the preliminary management responsibilities and challenges associated with owning any electrical contracting business.

Special Note:
- This study unit is primarily appropriate for residential and commercial electricians and electrical contractors.
006021

**Working with Multimeters**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Electrical Safety for the Trades (186005)
- AC Principles (Block A22)

**What Students Learn:**
When an electrician is asked to identify the source of a circuit or locate a fault in a machine, the first tool normally selected to help with this task is a multimeter. The multimeter can be used quickly to identify circuits, troubleshoot both AC and DC power supply problems, and find circuit breaker problems. In this study unit, trainees will learn how to use digital multimeters and their special features and capabilities. As is the case when working with any electrical equipment, encompassing live circuits and power supplies, safety considerations should be foremost in the workers’ mind at all times. Students will be able to:

- Define the terms voltage, current and resistance, and explain their relationship in a circuit.
- Discuss how voltage, current and resistance are measured with a multimeter.
- Discuss some of the most important safety precautions to take when working with a multimeter.
- Describe the purpose of a continuity test.
- Perform tests for short circuits.
- Perform resistance tests on resistors, switches and transformers.
- Measure current by using a direct series connection.
- Measure the output voltage of a DC power supply.

006022

**Reading Electrical Schematic Diagrams**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- AC Principles (Block A22)

**What Students Learn:**
- Electrical Diagrams; Meaning of Schematic Diagrams; Schematic Diagrams of Basic Electric Equipment and Connections, such as Types of Circuits; Sources of DC Power; Sources of AC Power; Transformers; Rectifiers; Motors; Measuring Devices; Protection and Control Devices; Schematic Diagrams of Lighting Circuits and Various Types of Motor Control Circuits; Typical Schematics Used in Generating Systems, Transmission Systems, and Distribution Systems.

**Special Note:**
- This updated course replaces, *Electrical Schematic Diagrams*, course 6634A-B.

006025

**Getting Started as an Electrician**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Introduction to the Entire Electric System, including the Generation, Transmission, Distribution, and Utilization of Electric Power; Types of Residential Branch Circuits; Service Entrance; Practical Wiring Examples; Required Subjects an Electrician Should Know.

**Special Notes:**
- This updated course replaces, *Getting Started as an Electrician*, course 4410.
- This study unit is primarily appropriate for residential and commercial electricians or electrical contractors.

006026

**Electricians' Tools**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
- Electrical Wiring Practices (086E02)

**What Students Learn:**
- Electricians' Equipment: Basic Hand Tools; Wire-Working Tools; Conduit-Working Tools; Power Tools; Knowledge as a Tool with Basic Introduction to the Metric System; Units of Electricity; Static Electricity; Electric Current, Measuring Instruments, and the Symbols and Terminology Used by Electricians.

**Special Notes:**
- This updated course replaces, *Electricians' Tools*, course 4401.
- This study unit is primarily appropriate for residential and commercial electricians or electrical contractors.

006027

**Electrical Equipment, Part 1**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
- Electrical Wiring Practices (086E02)

**What Students Learn:**
- Outlet Boxes: Types, Fittings, Sizing of, Installation of, and Wiring of; Junction Boxes; Splice Boxes; Pull Boxes; Cable and Conductor Fittings; Conduit Fittings.

**Special Notes:**
- This updated course replaces, *Electrical Equipment*, course 4403A.
- This study unit is primarily appropriate for residential and commercial electricians or electrical contractors.
**006028**

*Electrical Equipment, Part 2*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Electrical Wiring Practices (086E02)

**What Students Learn:**
Electric Control Devices: Manually Operated Switches, Automatically Operated Switches, Thermostats, Relays, Remote-Control Devices, Control Diagrams; Safety Devices: Fuses, Circuit Breakers, and GFCIs; Convenience Devices: Plugs and Receptacles; Lampholders; Electric Loads: Types, Rating.

**Special Notes:**
- This updated course replaces, *Electrical Equipment*, course 4403B.
- This study unit is primarily appropriate for residential and commercial electricians or electrical contractors.

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**006029**

*Wiring Electrical Components, Part 1*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Electrical Wiring Practices (086E02)

**What Students Learn:**
Electrical equipment, devices, and conductors are wired together to form circuits. In this study unit, you’ll learn how to combine what you know about electrical equipment and conductors in order to wire typical new residential circuits. You’ll also learn many of the features of electrical systems.

Students will be able to:
- Identify the function of various electrical components.
- Recognize and work with various types of electrical systems.
- Describe the function of grounding wires and connect them properly.
- Select the correct terminals on electrical equipment and properly connect them to circuit conductors.
- Select the proper switches, receptacles, and device boxes needed for given applications and describe how they are wired.
- Identify the terminals on light fixtures and how they are wired.

**Special Notes:**
- This updated course replaces, *Conduit*, course 4402A and *Wiring Electrical Components, Part 1*, course 4404A.
- This study unit is primarily appropriate for residential and commercial electricians or electrical contractors.

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**006030**

*Wiring Electrical Components, Part 2*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Electrical Wiring Practices (086E02)

**What Students Learn:**
You now understand how to wire a new electrical system. Specifically, you’ve learned how to install wiring from one point to another and how to install and wire the boxes and devices at those points where the wiring is interrupted. In this study unit, you’ll learn how to apply this knowledge to old-work situations. While much of the old-work task involves the same skills you’ll use when doing new work, there are additional things you’ll need to know. This unit also discusses certain special wiring situations that are commonly encountered but not part of every job. It also explains how electricians use circuit measurement techniques to troubleshoot problems.

Students will be able to:
- Explain how old work differs from electrical jobs for new construction.
- Identify several ways to run wire in existing structures.
- Describe the steps to take when installing new electrical devices in existing structures.
- Outline the acceptable procedure for adapting existing aluminum wire for use with modern devices.
- Explain how electricians rely on electrical measurements to troubleshoot an existing circuit.

**Special Notes:**
- This updated course replaces, *Conductors*, course 4402B and *Wiring Electrical Components, Part 2*, course 4404B.
- This study unit is primarily appropriate for residential and commercial electricians or electrical contractors.

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**006031**

*Electric Lamps, Part 1*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
AC Principles (Block A22)

**What Students Learn:**
This study unit is designed to provide basic information on the fundamentals of lamp operation. First, you’ll learn about the concept of light and how it’s measured. You’ll also learn about basic lamp types. The main body of the study unit, however, will provide you with a thorough introduction to the incandescent lamp.

Students will be able to:
- Describe the concept of light.
- Define several important photometry terms.
- Name the three major lamp types.
- Explain the term lamp efficacy.
- Calculate the lumen depreciation of a lamp.
- Explain the importance of a lamp’s chromaticity and color rendition index (CRI).
- Describe the differences between incandescent lamps and discharge-type lamps.
• List the basic components of an incandescent lamp.
• Explain how a halogen lamp differs from an incandescent lamp.
• Use catalog ordering codes to determine incandescent lamp shapes, bases, and wattages.

Special Note:
• This updated course replaces, Electric Lamps, course 6682A.

006032
Electric Lamps, Part 2

Duration: 10 hours (includes 1 test)

Course Prerequisite:
AC Principles (Block A22)

What Students Learn:
This study unit is the second part of learning about lamps. This course describes the components of discharge lamps and what they are used for. Fluorescent and high intensity discharge (HID) lamps are the two major lamp groups that will be covered in this text.

Students will be able to:
• Understand the advantages and disadvantages of each lamp.
• Recognize the different characteristics of each lamp.
• Recognize the proper application of these lamps.
• Specify or read specifications of discharge lamps.
• Understand the basic manufacturer’s ordering codes.
• Carefully recognize problems before changing a lamp.
• Realize some of the complications that may occur in an electrician’s work.

Special Note:
• This updated course replaces, Electric Lamps, course 6682B.

006033
Lighting Control

Duration: 10 hours (includes 1 test)

Course Prerequisite:
AC Principles (Block A22)

What Students Learn:
Electrical lamps are available in a wide range of different styles and can be used for lighting any type of area. In earlier study units you learned about the different types of lamps and fixtures, as well as the controlling devices. This study unit is designed to teach you about combining these items to design different types of lighting control systems. It will also teach you how to apply the different systems efficiently and conveniently.

Students will be able to:
• Combine natural light and dimming devices efficiently.
• Use multi-level lighting with fluorescent lamps.
• Divide an area into different zones for different lighting needs.
• Place switches in convenient areas.
• Apply sensors and timers in lighting control systems.

Special Note:
• This updated course replaces, Electric Heating, course 4310, and Electric Space Heating, course 4312.

006036
Electrical Blueprint Reading

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
AC Principles (Block A22)

What Students Learn:
In this study unit, you’ll learn to read several different types of electrical blueprints. Reading and understanding the information that appears on a blueprint will be emphasized, not the design details of a particular project. Engineers and designers use blueprints to present design information in a variety of ways. The general principles for preparing blueprints will also be covered. The skills you learn can be applied to reading blueprints for residential, commercial, manufacturing, and electric utility projects.
Students will be able to:

- Explain how blueprints are prepared.
- Discuss how and why blueprints are copies of original drawings.
- Talk about the relationship of electrical blueprints to the architectural drawings and drawings of other trades.
- Read and understand the information presented on blueprints.
- Identify the different methods of presenting information.
- Interpret the common symbols used on electrical blueprints.
- Trace a wiring diagram and understand it.

Special Note:
- This updated course replaces, *Electrical Blueprint Reading*, course 6635.

### 006037

**Wiring Electrical Circuits**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Electrical Wiring Practices (086E02)

**What Students Learn:**
All electrical systems, whether for industrial plants, office buildings or houses, have one thing in common: they must be properly connected. To assure the proper connection and maintenance of electrical systems, schematic diagrams and wiring plans are a must. As an electrician, students will need to know the common wiring terms and symbols used on these diagrams and plans. This study unit will prepare you for a better understanding of these electrical "road maps." Although most of the branch circuits and panel board equipment discussed in this study unit are based on residential electrical use, they apply as well to many commercial and industrial applications.

Students will be able to:
- Differentiate between feeder and branch circuits.
- Select the correct type of general and special-purpose circuit when given a list of circuit descriptions.
- Describe how wiring is installed for branch circuits in a residence, given particular situations.
- Select the correct electrical components for wiring a residence.
- Differentiate between portable, fixed and stationary appliances and describe how each type is wired.
- Select the components needed for an electric circuit.
- Calculate the current in a neutral conductor.

Special Note:
- This course replaces, *Wiring Electrical Circuits*, course 4405.

### 086052

**Industrial AC Motors**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
AC Principles (Block A22)

**What Students Learn:**
Construction and Operation of Single- and Three-Phase AC Motors; Principles of Electromagnetic Induction; Identify and work with Starter Systems for Single- and Ploy-Phase Motors including Shaded-Pole, Split-Phase Capacitor, and Repulsion-Induction Motors; Troubleshoot Polyphase Motor Systems.

Special Note:
- This course replaces, *Wiring Electrical Circuits*, course 6698.

### 086053

**Controlling Industrial Motors**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
AC Principles (Block A22)
Industrial DC Motors (086051)
Industrial AC Motors (086052)

**What Students Learn:**
How Stepper Motors are Electronically Controlled; Steps to follow when Troubleshooting Stepper Motor Controls; Explain how AC Line Frequency sets Motor Speed; How Frequency Inverters Control Motor Speed in Three-Phase Installations; Describe how Servo Motors are Controlled; Explain how Brushless Motors Work and how their Shafts are precisely Positioned; List the steps to follow when Troubleshooting Brushless Motor Controller Systems.

Special Note:
- This course, in conjunction with courses 006010, 006011 and 006012 covering *Industrial Motor Control for PLCs*, replaces *Industrial Motor Control*, course 6699A-C.

### 086062

**Component Testers**

**Duration:** 6 hours (includes 1 test)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
AC Principles (Block A22)

**What Students Learn:**
Identify the type of Component Testers for such “piece parts” as Resistors, Capacitors and Inductors; Calculate Turns Ratio; Show the correct connection scheme for testing Diodes, SCRs, and Transistors; Relate proper Soldering and Desoldering techniques; Cite the safety procedures to be used when handling Electronic Chemicals and Lubricants.

Special Note:
- This updated course replaces course B0105.
086063

**Digital Test Equipment**

**Duration:** 6 hours (includes 1 test)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- AC Principles (Block A22)

**What Students Learn:**
- Cite the use of Binary Math in Digital Circuits; Identify various types of Gate Circuits; Explain the use of a Logic Probe; Relate the differences between an Oscilloscope and a Logic Analyzer.

**Special Note:**
- This updated course replaces course B0106.

086084

**Distributed Control Systems, Part 1**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Basic types of control loops and their elements
- Define basic process control characteristics and terms
- Identify the five control modes found in industrial systems
- How control system components interface
- Basic components found in DCS architecture

086085

**Distributed Control Systems, Part 2**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- The characteristics and development of the HART protocol
- OSI layers used in HART messaging
- Distinguish between point-to-point and multidrop HART devices
- Functions of a device management system
- Seven layers of the OSI standard

086086

**Distributed Control Systems, Part 3**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- How Foundation Fieldbus works
- Functions and applications served with Foundation Fieldbus
- Determine existing fail-safe conditions
- Commands for opening a download
- Addressing thermal inertia

086087

**Experiments with Basic DC Theory – Lab Manual**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- DC Principles (Block A21)
- Electronics Simulation Software (086800)

**What Students Learn:**
- Basic lab exercises and elementary troubleshooting problems using the Electronics Simulation Software are contained in this manual. Practice exercises using electrical notations, prefixes, Ohm's law, series and parallel connections, and basic circuit construction are included. The manual includes the basic operational instructions for the software.

086088

**Experiments with Basic AC Theory – Lab Manual**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- DC Principles (Block A21)
- AC Principles (Block A22)
- Electronics Simulation Software (086800)

**What Students Learn:**
- The characteristics and development of the HART protocol
- OSI layers used in HART messaging
- Distinguish between point-to-point and multidrop HART devices
- Functions of a device management system
- Seven layers of the OSI standard

086089

**Experiments in Electrical Measurements – Lab Manual**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Analog Circuit Measurement (Block A23)
- Electronics Simulation Software (086800)

**What Students Learn:**
- Students will complete lab exercises and troubleshooting problems using the electronics simulation software. This lab manual will provide experience using the many simulated instruments that are part of the software package. Troubleshooting simulations using the digital multimeter, oscilloscope, function generator, and bode plotter are included in these exercises. The manual includes the basic operational instructions for the software.
086090

Experiments with Resonant Circuits – Lab Manual

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Reactive Circuits (Block B22)
Electronics Simulation Software (086800)

What Students Learn:
Students will complete lab exercises and troubleshooting problems using the electronics simulation software. This lab manual will provide experience using the many simulated instruments that are part of the software package. Troubleshooting simulations using resonant circuits, coupled circuit traps, filters and transmission lines are included in these exercises. The manual includes the basic operational instructions for the software.

086800

Electronics Workbench®

Produced by MultiSIM

Course Prerequisite:
DC Principles (Block A21)

What Students Learn:
Electronics Workbench is an electronics lab in a computer. A powerful software tool that simulates the behavior of analog circuits, digital circuits, and the corresponding test equipment. Students perform experiments faster, in a safe, user friendly environment. Sophisticated troubleshooting options allow trainees to make practical evaluations of the theory they have been learning. High-quality, visual circuit paths are recreated. The simulator lets students design, build, and verify circuits significantly faster than on a real test bench. As self-paced study, students can experiment with “what if” scenarios. Circuits can be created with any number of faults or malfunctions for students to diagnose, isolate, and repair.

Realistic test instruments used in working applications include the digital multimeter, oscilloscope, function generator, word generator, logic analyzer, logic converter, and bode plotter. A “bottomless” bin of real world components for both digital and analog circuits include over 125 74xx and 74xxx chips, resistors, diodes, capacitors, a wide variety of logic gates, scrs’, triacs, npp, and pnp transistors and many more.

086802

8085 Microprocessor Trainer

What Students Learn:
This trainer enables the student to build an 8085 microprocessor computer system from scratch. Students are taught how to write into RAM’s, ROM’s, and run an 8085 microprocessor. They learn about input and output ports, computer timers, writing instructions and storing them to permanent memory, along with basic assembly skills.

The trainer comes with a lesson manual, instructions, experiments manual, and a power supply.

Special Notes:
• It is suggested (but not required) that this trainer be used in conjunction with the course titled Industrial Microprocessors (086E05).
• The soldering kit included in course SLD1, How to Solder and Desolder, is needed for this trainer.

086803

Fiber Optics Training Kit

Course Prerequisite:
Fiber Optics (086E03)

What Students Learn:
Students build a separate transmitter and receiver connected by fiber optic cable and connectors. Detailed instructions include a review of basic fiber-optics technology. This kit reinforces basic electronics component recognition and soldering skills.

086E01

Electrical Grounding

Duration: 25 hours (includes 5 tests)

Course Prerequisites:
Basic Industrial Math (Block X21)
DC Principles (Block A21)
AC Principles (Block A22)

What Students Learn:
Lesson 1 - Principles of Grounding
• Understanding National Electric Code Grounding Requirements (article 250); Grounding for Safety; Fault Detection; Grounding Electrode Systems and Types.

Lesson 2 - Grounding Systems:
• Grounding Electrode Conductor (AC and DC) Material, Types and Sizing; Circuit Grounding; System Grounding; Grounded Conductor Installation, Sizing and Identification; Main Bonding Jumper Locations, Sizing and Connections.

Lesson 3 - Equipment and Enclosure Bonding and Grounding, Part 1:
• Understanding Effective Ground Paths; Equipment Grounding Conductor Types, Installation, and Sizing; Equipment Grounding Conductor Raceways, Connections and Boxes; Using Earth as an Equipment Grounding Conductor; Bonding Service Equipment; Working with Bonding Jumpers.

Lesson 4 - Equipment and Enclosure Bonding and Grounding, Part 2:
• Grounding Panelboards, Receptacles, Towers and Computers; Ground-Fault Protective Equipment; GFCI's.

Special Note:
The soldering kit included in course SLD1, How to Solder and Desolder, is needed for this kit.
Lesson 5 - High Voltage Grounding Applications:
• System and Circuit Grounding for 1kV and Over; Separately Derived Systems; Dedicated Five-Wire Systems; Grounding Two or More Buildings; Calculating Fault Currents and Grounding Conductor Withstand Ratings.

Special Notes:
• This course consists of a textbook and supplemental study guide.
• This course is primarily appropriate for plant electricians and industrial maintenance training.

086E02
Electrical Wiring Practices

Duration: 20 hours (includes 4 tests)

Course Prerequisites:
Basic Industrial Math (Block X21)
DC Principles (Block A21)
AC Principles (Block A22)
Electrical Equipment (Block A24)

What Students Learn:
Lesson 1 - High Voltage Applications
• Working with Site Plans and Symbols; Unit Substations; Transformer and Overcurrent Protection; Transformer Fuse Sizing; High-voltage Metering Equipment; Feeder Bus Systems; Panelboards and Protective Devices; Trolley Busways.
Lesson 2 - Wiring Motors, Controllers and Signaling Systems:
• Using Wire Tables and Sizing Conductors; Wiring Signal Systems; Motor Types, Characteristics and Installation; Wiring DC, Single, Double and Triple Phase Motors.
Lesson 3 - Wiring of Special Equipment and for System Protection.
• Working with Power and Motor Power Factors; Installing and Testing Capacitors; Wiring HVAC System Controls; Circuit Breakers and Wiring for System Protection; Lightning Protection.
Lesson 4 - Wiring for Hazardous Locations
• Safe Circuits and Equipment; Panels, Seals, Fixtures, Controls and Other Equipment for Hazardous Locations; Wiring of PLC’s and Site Lighting.

Special Notes:
• This course consists of a textbook and supplemental study guide.
• This new course replaces Electrical Wiring, course 4300A-C.
• This course is primarily appropriate for plant electricians and industrial maintenance training.

086E04
Electrical Estimating

Duration: 15 hours (includes 1 test)

What Students Learn:
Introduction to Electrical Estimating; Methods used to install equipment; How to compute Man Hours worked; Projecting the cost of Materials and Overhead; Calculate Bid Price and Profit; Methods used in estimating; Unit of Measurement / Labor Unit; The Take Off; Counting of Symbols; Measuring the Conduits and Conductors drawn on Blueprints; Determine a Bill of Materials; Preparing an Estimate Summary; Manual method of estimating; Computer-based estimating and Bid proposal software; Completing a Specification Checklist.

Special Notes:
• This new course consists of Electrical Estimating textbook, stock number TB0310 and a study guide, stock numbers 006019.
• This study unit is primarily appropriate for residential and commercial electricians and electrical contractors.

086E05
Industrial Microprocessors

Duration: 90 hours (includes 6 tests)

Course Prerequisites:
Basic Industrial Math (Block X21)
Analog Circuit Measurement (Block A23)
Basic Electronic Circuits (Block B24)
Introduction to Microprocessors (Block B11)

What Students Learn:
Preview
This course offers a complete and in-depth introduction to microprocessor hardware. The assembly language and programming covered, and the description of the interfacing capability with input and output data communications devices (I/O), are used in many industrial applications. The 8085 is a simple design, 8-bit microprocessor. It has 74 different instructions that can be programmed into memory and executed to make the microprocessor perform a wide variety of tasks. This rich in function, yet limited number of instructions, enable the 8085 microprocessor to be an ideal learning tool. The programming and logic techniques described in this course, apply to many other modern, more powerful microprocessors and microcontroller systems.

The textbook provided with this course includes a compact disk, CD-ROM based microprocessor simulator, that is Windows compatible. The simulator allows the trainee to generate, edit, and execute programs, then observe the results, while working with a graphical user interface (GUI). The CD also features an editor that is used to evaluate and run existing microprocessor programs.

An 8085 Microprocessor Trainer is available in conjunction with this course to provide the trainee with hands-on practice using common programming techniques and gain experience interfacing with external devices.

086E03
Fiber Optics

Duration: 30 hours (includes 6 tests)

What Students Learn:
Discuss the evolution of Fiber Optics as a Communications Medium; Identify Fiber Optic components; Understand how Fiber Optic Components are linked to construct a Fiber Optic System; Identify the Test Equipment used in fiber optic systems.

Special Note:
• This course consists of a textbook and a supplemental study guide.
Objectives
When a student completes this course, he and she will be able to:

Lesson 1
• Explain the major parts of a microprocessor.
• Describe the differences between low- and high-level languages and identify various language types, such as assembly and machine language.
• List the instructions in a program for adding or subtracting two numbers using the 8085 microprocessor.
• Explain how to address various sizes of memory devices.
• Explain how to interface and program the 8259A programmable interrupt controller and the 8237 direct memory access (DMA) chips.
• Identify codes for alphanumeric data transfer.

Lesson 2
• Explain how to interface a device so that the microprocessor can read its digital status into the accumulator, or write the contents of the accumulator to the output device.
• Explain the differences between the peripheral mapped and the memory mapped I/O.
• Identify various data transfer, arithmetic logic, and branch operations used with the 8085 microprocessor.
• List the steps of debugging a program.
• Explain looping, counting, and indexing instructions as they relate to assembly language programs.
• Discuss how to use 16-bit instructions for data transfer, arithmetic, and logic operations.

Lesson 3
• Explain how to create counters and timers, particularly, countdown counters and timers with extended ranges using the Jump instruction.
• Describe how to use a stack to store temporary data, how to view the status of the flags using the stack, and how to PUSH and POP data stored on the stack.
• Discuss how subroutines are used in programs, how the CALL and RET (Return) statements are used for subroutines, and how special conditional subroutine calls should be used.
• Explain how various computer codes are structured and how they may be converted to and from binary representations.
• Describe the various characteristics of common operating systems.
• Explain how assemblers and cross assemblers operate to create object codes for the microprocessor.

Lesson 4
• Describe how the 8085 microprocessor handles its various interrupts by using specific call addresses and service routines.
• Explain how to mask and unmask interrupts.
• Discuss how to use the restart instruction to serve as a breakpoint in a program.
• Describe how a typical digital to analog converter (DAC) operates.
• Define how common DACs are connected to a microprocessor system and what programming commands are needed to perform the conversion and data acquisition process.
• Describe how common analog to digital converters (ADCs) operate.
• List the necessary programming commands and interface signals needed to interface an ADC to a microprocessor system.

Lesson 5
• Explain how to interface and use an 8155 programmable I/O and timer IC.
• Describe the interface and programming techniques used for the 8279 programmable keyboard and display.
• Discuss how to interface and use integrated circuits, such as the 8255A peripheral interface and the 8254 interval timer chips.
• Explain how to interface and program the 8259A programmable interrupt controller and the 8237 direct memory access (DMA) chips.
• Describe how to use an interface IC to connect the 8085 to a serial data source or destination.

Lesson 6
• Explain how to interface multiplexed displays to a microprocessor system.
• Discuss how to interface a keyboard to a microprocessor system using the National Semiconductor MM74C923 IC.
• Discuss how to use slower memory with a faster microprocessor using wait status.
• Explain how to design a system from scratch using the IC chips shown throughout this study unit.
• Describe how emulators, debugging tools, and logic state analyzers can help you develop and troubleshoot a system.
• List the various types of modern 8- through 64-bit processors and describe how they compare to the 8085 microprocessor.

Contents
Lesson 1 (086910) Microprocessors and their Programming
Microprocessors, Microcomputers, and Assembly Language; Introduction to 8085 Assembly Language Programming; Microprocessor Architecture and Microcomputer Systems; 8085 Microprocessor Architecture and Memory Interfacing.

Lesson 2 (086911) Interfacing and Programming the 8085
Microprocessor Interfacing Input / Output (I/O) Devices; Introduction to 8085 Instructions; Programming Techniques with additional Instructions.

Lesson 3 (086912) Advanced Programming and Applications with the 8085
Counters and Time Delays; Stack and Subroutines; Code Conversion, BCD Arithmetic, and 16-Bit Data Operations; Software Development Systems and Assemblers.

Lesson 4 (086913) Microprocessor System Interfacing Interrupts; Interfacing Data Converters.

Lesson 5 (086914) Communicating through Parallel and Serial Ports
Programmable Interface Devices; 8155 I/O and Timer; 8279 Keyboard and Display Interface; General Purpose Programmable Peripheral Devices; Serial I/O and Data Communication.

Lesson 6 (086915) Modern Microprocessors and their comparison to the 8085
Microprocessor Applications; Extending 8-Bit Microprocessor Concepts to higher level Processors and Microcontrollers.

Special Notes:
• This new course replaces Microprocessor Applications, Block B12.
• This course consists of the Microprocessor Applications 8085 textbook, stock number TB0491, and a study guide, stock number 086082.
• Covers subject at an advanced, in-depth level.
• A hands-on trainer accompanies this course, stock number 086802 (EM0256). Use of the trainer is optional.
086E16

Data, Voice, and Video Cabling

Duration: 20 hours (includes 4 tests)

Course Prerequisites:
Electrical Equipment (Block A24)

What Students Learn:
Lesson 1 – Communication Cabling Systems:
• Early wired and wireless technologies; Planning the wiring installation; Applicable standards organizations; UTP cabling.
Lesson 2 – Copper Wiring for Telephone, Video, and Network Systems:
• Details of cable installation; Assess quality of work performed; Materials required; Handling cable without damage; Workplace security and safety.
Lesson 3 – Terminating and Testing Communication Wiring:
• Advantages and disadvantages of wireless networking; Installing wireless access points; Site testing of wireless networks; Cableworking and testing tools; Recognizing common cable problems; Terminating popular types of coaxial and copper-cable connectors.
Lesson 4 – Working with Fiber Optics:
• Principles of optical fiber transmission; Different types of fiber-optic cabling; Optical fiber connections, terminations, and splices; Pulling, cleaving, connecting, and polishing optical fiber cables; Testing fiber optic connections; Allowable tolerances for loss in fiber-optic connections; Safe practices.

Special Note:
• This course consists of a textbook and a supplemental study guide.

086E18

Digital Electronics

Duration: 60 hours (includes 6 tests)

Course Prerequisites:
Electronic Systems (Block B25)

What Students Learn:
Lesson 1 – Number and Logic Systems:
• Perform various number and logic conversions including: decimal to binary and binary to decimal, binary to octal and octal to binary, binary to hexadecimal and hexadecimal to binary, and from decimal to BCD and BCD to decimal.
Lesson 2 – Boolean Algebra with OR Gate Applications:
• Reduce Boolean expressions; Write the truth table for an exclusive-OR gate; Designing and analyzing digital circuits; Use various theorems related to Boolean Algebra.
Lesson 3 – Adders and Collection Gates:
• Define and draw the block diagram and truth tables for both half and full adders; Program a GAL device; Identify and calculate fan-out and noise margin; Applications for open-collector gates.
Lesson 4 – Flip-Flops and Shift Registers:
• Operation of various flip-flop types including SR, master-slave, JK, and D; How latches are used in control applications; IC flip-flops; Shift registers for serial communication devices; ASCII code and RS-232 communication standards.
Lesson 5 – Counting and Timing Circuits and D/A and A/D Conversion:
• Binary counters; Frequency dividing using synchronous and asynchronous counters; Clock-pulses generators; Multivibrator circuits incorporating the 555 timer IC; A/D and D/A converter construction.
Lesson 6 – Digital Electronic Applications:
• Decoders, multiplexers, and demultiplexers; LED connection; Properly connecting tri-state output devices to circuits; driving high-current transistor interfaces; Circuit isolation; Memory; Microcomputers and microcontrollers.

Special Notes:
• This course consists of a textbook and a supplemental study guide.
• This course replaces Blocks B07, B08, and B09.

2002A-D

Electronics

Duration: 40 hours (includes 4 tests)

Course Prerequisite:
AC Principles (Block A22)

What Students Learn:
Part 2 (2002B). Introduction to Three-Element Electronic Devices; Amplification and Impedance Matching; Basic Transistor Amplifiers and Characteristics; Operation of the Vacuum-Tube Triode and its Use as an Amplifier in Basic Circuits; Tetrodes, Pentodes, and Other Multi-Element Devices; Detailed Discussions of Various Transistor Amplifier Circuits, Classes of Amplification, and Interstage Coupling.

Part 4 (2002D). Descriptions, Operation, and Application of Various Electronic Switching Devices, such as Field-Effect Transistors, Unijunction Transistors, Tunnel Diodes, and Silicon-Controlled Switches; Explanations of Regulatory Devices; Voltage-Regulator Tubes; Zener Diodes and Thermistors; Magnetic Amplifiers; Ward-Leonard System; Amplidyne Generator; Basis of Communications Electronics; AM and FM Transmission.

Special Note:
- Covers subject at an advanced, in-depth level.

### 2007A-C

**Solid State Circuits**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisite:**
AC Principles (Block A22)

**What Students Learn:**
Part 1 (2007A). Development of Semiconductor Diodes; Basic Theory; Structure of Semiconductor Crystals; Intrinsic Semiconductors; n-type Semiconductor; p-type Semiconductor; Biasing, Characteristic of p-n Junction; Reverse Breakdown; Applications of Diodes; Construction and Operation of Transistors; Structure of Junction Transistors; Input and Output Circuits of a Transistor; Common Terminal Connections; Transistor Amplifier Gains; Transistor Characteristics.

Part 2 (2007B). Special Solid-State Devices; Zener and Avalanche Diodes; Varactor Diodes; Tunnel Diodes; The Unijunction Transistor; Silicon-Controlled Rectifier; Characteristics and Uses of SCRs; The TRIAC; Field-Effect Transistors; Junction FET; the MOSFET; Photo Devices; Thermistors; Factors Limiting Performance; Hi-Frequency Performance of Transistors.

Part 3 (2007C). Transistors as Circuit Elements; Current Amplifier; Small Signal Amplifiers; Equivalent Circuits; The h-Parameters; Characteristics and Operation of Typical Transistor Circuits.

Special Note:
- Covers subject at an advanced, in-depth level.

### 2008A-B

**Advanced Solid State Circuits**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
AC Principles (Block A22)
Basic Electronic Circuits (Block B24)

**What Students Learn:**
Part 1 (2008A). Multistage Amplifiers; Frequency Response; Analysis of Multistage Amplifiers; Equivalent Circuits; Midband Current Gain; Low-Frequency Amplification; Hi-Frequency Amplification; Alpha Cutoff Frequency; Bandwidth; Power Amplifiers; Power Transistors; Classification of Amplifiers; Performance Factors; Series-Fed and Shunt-Fed Class-A Amplifier; Common-Base Class-A Power Amplifier; Class-B Push-Pull Power Amplifier; Graphical Representation; Power and Collector Efficiency; Distortion in Class-B Amplifiers; Class-AB Push-Pull Amplifier; Phase Inverters; Complementary Symmetry; Direct-Coupled Power Amplifiers; Basic Bridge Circuits; Compound Connected Driver; Quasi-Complementary Power Amplifier.

Part 2 (2008B). Introduction to Feedback Principles; Negative Feedback Effects on Frequency Bandwidth; Nonlinear Distortion; Stabilization of Gain; Input and Output of Resistance; Transistor Amplifier with Current Feedback; Series Feedback Formulas;Emitter Follower; Multistage Feedback; Operational Amplifier; Gain, Input, and Output Resistance of Operational Amplifier; Practical Circuits: Operational-Amplifier Audio Amplifier; Operational Adder Circuit; Feedback Oscillators; Crystal Oscillators; Negative Resistance Oscillators; Tunnel Diode Oscillators; Relaxation Oscillators; Multivibrators; Unijunction Oscillators; Switching; Selected Circuits; Power Supplies; Hi-Fi Preamplifier; FET Voltmeter; Light Flasher Superheterodyne Receiver; SCR Drive for Universal Motor.

### 2020

**Vacuum Tube Fundamentals**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
AC Principles (Block A22)

**What Students Learn:**
Electrical Characteristics and Performance of the Diode; Triode, Tetrode, Pentode, and Other Multielement Tubes; Their Performance under Actual Operating Conditions; Static and Dynamic Characteristics; Characteristic Curves; Tube Constants; Rectification and Amplification; Interpretation of Important Data on Commercial Vacuum Tubes; Typical Amplifier Circuits Considered.

Special Note:
- Covers subject at an advanced, in-depth level.

### 2020

**Basic Electronic Components and Schematic Symbols**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Fundamental Electrical Quantities; Units for Measuring Electrical Quantities; Common Electronic Components and Their Symbols; Resistors, Capacitors, Inductors, Transformers, Rotary Devices, Switches, Protective Devices, Antennas, and Loudspeakers; Basic Vacuum Tubes and Their Symbols; Special-Purpose Gas and Vacuum Tubes; Semiconductor Devices; Transistors; Special-Purpose Semiconductor Devices; Standards of MIL, AES, EIA, IEEE, and ASA Followed.

### 2021

**Understanding and Using Electronic Diagrams**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Basic Electronic Components and Schematic Symbols (2020)

**What Students Learn:**
Understanding Diagram Practices; Learning to Trace Circuits; Identifying Components and Their Functions; Assembling Equipment from Diagrams; Troubleshooting and Using Diagrams; Locating Components and Common-Connection Points; Schematics; Blueprints; Pictorials; Layouts; Wiring Diagrams; Block Diagrams; Functional Diagrams.
2080

**Industrial Electron Tubes**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
AC Principles (Block A22)

**What Students Learn:**
Characteristics, Operating Conditions, and Applications of Vacuum Thermionic and Gas-Filled Diodes; Construction, Operation, and Application of Glow Tube; Triode, Tetrode, and Pentode Circuits; Beam Power Tubes; Thyrons, Mercury-Pool Tubes, Ignitions, and Their Applications; Concepts of Phase Shift and Control; Photoelectric Tube Principles and Applications; Cathode-Ray Tube and Other Electron Beam Tubes; Principles and Operation of X-Ray Tube, Geiger Tube, and Ion-Gage Tube.

**Special Note:**
- Covers subject at an advanced, in-depth level.

2132

**Organization of Digital Computers**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Basic Electronic Circuits (Block B24)

**What Students Learn:**
Analysis of Typical Computer; Types of Memory Units; Components of Arithmetic Unit and Their Operations; Functions of Control Unit Components; Input/Output Devices; Machine Instructions and Information Flow; Examples of FORTRAN and COBOL Language Programs; Examples of Computer Applications.

**Special Note:**
- Covers subject at an advanced, in-depth level.

2130A-B

**Number Systems and Logic**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisite:**
AC Principles (Block A22)

**What Students Learn:**
Part 1 (2130A). Number Systems and Their Representations; Binary and Binary-Coded Decimal Numbers; Negative Numbers; Other Bases (8, 16) and Codes.
Part 2 (2130B). Real Number Representation; Introduction to Boolean Algebra; De Morgan's Theorem and Applications; AND, OR, and NOT Logic; Concepts of NOT and NOR; Transistor Logic Circuits; Truth Tables; Logic Applications.

**Special Note:**
- Covers subject at an advanced, in-depth level.

2131A-B

**Digital Methods and Components**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
AC Principles (Block A22)
Basic Electronic Circuits (Block B24)

**What Students Learn:**
Part 1 (2131A). Digital Representations of Quantities, Binary Number System; Binary Logic; Boolean Algebra; Transistor Logic Gates and Circuitry.
Part 2 (2131B). Characteristics of Logic Gates; RTL, DTL, HTL, TTL, ECL, and MOS Logic Circuits; Digital Integrated-Circuit Packages; Flip-Flops, Shift Registers, Counters, Adders, Decoders, and Complement Gates; Memory Systems; Advanced Developments.

2133

**Analog Systems**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Basic Electronic Circuits (Block B24)

**What Students Learn:**
Definition of Analog Systems; Components and Basic Circuit Configurations Used in Analog Systems; Summing Circuits, Amplifiers, and Feedback Circuits; Operational Amplifier Configurations, including Scale-Changer, Inverter and Operational Adder; Multiplier, Divider, Square Root, and Other Circuits; Use of Nonlinear Circuits, Servomechanisms and Switching Circuits; Integrators and Differentiators; Analog Computers: Digital-to-Analog and Analog-to-Digital Conversion Techniques; Mechanical Encoding.

**Special Note:**
- Covers subject at an advanced, in-depth level.

2148A-B

**Electronics for Numerical Control**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisite:**
Basic Electronic Circuits (Block B24)

**What Students Learn:**
Part 1 (2148A). Elements of Numerical Control Systems; Positioning, Point-to-Point, Continuous-Path, and Contouring Systems; Applications of Numerical Control; Advantages; Components of System; Tape Standards; Tape Codes; Tape Preparation; Tape Programming, Operations Controllable by Tape; Examples of Tape Format and Tape Programs; Fundamentals of Electrical Waveforms; Pulses for Timing, Controlling, and Indicating; Pulse Dimensions; Pulses in Numerical Control Applications; Pulse-Wave Representation of Punched Tape; Review of Frequency- and Time-Related Circuits; Time-Constant Circuits; Storage, Charge and Discharge; Basic Integrating and Differentiating Circuits; Resonance; Filter Circuits; Number Systems for Numerical Control; Decimal System; Binary System; Trinary System; Octal System; Bi-Quinary System, Systems.
Comparisons; Binary-Coded Decimal System; Representation of Numerical Control Data by Pulses and Hole Combinations; Tape Readers and Information Conversion; Logic-Circuit Fundamentals and Examples of Circuits; Truth Tables; Static, Magnetic Solid-State, Transistor Circuits; Logic-Circuit Importance and Applications in Numerical Control Systems.

**Part 2 (2148B).** System Circuits and Devices Affecting Axis Movement, Timing and Counting, and Servo; Modules and Printed Circuit Cards; Toroids; Reed Switches; Reed Relays; Resolvers, Hydraulic System, Action of Servosystem; Interactions of Electrical Signals and Logic Circuits; Limiter Circuits; Diode and Transistor Circuits; Maintenance; Logical Isolation of Troubles; Planning for Maintenance Program; Spare Parts Needed; Working with Factory Service People; Good Troubleshooting Practices; How-Far-to-Go or Where-to-Stop in Troubleshooting; Maintenance Log; Trouble Analysis by Logic; Test Instruments; Safety Precautions; Loss to Employer Due to System “Downtime;” Typical Troubleshooting Procedures; Typical Preventive Maintenance Program.

**Special Note:**
- Covers subject at an advanced, in-depth level.

### 2720A-C

**Design of DC Machines**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- DC Principles (Block A21)

**What Students Learn:**
- Part 1 (2720A). Aims in Designing; Performance of a Motor; Generator Performance; Methods and Process of Design; Armature Design; Armature Core Size and Current Values; Armature Slots, Bars, and Coil Pitch; Armature Coil Insulation; Commutator and Brush Requirements; Commutator Insulation.
- Part 2 (2720B). Slot Size and Armature Conductor Dimensions; Determination of Core Dimensions; Armature Equalizing Dimensions; Resistance of Armature Winding; Main Pole and Air Gap Dimensions; Frame Design; No-Load and Full-Load Saturation Curves; Combined Teeth and Air Gap Curves; Causes and Remedies of Commutation Problems.
- Part 3 (2720C). Purpose and Design of Commutating Poles; Air Gap Characteristics; Field Coil Construction and Insulation; Commutating-Pole Coils, Shunt-Field Coils; Series Field Coils; Efficiency of Motors and Generators; Calculation of Losses; Relation between Efficiency, Input, Output, and Losses.

### 2727A-C

**Design of Alternating Current Machines**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Analog Circuit Measurement (Block A23)

**What Students Learn:**
- Part 1 (2727A). Factors Affecting Voltages Generated in an Alternator; Armature Winding and Insulation; Armature Reaction, Leakage Reactance, and Synchronous Impedance; Vector Diagrams of Voltages and Magnetomotive Forces; Excitation; Heating and Efficiency; Mechanical Design of AC Machines.
- Part 2 (2727B). Order of Determining Approximate Dimensions of a Machine; Complete Design of a 5000-kVA Salient Pole Alternator; Design of a 5000-kVA Turbo-Alternator; Cooling of Turbo-Alternators.
- Part 3 (2727C). General Rules for Design of Induction Motors; Use of Circle Diagram; Design of a 125-hp Induction Motor; Design of a 220-hp Synchronous Motor; Synchronous Condensers; Synchronous Converters.

### 3306

**Resonant Circuits**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
- AC Principles (Block A22)

**What Students Learn:**
- Review of Time-Constants; Resonance; Inductance and Capacitance in DC Circuits; Inductance and Capacitance in AC Circuits; Series-Resonant Circuits; Parallel-Resonant Circuits; Q Factor; Filters; Tuned Circuits in Radio Receivers; Filters; Distributed Circuit Constants; Tuning Effect on Current; High C Circuits.

### 3517

**Tuned Circuits**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Analog Circuit Measurement (Block A23)
- Resonant Circuits (3306)

**What Students Learn:**
- Series LR, CR, and LC Circuits; Series LCR Circuits; Parallel LR, CR, and LC Circuits; Parallel LCR Circuits; Inductively Coupled Tuned Circuits; Filter Circuits; Tuned Circuits with Distributed Constants; Tuned Circuits in Vacuum Tube and Transistor Circuits.

**Special Note:**
- Covers subject at an advanced, in-depth level.

### 4010A-C

**Electricity and Magnetism**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)

**Electricity (4210A-C)**

**What Students Learn:**
- Part 1 (4010A). Basic Electrostatic Laws; Capacitance; Capacitors; Dielectric Materials; Electric Current; Ohm’s Law; Voltage Drops; Resistance; Conductors; Insulators; Electric Power; Electric Energy; Effects of Electricity; Methods of Generating Electromotive Force.
- Part 2 (4010B). Basic DC Circuits; Grounded and Ground-Return Circuits; Circuit Calculations; Compound Circuits and Equivalents; Kirchoff’s Laws; Calculations and Example Problems on Kirchoff’s Laws; D-to-Y and Y-to-D Conversion; Superposition Theorem, Applications, and Example Problems; Thevenin’s Theorem, Applications, and Example Problems; Thevenin’s Theorem in Bridge-Circuit Analysis; Norton’s Theorem, Applications, and Example Problems;
Electrical and Electronics

Problems; Maximum-Power-Transfer Theorem and Example Problems.
Part 3 (4010C). Magnetism; Natural and Permanent Magnets;
Magnetic Materials; Formulas for Calculating Magnetic Properties;
Electromagnetism, Magnetic Effects of Electric Current;
Magnetomotive Force; Magnetic Field; Magnetic Circuits and Their
Properties; Force Produced by Magnetism; Electromagnetic Induction;
Generator and Motor Principles; Self-Inductance; Mutual Inductance;
Transformer Principle.

Special Note:
• Covers subject at an advanced, in-depth level.

4018A-D

Principles of AC Circuits

Duration: 40 hours (includes 4 tests)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
AC Principles (Block A22)

What Students Learn:
Part 1 (4018A). Generation of Alternating Current; Phasor
Representation of Currents and Voltages; Characteristics of Alternating
Current; Phase Relations of Currents and Voltages; Reactances,
Impedance, and Examples of Their Calculations; Power in Single-Phase
AC Circuit; Power Factor; Power Triangle; Waveforms.
Part 2 (4018B). Graphical Representation of Sine Waves by Phasors;
Mathematical Techniques for Addition, Subtraction, and Multiplication
of Phasors; Use of Operator j; Series Single-Phase Circuits; Representa-
tion of Phasors in Rectangular and Polar Forms and Their Conversion
Techniques; Effects of Varying Inductive and Capacitive Reactances;
Resonant Circuits; Power in a Series Circuit.
Part 3 (4018C). Parallel Single-Phasor Circuits; Use of Ohm’s Law,
Kirchhoff’s Laws, and Phasors for Solving Circuit Problems;
Conductance, Inductive and Capacitive Susceptances, and Admittance,
Frequency Characteristics; Relationship of Currents in RC, RL, and RLC
Circuits; Resonant Effects; Solving Combination Single-Phase Circuits such as
Equivalent Circuits; Transmission Lines, Aperiodic Circuits, and Power
Relationships; Use of Thvenin’s Theorem and Loop Current Analysis.
Part 4 (4018D). Single-Phase and Polyphase AC Circuits; Two-Phase,
Four- and Three-Wire Systems; Three-Phase Y- and D-Connected
Systems; Balanced Y- and D-Connected Systems; Three- and Four-Wire
Y- and D-Connected Systems; Relationship of Voltages, Currents, and
Powers; Interconnected Y and D Systems for Balanced and Unbalanced
Loads; Conversion of Y or D Systems.

Special Note:
• Covers subject at an advanced, in-depth level.

4019A-B

Electric Power Measurements

Duration: 20 hours (includes 2 tests)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Analog Circuit Measurement (Block A23)

What Students Learn:
Part 1 (4019A). Components of Watthour Meters; Current, Voltage,
and Power in AC Circuits; Types of Circuits and Their Measurements;
Adjustments and Compensation of Meters; Use of Current and Potential
Transformers; Register Constants and Multipliers; Meter Mountings and
Service Connection Diagrams.
Part 2 (4019B). Watthour Meter Testing and Adjustments; Types of
Testing; Testing Methods; Demand Metering; Mechanical Demand
Registers; Pulse Devices; Thermal Watt Demand Meters; Measurement of
Reactive Power and Apparent Power; Nonsinusoidal Waveforms; Control
of Resistance Loads by SCRS; Waveform Analysis, Effect of
Nonsinusoidal Waveforms on Measurements.

4030A-B

DC Machines

Duration: 20 hours (includes 2 tests)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Industrial DC Motors (086051)
DC Motors and Generator Theory (086006)

What Students Learn:
Part 1 (4030A). Operation Principles of DC Generators and
Motors; Voltage Generators; Motor Action; Electric Connections; Effects of
Magnetic Saturation and Armature Reaction; Principal Parts such as Brushes,
Bearings, Frame, and Rotor; Machine Applications and Ventilation.
Part 2 (4030B). Operational Characteristics of Shunt-Wound,
Series-Wound, and Compound-Wound DC Generators and Motors;
Starting and Controlling DC Motors; DC Machine Losses and
Efficiency; Load, Temperature, and Speed Ratings; Special DC Machines
such as Three-Wire Generators, Voltage Regulators, and Permanent-
Magnet Motors.

Special Note:
• Covers subject at an advanced, in-depth level.
4031
Alternators
Duration: 10 hours (includes 1 test)
Course Prerequisites:
AC Principles (Block A22)
Industrial AC Motors (086052)
What Students Learn:
Theory and Parts of Alternators; Alternator Ratings; Operating Characteristics of Alternators; Structural Features of Stator; Stator Core; Stator Windings; Bar Windings; Two-Layer Coil Windings; Structural Features of Rotor; Mechanical and Electrical Details; Collectors and Brush Rigging; Horizontal-Shaft Bearings; Bearing Temperature Relays; Ventilation; Engine-Driven Alternators; Waterwheel-Driven Alternators; Steam Turbo-Alternators; Stator Construction; Rotor Construction; Air Supply; Hydrogen-Filled Generators; Connections of Alternator Winding Field and Armature.
Special Note:
• Covers subject at an advanced, in-depth level.

4032
Alternating Current Motors
Duration: 10 hours (includes 1 test)
Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
AC Principles (Block A22)
What Students Learn:
Principles of Operation of Induction Motors; Polyphase Primaries and Polyphase Secondaries; Squirrel-Cage Rotor, Phase-Wound Rotors; Starting Induction Motors; Squirrel-Cage Motors, Phase-Wound Motors; Performance and Speed Control: Adjustable-Speed Induction Motors; Synchronous Motors; Types, Operation, Theory, and Application; Single-Phase Motors: Types, Operating Characteristics.
Special Note:
• Covers subject at an advanced, in-depth level.

4033
Fractional Horsepower Motors
Duration: 10 hours (includes 1 test)
Course Prerequisite:
AC Principles (Block A22)
What Students Learn:
Operating Characteristics of Fractional-Horsepower Motors; Split-Phase Motors; Capacitor-Start Motors; Two-Value and Permanent-Split Capacitor Motors; Shaded-Pole, Polyphase, DC, and Universal Motors; Brush-Shifting Repulsion Motors; Repulsion-Start, Repulsion-Induction, and Electrically Reversible Repulsion Motors; Thermal Overload Protection.

4034
Repairing Fractional Horsepower Motors
Duration: 10 hours (includes 1 test)
Course Prerequisite:
AC Principles (Block A22)
What Students Learn:
Troubleshooting Defective Motors to Determine Defects by Physical Examination and Simple Electrical Tests; Repair of Mechanical Faults, found in Bearings, Starting Switches, and Brushes; Testing for Electrical Faults, such as Grounds, Short Circuits, and Open Circuits; Chart of Common Motor Troubles and Their Causes.

4040
Transformers
Duration: 10 hours (includes 1 test)
Course Prerequisite:
AC Principles (Block A22)
What Students Learn:
Essential Transformer Properties; Operation Under Load and Without Load; Losses; Voltage Regulation; Rating; Types of Core and Windings; Insulation; Bushings; Tap Changers; Polarity; Single-Phase and Polyphase Transformers; Delta, Star, Open-Delta, and Scott Connections; Special Transformers, Autotransformers, Reactors, Step-Voltage Regulators; Instrument Transformers; Maintenance of Transformers; Design of Small Low-Voltage Transformers.

4041
Transformer Operation
Duration: 10 hours (includes 1 test)
Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
AC Principles (Block A22)
Transformers (4040)
What Students Learn:
Calculations Pertaining to Transformer Operation; Phasor Diagrams; Equivalent Circuits; Losses; Efficiency; Three-Phase Transformer Connections; Harmonic Currents and Voltages; Parallel Operation of Transformers; Phase Transformation; Regulation of Voltage with Tap Changers and Separate Units; Operation of Autotransformers and Three-Winding Transformers; Testing of Transformers.
**4042**

**Distribution and Power Transformers**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
AC Principles (Block A22)
Transformers (4040)

**What Students Learn:**
Distribution Transformer: Core-Form and Shell-Form Transformers; Insulation, Connections, Protective Devices; Types of Distribution Transformers; Air-Core and Iron-Core Reactors, Furnace and Neon-Sign Transformers; Rectifiers, Transformers, and Test Transformers; Power Transformers: Rating, Core Construction, Coil Forms, Bushings, Protection and Temperature Control, Cooling Methods, Oil Protection, Maintenance.

**4048**

**Telemetering**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Analog Circuit Measurement (Block A23)
Transformers (4040)

**What Students Learn:**
Definition and Classification of Telemetering; Analog Telemetering Systems; Frequency Telemetering System; Impulse Duration Telemetering System; Digital Telemetering System; Transmission of Data Signals; Telemetering Channels; Computations in Telemetering; Telemetering for Automatic Control; Electric-Power-System Control.

**4146A-C**

**Electrical Measuring Instruments**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)
AC Principles (Block A22)

**What Students Learn:**
Part 2 (4146B). Bridge Measurements; DC Bridge Measurements; AC Bridge Measurements; Calibration of Instruments; Telemetering.
Part 3 (4146C). Multimeters; Volt-Ohm-Milliammeters; Vacuum-Tube Voltmeters; Transistor Volt-Ohm-Milliammeters; Field-Effect Transistor Volt-Ohm-Milliammeters; Digital Meters; Oscilloscopes.

**Special Note:**
- Covers subject at an advanced, in-depth level. It is recommended that Apprentices, Maintenance Staff, and Trades Workers study Block A23, Analog Circuit Measurements.

**4210A-C**

**Electricity**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
AC Principles (Block A22)

**What Students Learn:**
Part 1 (4210A). Structure of Matter and Particles; Voltage, Current, Conductance, and Resistance; Conductors, Insulators, and Semiconductors; Wire Gages; Electric Cells and Batteries; Resistors; Switches; Basic DC Circuits; Parallel, Series, and Series-Parallel Circuits; Ohm's Law; Electric Power; Electric Energy; First Aid for Electric Shock.
Part 2 (4210B). Analysis of DC Circuits; Characteristics of Series, Parallel, Series-Parallel, and Parallel-Series Circuits; Examples of Reducing Combination Circuits; Open-Circuit and Short-Circuit Calculations; Magnetism and Electromagnetism; Solenoids; Electromagnetic Inductance; Generator and Motor Action; Mutual Inductance; Self-Inductance.
Part 3 (4210C). Theory of Alternating Currents; Single-Phase AC Circuits; Inductance and Capacitance; Inductive and Capacitive Reactances; Impedance; Typical Circuits with Capacitors and Inductors; Resonant Circuits; Filter Circuits; Power in Single-Phase Circuits; Three-Phase Circuits, Characteristics of Y (Star) and D (Delta) Connections; Principle of Transformers; Rotating AC Machines.

**4220A-B**

**Repairing DC Motors and Generators**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
AC Principles (Block A22)
Industrial DC Motors (086051)

**What Students Learn:**
Part 1 (4220A). Construction of Armatures and Commutators; Types of Windings; Characteristics and Classes of Insulation; Armature Defects; Use of Testing Instruments; Nature of Trouble; Temporary Repairs; Repair of Mechanical Defects; Commutator Troubles; Armature Repair Tools; Dismantling of Armature; Removing and Rebuilding of Commutators; Armature Assembly; Mechanical Balance; Rewinding for Other Voltages; Winding and Inserting Coils; Sealing the Winding; Final Tests.
Part 2 (4220B). Construction, Connections, and Effects of Field Coils; Kinds of Field Coil Faults; Insulation Requirements and Testing; Polarity Checks; Locating and Repairing Open and Short Circuits and Grounds; Removing, Rewinding, Testing, and Installing of Coils; Centering of Armatures; Purpose of Brushes; Materials and Characteristics of Brushes; Brush Holders and Spacing; Methods for Determining Mechanical and Electrical Neutral; Brush Faults and Repair; Maintenance of Commutator Surface; Potential-Drop Curves; Air Gaps and Adjustment; General Procedure for Finding Commutation Problems.
**4341**

**Industrial Motor Applications**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- AC Principles (Block A22)
- Industrial DC Motors (086051)
- Industrial AC Motors (086052)
- Controlling Industrial Motors (086053)

**What Students Learn:**
- Motor Torque; Inertia of Loads; Motor Types and Characteristics; Power-Supply Factors; Types of Drives; Braking of Motors; Intermittent Service; Mechanical Connecting Devices; Motor-Driven Power Pumps; Fans and Blowers; Reciprocating, Rotary, and Centrifugal Compressors.

**Special Note:**
- This course is being replaced by an updated version, 086093, currently in development.

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**4415**

**Design of Transformers**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
- Distribution and Power Transformers (4042)

**What Students Learn:**
- General Design Procedures for Transformers; Applications and Specifications; Core Design; Winding Design; Transformer Losses; Transformer Characteristics; Thermal Consideration; Examples of Design for Typical Distribution Transformers; Single-Phase Shell-Form Transformer; Three-Phase Stacker Transformer; Three-Phase T-T Connected Transformer; Three-Phase Core-Form Transformer.

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**4420A-B**

**Electric Furnaces**

**Duration:** 20 hours (includes 2 tests)

**What Students Learn:**
- Part 1 (4420A). Construction and Operation of Electric Furnaces; Batch Furnaces, such as Box, Muffle, Pit, Bell, Elevator, Car-Bottom, and Bath Furnaces; Continuous Furnaces, such as Conveyor, Shaker, Rotary, Roller-Hearth, and Pusher Annealing and Hardening Furnaces; Controlled Atmospheres Using Exogas, Endogas, Monogas, and Dissociated Ammonia; Glossary of Heat-Treating Terms Included.
- Part 2 (4420B). Types of Melting Furnaces such as Direct-Arc, Indirect-Arc, and Induction Furnaces; Vacuum Furnaces, including Arc-Melting, Electron-Beam, and Induction-Melting Furnaces; Special Furnaces, such as Vacuum Degassing, Continuous Casting, High-Frequency Induction, and Electrochemical; Temperature Control Indicators and Controllers.

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**6515**

**Radio Frequency Circuits**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
- AC Principles (Block A22)

**What Students Learn:**
- Broadcast Signal; Broadcast Receiver; Antenna Circuit; Tuned Circuits in Radio Receivers; RF Amplifiers; Detector and Automatic Volume Control; Regenerative Detector; RF Oscillator.
6520A-B

Electronics and Ultrasonics

Duration: 20 hours (includes 2 tests)

Course Prerequisite:
Analog Electronic Components (Block B23)

What Students Learn:
Part 1 (6520A). Mechanical Wave-Motion in Solids; Elastic Waves in Solids; Transducers for Generating and Receiving Ultrasonic Waves; Electrical Characteristics of Transducers; Types of Transducers Discussed; Piezoelectric; Electrostrictive; Magnetostrictive; Materials; Ceramic; Quartz; Ferromagnetic; Vibrations; Dilatational or Thickness and Shear Modes.
Part 2 (6520B). Ultrasonic Cleaning; Cavitation; Erosion of Metal Surfaces; Basic Generator Circuit Details; Cleaning Applications; Flaw-Detecting, Ranging and Gaging; Pulse Forms Used; Typical Generating Circuit; Pulse Frequency Spectra; Transducers and Filters; Probes; Methods of Thickness Measurement; Effects of Dispersions; Pulse-Echo Technique; Thickness Measurements; Attenuation Liquid Level Sensors; Level Monitoring Systems; Ultrasonic Devices in Electronic Circuits; Resonators; Filters; Delay Lines; Impedance; Selectivity; Q-Factor; Advantages and Disadvantages; Ultrasonic Machining and Ultrasonic Welding; Ultrasonic Mechanical Transformer and Ultrasonic Generator in Machining and Welding Applications; Principles of Ultrasonic Machine Tools in Cutting and Drilling and Their Applications; Advantages and Disadvantages; Welding of Thin Sheets; Spot Welding Large Plates; Seam Welding; Special Advantages.

Special Note:
• Covers subject at an advanced, in-depth level.

6525

Fundamentals of Electronic Instrumentation and Control

Duration: 10 hours (includes 1 test)

Course Prerequisites:
AC Principles (Block A22)
Basic Electronic Circuits (Block B24)

What Students Learn:
Introduction to Basic Concepts; Electronic Circuits and Measurements in Industrial Measurement and Control; Techniques of Electronic Measurement of Voltage, Current, and Resistance; Standard and Specialized VTMVs; Electron-Ray-Tube Voltmeters; Wheatstone Bridge; Electronic Power Measurements; Measurement of Frequency by the Heterodyne, Frequency-Difference, and Electronic Counter Methods; Decade Counters and Circuits; Types of Transducers; Electronic Computers; Control Systems and Circuits; Components of Control Systems and Circuits; DC Amplifiers, Choppers, and Commutators; Integrating and Differentiating Circuits.

Special Note:
• Covers subject at an advanced, in-depth level.

6526

Electronic Instrumentation
Methods and Circuits

Duration: 10 hours (includes 1 test)

Course Prerequisites:
AC Principles (Block A22)
Basic Electronic Circuits (Block B24)

What Students Learn:
Components, Circuits, and Techniques of Electronic Instrumentation; Graphic Recorders; Multichannel Recorders; Recording Oscillographs, including Null-Balance Type; Use of Tape Recorders; Feature of the Telautograph and its Application for Remote Instantaneous Reproduction of Handwriting and Other Recorded Data; Electronic Methods of Temperature, Pressure, Liquid-Level, and Strain Measurement, including Radioactive and Ultrasonic Techniques; Electronic Measurement of Vibration, Rotational Velocity, Speed, Acceleration, and Altitude; Nuclear and Infrared Instrumentation, including Ionization Chamber, Geiger-Muller Counter, Scintillation Counter; Infrared Transmission and Reception in Industrial and Space Vehicle Applications; X-Ray Tubes; The Gyroscope and Gyroscopic Inertial and Gyroscopic Precession.

Special Note:
• Covers subject at an advanced, in-depth level.

6531A-B

Electronic Test Instruments

Duration: 20 hours (includes 2 tests)

Course Prerequisite:
AC Principles (Block A22)

What Students Learn:
Part 1 (6531A). Methods of Measuring Current, Voltage, Power, and Resistance by Means of Permanent Magnet and Dynamometer Meter Movements and Bridge Circuits; DC Vacuum-Tube Voltmeters; Methods of Measuring Alternating Current, RF Voltages, Inductance, and Capacitance; VOMs; VTVMs; Capacitor Checkers; Tube and Transistor Testers; Audio and RF Signal Generators; Sweep-Frequency Generators; Cathode-Ray Oscilloscope.
Part 2 (6531B). Oscilloscopes and Their Important Characteristics; Troubleshooting with the Oscilloscope and Auxiliary Instruments; Testing and Troubleshooting of High Fidelity Systems; Testing and Troubleshooting of Industrial Electronic Circuits.

Special Note:
• Covers subject at an advanced, in-depth level.
6538A-B

Protective Relaying

Duration: 20 hours (includes 2 tests)

Course Prerequisite:
AC Principles (Block A22)

What Students Learn:
Part 1 (6538A). Purpose of Protective Relays; Classification of Relays; Methods of Protection; Symbols and Diagrams in Protective Relaying; Power Circuit Breakers and Their Control Circuits; Relaying Accuracy of Current Transformers; Potential Transformers; Protective Relay Units, such as Induction Disk, Induction-Cylinder, Plunger, Polarized DC, Moving Coil, and Clapper Relays; Auxiliary Protective Equipment for Relaying; Testing of Relays by Test Plugs; Testing Procedures.
Part 2 (6538B). Principles of Relay Applications; Protective Relaying of Generators, Motors, Transformers, and Buses.

6580

Electronic Control Circuits and Applications

Duration: 10 hours (includes 1 test)

Course Prerequisites:
AC Principles (Block A22)
Basic Electronic Circuits (Block B24)

What Students Learn:
Open and Closed Loop Control Systems; Transmission Circuits for DC and AC Control Signal; Carrier and Tone Methods of Control Signal Transmission; On-Off Tone Generators and Receivers; Selectivity Requirements; Dial-Code Senders and Decoders; Multiple Code Decoders; Diode-Type Voltage Selective Circuits; Light-Operated and Lighting Control Circuits; Generator and Motor Speed Regulation; Electronic Welding Control; Ultrasonic Intrusion Alarm; Traffic-Signals; Controllers; Radar Traffic Counters; Electronic Applications in Automation; Electronic Control of Machine Tools; Preventative Maintenance and Troubleshooting.

Special Note:
• Covers subject at an advanced, in-depth level.

6598

Batteries and Electronic Power Supplies

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
AC Principles (Block A22)

What Students Learn:
Types of Dry Cells; Testing of Dry Cells; Application of Dry Batteries; A, B, and C Batteries; DC and AC Power-Supply Circuits; Transformers; Rectifiers; Bridge Circuits; Power-Supply Filters; Voltage Dividers; Voltage Regulation; Zener Regulators; Transistor Voltage Regulators; Storage Battery Characteristics and Applications; Battery Chargers; Rotary, Vibrator, and Transistor Converters; Rotary, Vibrator, and Solar Inverters; TV-Receiver Power Supplies; Nickel-Cadmium Cells.

6601

Theory of RL, RC, and RLC Circuits

Duration: 10 hours (includes 1 test)

Course Prerequisite:
AC Principles (Block A22)

What Students Learn:
Inducing a Voltage in a Conductor; Inductance; Characteristics of Magnetic Materials; Effects of Frequency on Reactance; Capacitance; Displacement Current; Types of Dielectrics and Dielectric Strength; Capacitor in Series and Parallel Circuits; Capacitive Reactance; Circuits Containing Inductors and Capacitors; Time-Constant Circuits; Inductance of a Capacitor; Capacitance of an Inductor; Practical Uses of Inductors; Methods of Minimizing Circuit Losses; Practical Capacitors; Types of Capacitors; Physical Characteristics; Capacitance Color Coding Systems and Various Systems in Use; Use of Powers of 10 Review.

Special Note:
• Covers subject at an advanced, in-depth level.

6613

Switchgear

Duration: 10 hours (includes 1 test)

Course Prerequisite:
AC Principles (Block A22)

What Students Learn:
Switchgear and the Power System; Flow of Power; Protection of the Power System; Overlapping Protective Zones; Differential Protection Schemes; Automatic and Manual Control of Generating Stations; Minimum Protection for Generators and Transformers; Protection of Distribution Systems; Circuit Breaker Ratings and Designs; Operation of Circuit Breakers; Interruption of AC and DC Circuits; AC Reclosing Service; Station-Type Cubicle Switchgear; Metal-Clad Switchgear; Low-Voltage Metal-Enclosed Switchgear; Supervisory and Control Switchboards; Switchgear Devices.

Special Note:
• This course is being replaced by an updated version, 086092, currently in development.
6617

**Inductance and Capacitance**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
AC Principles (Block A22)

**What Students Learn:**
Practical Aspects of Self-Induction; Calculating Inductance of Coils; Inductive Reactance; Impedance of an Inductive Circuit; Capacitors; Meaning of Capacity; Dielectric Strength; Fixed Capacitors; Electrolytic and Variable Capacitors; Capacitor Color Code; Time Constant.

6631A-B

**AC Motor Repair**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
AC Principles (Block A22)
Industrial AC Motors (086052)

**What Students Learn:**
Part 1 (6631A). Determining Common Defects on Stators; Connection Diagrams and Tables; Testing for Electrical Defects; Standard Designation of Coil Insulation; Recording of Winding Data for Stators; Stators with Partly Closed Slots; Core Insulation, Flat and Pulled Mash Coils; Two-Layer and Overlap Winding; Inserting Coils into Slots; Finishing the Winding Outside of Slots; Varnish Treatment; Tools Used in Winding Stators; Stators with Open Slots; Slot Insulation; Conductors for Open-Slot Coils; Winding Open-Slot Coils; Coil Insulation; Installing Windings in Open Slots; Connecting Stator Windings.
Part 2 (6631B). Rotor Types; Repairing Squirrel-Cage Rotors; Electrical Faults on Lap-Wound Rotors; Pitch Values of AC Wave Windings; Phase Leads; Determining Slots per Pole per Phase (SPP); Connection Diagrams and Tables; Checking Tables for Connection Diagrams; Winding of Wave-Wound Rotors; Preparation for Rewinding; Rewinding Rotors with Standard Leads and No Phase Coils, with Standard Lead Phase Coils, and with Short-Lead Phase Coils; Placing Coils into Rotor Slots; Connectors of Wave Windings; Banding and Bank Insulation; Repair of Synchronous Motors.

6646

**Illumination Principles**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
AC Principles (Block A22)

**What Students Learn:**
Photometry as Means of Measuring Intensity and Quantity of Light; Degree of Illumination and Brightness; Light Control by Reflection, Refraction, Transmission, Absorption, and Polarization; Materials Providing Specular and Nonspecular Reflection; Transmitting Materials; Light Distribution of Luminaries; Brightness Ratios; Glare; Uniformity of Illumination; Computations of General Lighting Designs; Design of Supplementary Lighting; Zonal Cavity Method.

6687

**DC Generators and Motors**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
AC Principles (Block A22)

**What Students Learn:**
Principle of Generator Operation; Construction and Types of DC Generators; Special DC Generators; Operation of DC Generators; Principle of Motor Operation; Shunt-, Series-, and Compound-Wound DC Motors; Mechanical Features of DC Motors; Their Ratings and Efficiency.

6698

**AC Motors, Generators, and Rectifiers**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
AC Principles (Block A22)

**What Students Learn:**
Squirrel-Cage and Phase-Wound Three-Phase Induction Motors, Their Construction, Operation, and Rating; Synchronous Motors; AC Generators or Alternators, and Their Operation and Maintenance; Main Types of Rectifiers and Their Application.

6699A-C

**Industrial Motor Control**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
AC Principles (Block A22)
DC Generators and Motors (6687)
AC Motors, Generators, and Rectifiers (6698)

**What Students Learn:**
Part 1 (6699A). Principles of Motor Control; Manual Motor Control; Manual Starters for Squirrel-Cage and Wound-Rotor Induction Motors; Manual Starters for DC Motors; Magnetic Control Components, such as Magnetic Contactors, Relays, Interlocks and Brakes, Master Switches, Resistors, Motors, Circuit Protective Devices, and Control Panel.
Part 2 (6699B). Control Circuits of Line Starters, Reduced-Voltage Magnetic Starters for AC Motors; Control Systems for Wound-Rotor Motors; Control System for Synchronous Motors; Constant-Voltage Controllers for DC Motors; Adjustable-Voltage Controllers for DC Motors; Voltage, Speed, and Current Regulators; Static Regulators.
Part 3 (6699C). Common Drive Systems; Symbols; Semiconductor Principles: Semiconductor Characteristics of Diodes, Zener Diodes, Transistors, Unijunction Transistors, and Silicon-Controlled Rectifiers; Basic Drive Systems; SCRs as AC to DC Converters; Types of Converters; Protection of Converters; Power Ratings; Use of Semiconductor Amplifiers in Converters; Acceleration and Deceleration Circuits; Block Diagrams; Application, Construction, Installation, and Maintenance of Drive Systems.
6728

**Symmetrical Components**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Logarithms (5254)
- Plane Trigonometry (2309A-B)
- Electricity and Magnetism (4010A-C)
- Principles of AC Circuits (4018A-D)
- Transformers (4040)

**What Students Learn:**
- Fault Calculations in Three-Phase Systems; Sequence Currents and Voltages; Sequence Impedances; Network Connections for Fault Calculations; Calculations for Phase-to-Ground Fault in such Steps as Reduction of Equivalent Impedances, Distribution of Current, Computation of Phase Currents, and Computation of Voltages; Calculations for Three-Phase Fault; Phase-to-Phase Fault, and Two-Phase-to-Ground Fault.

6793

**Instrument Transformers**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- AC Principles (Block A22)

**What Students Learn:**
- Fundamentals of Current and Potential Transformers; Types of Instrument Transformers; Instrument Transformer Construction Standards, such as Ratings and Insulation Classes; Instrument Transformer Performance Standards as to Burden, Accuracy, and Correction Factors; Practical Application of Instrument Transformers with Regard to Grounding, Rating, Connections, and Burden; Polarity and Accuracy Testing of Instrument Transformers Utilizing Various Methods and Procedures.

786001

**Cable Technology: Introduction to Transmission and Measurement**

**Duration:** 5 hours (includes 1 test)

**What Students Learn:**
- Discuss the purpose of the standards in the NTC Report No. 7 and the EIA/TIA-250-C Standard.
- Define common television transmission terminology.
- Explain standard measurement practices of television signals using a test signal generator, waveform monitor, and vectorscope.
- Discuss the importance of calibrating instruments and using sound test procedures.
- Identify and explain fundamental signal properties such as amplitude, time measurement, and the relationship between the subcarrier and horizontal phase.
- Describe the baseband interface parameters as they apply to the video signal channel and the audio signal channel.

786002

**Cable Technology: Performance Characteristics**

**Duration:** 5 hours (includes 1 test)

**What Students Learn:**
- Identify the performance standards of video signals.
- State the parameters of short-time, line-time, field-time, and long-time distortions.
- Define and measure chrominance-to-luminance gain and delay inequalities.
- Explain the four K-factor measurements.
- Define insertion gain and variation, the standard for insertion gain, and the method of measurement.
- Identify nonlinear distortions and signal interference.
- Identify the performance standards of audio signals, including frequency response and total harmonic distortion.
- Determine the signal-to-noise ratio.
- Define and measure insertion gain and variation.
- State the definition of the gain difference between stereo A and B channels, the standard, and the method of measurement.
- Identify the phase difference and the crosstalk coupling loss between stereo A and B channels.

Block A04

**Electrical Equipment**

**Duration:** 36 hours (includes 4 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- Analog Circuit Measurement (Block A23)

**What Students Learn:**
- The twelve lessons in this block provide the student with the skills and knowledge needed to install basic industrial electrical equipment. In addition to learning the symbols for the various types of equipment, the student will learn how to safely install conductors and electrical fittings. The type of equipment discussed includes outlet boxes, panels, raceways, conduits, switches, fuses, circuit breakers, plugs, receptacles, and lampholders. The student will also learn how to calculate electrical loads, lay out circuits, and troubleshoot control circuits.

**Components:**
- A0401 Electrical Equipment Applications and Symbols
- A0402 Outlet Boxes
- A0403 Industrial Boxes, Panels, and Raceways
- A0421 Progress Examination
- A0404 Conductor Properties and Installations
- A0405 Conduit Characteristics and Installations
- A0406 Electrical Fittings and Bending Conduit
- A0422 Progress Examination
- A0407 Switches and Their Operation
- A0408 Automatic Controls and Control Circuits
- A0409 Fuses
- A0410 Circuit Breaker Operation and Maintenance
- A0423 Progress Examination
- A0411 Plugs, Receptacles, and Lampholders
- A0412 Electrical Loads
- A0424 Progress Examination
- A0420 Progress Examination Booklet

**Special Note:**
- This program has been replaced by an updated program, Block A24.
Block A21

DC Principles

Duration: 30 hours (includes 6 tests)

Course Prerequisite:
Basic Industrial Math (Block X21)

What Students Learn:
In this block consisting of six study units, the trainee will learn the basics of electrical theory. These units introduce electrical terms, symbols, and the operation of simple circuits. Ohm's law receives extensive coverage including practical troubleshooting examples used to industry. A new unit specific to capacitors and inductors provides more in-depth coverage. Up-to-date information on conductors, insulation, and specialty batteries forms a revised study unit. Study units covering magnetism, electromagnetism, motors, and generators are included with industry related examples.

Special Note:
• This updated course replaces DC Principles, Block A01. Each study unit contains a progress exam.

Components:
086001 Nature of Electricity
086002 Circuit Analysis and Ohm’s Law
086003 Capacitors and Inductors
086004 Magnetism and Electromagnetism
086005 Conductors, Insulators, and Batteries
086006 DC Motors and Generator Theory

086003

Capacitors and Inductors

Objectives:
• Explain how a capacitor holds a charge.
• Describe common types of capacitors.
• Identify common capacitor ratings.
• Calculate the total capacitance of a circuit containing capacitors in series or in parallel.
• Calculate the time constant of a resistance-capacitance or RC circuit.
• Explain how inductors are constructed.
• Describe the system used to rate inductors.
• Describe how an inductor regulates the flow of current in a DC circuit.
• Calculate the total inductance of series or parallel connected inductors.
• Calculate the time constant for a resistance-inductance or RL circuit.

086004

Magnetism and Electromagnetism

Objectives:
• Identify the north and south poles of permanent magnets and electromagnets.
• Name magnetic and nonmagnetic materials.
• Describe how to magnetize a piece of steel by induction.
• Explain the difference between simple, compound, and closed magnetic circuits.
• Locate the direction of magnetic lines of force around a conductor (if the direction of current is known).
• Use the right-hand rule to locate the poles of a solenoid.
• Describe the operation of simple electromagnetic relays, buzzers, and stepping switches.
• Explain how a DC motor operates.
• Give a simplified explanation for generator action and motor action with electromagnetic induction.

086005

Conductors, Insulators, and Batteries

Objectives:
• Describe the various types of conductors and discuss their conductivity.
• Explain the American Wire Gage System of sizing copper conductors.
• Determine the size of conductor needed for an application.
• Identify the various types of insulating materials and their temperature ratings.
• Explain the difference between a dry cell and a storage battery.
• How to connect cells together to obtain more voltage, more current, or more of both voltage and current.
• Describe the proper safety precautions used when working with storage batteries.
• Describe how to properly clean and care for storage batteries.
• Discuss the instruments used for testing storage batteries.
• Explain how NiCad, lithium, and other types of special batteries operate, and describe their ratings.
086006

DC Motors and Generator Theory

Objectives:
• Identify a series-, shunt-, and compound-wound motor and discuss their application.
• Explain how a permanent-magnet and stepper motor operate.
• List the steps to reversing a DC motor’s direction.
• Discuss how the speed of a DC motor can be controlled.
• Explain the basic principle for generating a direct current.
• Name the factors that affect the strength of the induced voltage.
• Describe the purpose of a commutator and brush assembly.
• Discuss the difference between the field connections of series-, shunt-, and compound-wound machines.
• Give the reason for shifting brushes.
• Discuss the use of commutating poles and compensating windings for better generator operation.
• List the various types of machine losses.

086007

Alternating Current

Objectives:
• Draw a graph of an AC voltage and describe how AC voltage is created.
• Explain AC cycle terms: “alternation,” “peak,” “positive,” and “negative.”
• Define the time period of an AC voltage as expressed in degrees.
• List the characteristic values of an AC cycle and describe the relationship between the values.
• Define phase angle and describe how it relates to reactive circuits.
• Calculate power for single-phase and three-phase circuits.
• Describe how a 220 VAC single-phase circuit operates.
• Illustrate the phase relationship of three-phase wave forms.
• Determine real power by reading a power factor meter.
• Describe delta and wye three-phase circuit connections.

086008

Alternating Current Circuits

Objectives:
• Identify electric circuits in terms of their circuit characteristics.
• List several circuit characteristics that are used to describe a circuit for a particular load application.
• Connect electrical components in series and parallel circuits.
• Control loads from one or two switch points.
• Describe how delta- and wye-connected three phase circuits are different.
• Explain how grounding a circuit increases its safety.
• Recognize the difference between control circuits and power circuits.

086009

Inductors in AC Circuits

Objectives:
• Explain how an inductor is made and how it operates in a DC and AC circuit.
• Describe inductive reactance and impedance, and how AC frequency effects inductance.
• Use Ohm’s law in an AC circuit that includes an inductor.
• Calculate the impedance of a series RL circuit.
• Calculate the impedance of a parallel RL circuit.

086010

Capacitors in AC Circuits

Objectives:
• Describe how a capacitor stores a charge and how series connected and parallel connected capacitance values are calculated.
• Discuss capacitive reactance and use Ohm’s Law in AC circuits that contain a capacitor.
• Calculate the impedance of a series RC circuit.
• Explain how changing the frequency of an AC signal changes capacitive reactance.
086011

Transformers

Objectives:
- Explain what the main components of a transformer are.
- Tell how mutual inductance makes it possible to change an AC voltage from one value to another when using a transformer.
- Determine the turns ratio of a transformer when the primary and secondary voltages are known.
- Calculate primary or secondary voltages or current when either one of these and the turns ratio are known.
- Explain why transformers are laminated.
- Connect three single-phase transformers for three-phase operation.
- Calculate line current (if phase current is known) in delta-connected transformers.
- Explain the operating principles of an auto transformer.

086012

Alternators

Objectives:
- Explain how single- and three-phase alternators operate.
- List and describe the major components of an alternator.
- Discuss alternator ratings in terms of power, voltage, speed, and temperature.
- State the steps required for starting, stopping, and operating alternators.
- Describe the similarities and differences of the three main types of alternators.

086013

Electrical Energy Distribution

Objectives:
- Explain the difference between feeder and branch circuits.
- Describe the different types of systems available for distributing power within a plant.
- Recognize and identify utilization equipment.
- Discuss the use of transformers in energy distribution.
- Identify by name and describe the uses of various types of raceways.
- Distinguish between panel boards and switchboards.
- Describe the electrical system of a power utility.
- Describe how electricity is generated at a power station or utility.

086014

Rectification and Basic Electronic Devices

Objectives:
- Explain how diodes are used as rectifiers.
- Discuss the basic operation of a diode and a triode electron tube.
- Connect a PN junction for forward and reverse bias.
- Explain how a transistor operates as an amplifier.
- Recognize transistor input and output circuits.
- Compare rectifier circuits with and without filter circuits.
- Describe the operation of an SCR and a triac.
- Calculate the ripple frequency of a half-wave and full-wave single-phase and three-phase rectifier.

086025

Basic Test Equipment

Objectives:
- How to use the multimeter (also known as a volt-ohm-milliammeter or VOM).
- Define the terms voltage, current and resistance, and explain their relationship in a circuit.
- Discuss how voltage, current and resistance is measured with a multimeter.
- Identify the schematic symbols used to represent various reactive devices.
- Describe the major features of analog and digital VOMs.
- Explain how to use both analog and digital VOMs to measure voltage, resistance and current in a circuit.
- Learn about the special probes used with a digital VOM.
- Discuss the important safety precautions you must take when using a multimeter.

Block A23

Analog Circuit Measurement

Duration: 15 hours (includes 3 tests)

Course Prerequisites:
- Basic Industrial Math (Block X21)
- AC Principles (Block A22)

What Students Learn:
In this three unit block, trainees learn how to use electrical test instruments and measuring techniques. The instruments covered are multimeters, volt-ohm-milliameters (VOMs) and oscilloscopes. Students will learn how to measure voltage, resistance, and current values is a circuit. Troubleshooting tests on both AC and DC systems including PLC input and output problems are emphasized.

Special Note:
- This updated course replaces Electrical Measurements and Instruments, Block A03. Each study unit contains a progress exam.

Components:
- 086025 Basic Test Equipment
- 086026 Troubleshooting with Volt-Ohm-Milliamp Meters (VOMs)
- 086027 Using Basic Oscilloscopes
**086026**

**Troubleshooting with Volt-Ohm-Milliamp Meters (VOMs)**

**Objectives:**
- Review the functions of a multimeter.
- Name the safe practices you should use when troubleshooting with a VOM.
- How to measure circuit resistance.
- Learn the purpose of, and how to perform, tests for continuity and short circuits.
- Perform resistance tests on resistors, fuses, solenoids, relays, switches, transformers, motors and semiconductors.
- How to take basic current measurements on power supplies, AC feeder lines and other such circuit areas.
- Measure current by using a direct series connection or by using a clamp-type ammeter.
- How to take basic voltage measurements on both AC and DC systems.
- Measure the output voltage of a DC power supply and the voltage of an AC feeder line.
- Measure voltage at disconnect switches, circuit breakers, contactors and transformers.
- Perform voltage tests on circuit boards, PLC systems and motor circuits.

**086027**

**Using Basic Oscilloscopes**

**Objectives:**
- An introduction to the basic controls and functions of an oscilloscope.
- Describe the component parts and features of a standard, dual-trace oscilloscope.
- How to use the front panel controls.
- How to connect an oscilloscope to a circuit.
- Learn how to perform low-voltage measurements on circuit boards.
- Measure the voltage output of a power supply and AC ripple.
- Describe how to perform measurements in SCR and TRIAC circuits.
- Test both DC and AC servo motor controller circuits and heater controller circuits.
- Perform basic scope measurements on digital circuits.
- Learn how to use an oscilloscope to troubleshoot industrial systems.

**Special Notes:**
- This updated course replaces Electrical Equipment, Block A04. Each study unit contains a progress exam.

**Components:**
- Conductors and Insulators in Industry (086070)
- Working with Conduit (086071)
- Electrical Boxes (086072)
- Industrial Enclosures and Raceways (086073)
- Connecting Electrical Equipment, Part 1 (086074)
- Connecting Electrical Equipment, Part 2 (086075)
- Industrial Fuses (086076)
- Industrial Circuit Breakers (086077)
- Plugs, Receptacles, and Lampholders (086078)
- Industrial Switches (086079)
- Industrial Relay Ladder Logic (086080)
- Industrial Relays, Contractors, and Solenoids (086081)

**086070**

**Conductors and Insulators in Industry**

**What Students Learn:**
- Identify the physical properties of various conductors.
- Describe the electrical properties of common conductor materials.
- Explain why conductors contain resistance, which causes voltage drops.
- Identify the common types of insulation materials that are used on industrial conductors.
- Explain how to repair faulty insulation on industrial conductors.
- Describe how to troubleshoot and repair conductor and insulation problems.

**Contents**
- Physical Properties and Characteristics: Conductor Terminology; Wire Sizes; Wire Tables; Mil-Foot and the Effect of Temperature; Electrical Properties and Characteristics: Conductivity; Wire Resistance; Voltage Drop; Types of Industrial Insulation: The Definition of an Insulator; Natural Insulators; Synthetic Insulators; High-Temperature Insulators; Shrink Tubing; Tapes; Other Forms of Insulators; Problems with Conductors and Insulators: Effects of Too Much Current or Heat; Effects ofAbrasion; Effects of Poor Conductor and Insulator Installation; Effects of Aging on Conductors.

**086071**

**Working with Conduit**

**What Students Learn:**
- Define the characteristics of different types of conduit.
- Describe how to install various types of conduit fittings and support.
- Explain how to properly cut and thread conduit using manual and machine methods.
- Identify and use the proper tools for bending conduit.
- List the equipment used in installing large conduit and its connectors.
- Determine conduit sizing when given a particular wiring assignment.

**Contents**
- Conduit Types and Characteristics: Rigid Metal Conduit Systems; Electrical Metallic Tubing (EMT); Intermediate Metal Conduit (IMC); Flexible Metal Conduit; Other Types of Conduit; Conduit Procedures: EMT Conduit Fittings; Rigid and IMT Fittings; Cutting, Reaming, and Threading Conduit; Bonding Conduit; Supporting Conduit; Conduit Nipples and Elbows; Using Insulating Bushings;
086074

Connecting Electrical Equipment, Part 1

What Students Learn:
- Describe the use of flexible conduit, strain relief fittings, plug connections, and terminal blocks in industrial equipment.
- Discuss why there are often two raceways run in parallel in an industrial system.
- Explain when to run rigid conduit, EMT conduit, wireway, or open cords in a system.
- Describe how to make basic connections in industrial control-panelboard enclosures.
- Explain the different classes of remote station and operator station wiring.
- Discuss why various types of cables and conductors must be kept separated.
- Explain how to properly connect communications and controller cables in an industrial control cabinet.

Contents
Connecting Devices to Intermediate Boxes: A General Layout; The AC Wireway; Strain Relief Connections; Larger Systems; Using Receptacles and Plugs; Using Flexible Conduit; The DC Wireway; External Devices; Connections to Terminal Blocks; Connecting Devices to Raceways: Using Rigid Conduit; Using EMT Conduit; Using Flexible Conduit; Using Strain Relief Fittings; Connections in the Control Cabinet: Terminal Block Connections; Connections to Motor Starters and Circuit Breakers; Connections to Fuses; Connecting Signal Cables for Electronic Equipment: Remote Operator Stations: Voltage Levels in Modern Remote Operator Stations; Grounding of Remote Operator Stations; Separating Signal and Control Cables; Broadband and Communication Circuits.

086075

Connecting Electrical Equipment, Part 2

What Students Learn:
- Describe types of solderless connectors.
- Explain the use of hand-operated and hydraulic crimping tools to make good electrical connections.
- Identify the proper size of wire nut or butt splice for splicing conductors.
- Describe how to make good connections with wire nuts and butt splices.
- Explain how to use large compression connectors, including solderless lugs and split-bolt connectors.
- Describe the installation of wires on terminal blocks, plugs and receptacles, and push-pin style terminals.

Contents
Solderless Connectors: Types of Solderless Connectors; Sizes of Solderless Connectors; Installation Tools; Installation of Solderless Terminals; Using Wire Nuts and Butt Splices: Types of Splice Systems; Butt Splices; Installing Wire Nuts; Installing Butt Splices; Compression Connectors: Installing Compression Terminals; Installing Compression Terminal Lugs; Installing Split-Bolt Connectors; Terminal Block and Plug / Receptacle Connections: Terminal Block Connections; Plate-Type Electrical Connections; Plug and Receptacle Pins; Push-Pin Connections.

086072

086073

Electrical Boxes

What Students Learn:
- Describe the role of electrical boxes in an installation.
- Explain why circuits are interrupted.
- Explain when and where electrical boxes are used in installations.
- Describe how to properly install electrical boxes.
- Identify the types of electrical pulling and splicing boxes.
- Explain how to properly install conductors in a system with electrical boxes.

Contents
Equipment Defined: When Wiring is Interrupted; Material Standards; Common Wiring Terms; Wiring Symbols; The Parts of an Electrical System; Electrical Boxes and Covers: Outlet Boxes; Where Outlet Boxes are Used; Boxes and Their Associated Fittings; Types of Outlet Boxes; Non-Metallic Outlet Boxes; Outlet Box Knockouts; Brackets; Fittings for Outlet Boxes; Flush Plates and Covers; Industrial Electrical Boxes; Boxes used for Pulling and Splicing; Junction Boxes; Special Boxes; Conduit Bodies; Straight Pull Boxes; Right-Angle Pull Boxes; Knockouts and Circuit Grounding; Installing an Outlet Box: The Volume of the Box; Locating an Outlet Box; Mounting an Outlet Box: Lighting Fixtures and Exhaust Fans; Cleaning an Outlet Box; Wiring an Outlet Box.

Industrial Enclosures and Raceways

What Students Learn:
- Describe the basic construction of industrial control cabinets and similar enclosures.
- Explain how to connect conduit to enclosures.
- List the proper procedures for installing a disconnect switch or main breaker in an enclosure and the procedures for connecting conductors to the switch.
- Explain how to properly ground the enclosure.
- Describe how to properly install wireways, such as wiring troughs.
- Explain how plugs and receptacles can be used to prefabricate a system.

Contents
Industrial Enclosures: Basic Enclosures; Types of Enclosures; Enclosures with Disconnects; Large Control Enclosures; Installing the Disconnect Switches: Installing the Door Handle Hardware; Installing the Rods and Rollers; Installing the Disconnect Switch Assembly; Connecting the Wiring to the Switch and Panel; Industrial Control Panelboard Layout: General Locations; DIN Rail; Locating Terminal Blocks; Wiring the Control Panel; Connecting Conduit to Enclosures: Layout; Creating Holes in Enclosures; Using Manual Hole Punches; Using Hydraulic Hole Punches; Installing Conduit Fittings; Using Insulating Bushings; Installing Raceways: NEC rules for Metal Wireways; Raceway Cutouts; Supporting Metal Wireway or Trough; Raceway to Machine Connections; Grounding Wireways and Troughs.
**Industrial Fuses**

What Students Learn:
- Discuss the purpose of fuses in industrial electrical and electronic circuits.
- Explain the numbering and lettering system for classifying a fuse’s shape, size, or circuit protection capabilities.
- Identify various types of fuse holders.
- Locate common failure points on different fuse holders.
- Explain how to properly test and replace a fuse.
- Describe common methods for repairing fuse holders.

Contents
The Purposes of Fuses: Protecting Electrical Wiring; Protecting Circuit Devices; Protecting Control Circuits; Protecting Output Devices; Fuse Ratings and Classifications: Current and Voltage Ratings; Time and Temperature Considerations; Interrupt Current Rating; Fuse Categories and Classifications; Sizes and Shapes of Fuses; Fuse Classifications: Glass and Ceramic Fuse Types; Class RK5 Fuses; Class RK1 Fuses; Class CC Fuses; Class L Fuses; Class J Fuses; One Time Fuses; Class G Fuses; Class T Fuses; Midgut Fuses; Specialty Fuses; Using Fuse Catalogs; Fuse Holders: Holders for Small Glass and Ceramic Fuses; Larger Fuse Holders; Blade Fuse Holders: Open Fuse Installation; Changing Fuses and Maintaining Fuse Holders: Removing Power; Testing the Fuses; Checking for a Short Circuit; Checking Fuse Holder Contacts; Cleaning and Maintaining Fuse Holders: Holders for Small Glass and Ceramic Fuses; Larger Fuse Holders; Blade Fuse Holders.

**Plugs, Receptacles, and Lampholders**

What Students Learn:
- Describe various types of convenience receptacles and their special features.
- Discuss how to properly wire a convenience receptacle.
- Explain how to pick the proper locking plug and receptacle for various currents, voltages, and circuit types.
- Discuss the use and installation of various types of industrial signal and power plugs and receptacles.
- Describe various types of industrial lamps and lamp holders.

Contents
Electrical Receptacles: Convenience Outlets Split-Wired Duplex; Receptacles Twenty-Amp Receptacles; Ground Fault Circuit Interrupter (GFCI) Receptacles; Special Types of Receptacles; Special Considerations When Installing Receptacles; Plugs for Straight-Blade Receptacles; Finding the Proper Plug for the Application; Industrial Locking Plugs and Receptacles: Common Single-Phase Plug and Receptacle Outlines; Three-Phase Locking Receptacles and Plugs; Installing Receptacles and Plugs; Installing Flange-Mounted Receptacles; Installing Drop Cords; Special Industrial Plugs and Receptacles: Pin-and-Sleeve Devices; Other Types of Plastic Receptacles and Plugs; Metal-Shell Plugs and Receptacles; Communications Connectors; Industrial Lampholders: Common Types of Lampholders; Fluorescent Lampholders; Lamp Bases; Special Lamp Bases and Lamp Shapes.

**Industrial Circuit Breakers**

What Students Learn:
- Explain the thermal and magnetic operation of a circuit breaker.
- Explain how a combination circuit breaker operates.
- Identify an electronic circuit breaker and its operation.
- List the various types of industrial circuit breakers.
- Describe the various types of circuit that single-pole and multiple-pole circuit breakers will be used in.
- Explain how to troubleshoot a circuit in which a circuit breaker has tripped.
- Describe the operation of a ground fault circuit breaker.

Contents
The Operation of a Circuit Breaker: An Automatic Switch; Thermal Circuit Breaker Operation; Magnetic Circuit Breaker Operation; Combination Circuit Breaker Operation; Circuit Breaker Accessories; Electronic Circuit Breakers; Current-Limiting Circuit Breakers; Circuit Breaker Time of Operation; Current Ratings and Interruption Current; Types of Industrial Circuit Breakers: Small Single Phase Breakers; Molded-Case Circuit Breakers: Adjustable Current and Time Delay Circuit Breakers; Air Circuit Breakers; Circuit Breaker Circuits: Protecting Single-Phase Circuits; Protecting Three-Phase Circuits; Alarm Circuit Contacts; Circuit Breaker Auxiliary Circuits: Working with Circuit Breakers; Finding A Replacement Circuit Breaker; Installing Circuit Breakers; Resetting Circuit Breakers; Checking Circuit Breakers; Causes for False Trips; Earth Leakage (Ground Fault) Circuit Interrupters: Terms used for Earth Leakage or Ground Fault Protection Devices; Tripping Current; GFCI Operation; Types of GFCIs; Testing GFCI Circuit Breakers and Outlets.

**Industrial Switches**

What Students Learn:
- Identify switch symbols on electrical drawings.
- Have a basic understanding of the process control hierarchy.
- Identify the various types of industrial switches.
- Identify components of various types of industrial switches.
- Discuss applications for various types of industrial switches.

Contents
Common Switch Terms: Actuator; Arcing; Maintained Contact; Momentary Contact; Normally Closed; Normally Open; Poles and Throws; Positions; Switch Current Rating; Control-Station Switches; Operator-Controlled Panel Switches; Toggle Switches; Capacitive Finger Switches; Lighted Switches; Thumbwheel Switches; Position Sensing Switches; Inductive-Positioning; Capacitive-Positioning; Actuator-Positioning; Photoelectric Sensors and Switches; Pressure, Level, Temperature, and Flow Switches; Pressure Switches; Level Switches; Temperature Switches; Flow Switches.
086080

**Industrial Relay Ladder Logic**

**What Students Learn:**
- Describe the fundamentals of relay ladder logic.
- Identify the different types of relays used in ladder logic.
- Identify the symbols for input and output elements used in ladder logic.
- Understand the principles such as power, current flow, rules of reading, numbering systems, and component interconnections applied in relay ladder logic.
- Interpret simple and complex ladder logic by applying the fundamentals learned.

**Contents**
Fundamentals of Relay Ladder Logic: Relays; Relay Applications; Motor Starters; Lighting Contactors; Control Relays; Relay Ladder Diagrams; Symbols in Relay Ladder Diagrams: Input Element Symbols of Relay Ladder Logic; Switch Symbols; Limit-Switch Symbols; Pushbutton Switch Symbols; Selector, Toggle, and Rotary Switch Symbols; Process-Switch Symbols; Foot-Switch Symbols; Relay-Contact Symbols; Supplementary Contact Symbols; Time-Delay Contact Symbols; Motor Overload Contact Symbols; Wiring and Connections; Output Element Symbols of Relay Ladder Logic; Coil, Solenoid, and Small Motor Symbols; Timer Symbols; Pilot Lights and Alarm Symbols; Fuse and Transformer Symbols; Principles of Relay Ladder Logic: Power Supply to the Relay Ladder Logic; Logic Current Flow; Rules of Reading Relay Ladder Logic; Numbering Systems Used in Relay Ladder Diagrams; Component Interconnections in Relay Ladder Logic; Fundamentals of Interpreting and Testing Circuit Ladder Diagrams: Interpreting Simple Ladder Diagrams; Single Start / Stop Pushbutton Control Relay with Running Lamp Circuit; Dual-Start/Stop Pushbutton Control Relay with Running Lamp Circuit; Motor Starter Power Schematic and Control Circuitry Ladder Diagram; Interpreting Complex Ladder Diagrams; Reversing Motor Starter Power Schematic and Control Circuitry Ladder Diagram; Ladder Logic Diagrams with Multiple Rungs and Rung Reference Numbers.

086081

**Industrial Relays, Contractors, and Solenoids**

**What Students Learn:**
- Distinguish between types of control relays, contactors, magnetic starters, and solenoids.
- Describe how each type operates.
- Identify the part of each type.
- Identify specific applications for each type.

**Contents**
Types of Industrial Control Relays, Magnetic Starters / Contactors, Solenoids and their Operating Principles: Control Relays; Magnetic Starters and Contactors; Solenoids; Components of Industrial Control Relays, Magnetic Starters, Contactors, and Solenoids: Control Relays; Magnetic Starters and Contactors; Solenoids; Applications of Industrial Control Relays, Magnetic Starters, Contactors, and Solenoids: Control Relays; Time-Delay on Plug-in Control Relays; Magnetic Starters and Contactors.

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**Block B06**

**Troubleshooting Electronic Equipment and Systems**

**Duration:** 36 hours (includes 2 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- Analog Circuit Measurement (Block A23)
- Electronic Systems (Block B25)

**What Students Learn:**
This block presents the troubleshooting techniques for the various types of systems and equipment found in industry. The emphasis will be to apply a "logical troubleshooting approach" to a functional block diagram concept. Since many plants use modular systems, the student must be trained in "fast-fault isolation" methods.

**Special Note:**
A new course covering more detailed industrial concepts and practices is now available, **Troubleshooting Industrial Electrical, Electronic and Computer Systems**, Block B26. Block B06 may still be applicable for training apprentices and entry-level workers in the troubleshooting topics covered by the following lessons as described below.

**Components:**
- B0601 Introduction to Troubleshooting
- B0602 Basic Troubleshooting Methods
- B0603 Selecting Instruments for Troubleshooting
- B0621 Progress Examination
- B0604 Measurement Techniques in Troubleshooting
- B0605 Support Services for Troubleshooting
- B0606 Practical Troubleshooting Problems
- B0620 Progress Examination
- B0620 Progress Examination Booklet

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**B0601 Introduction to Troubleshooting**

**Objectives:**
- Locate the causes of trouble in basic electronic circuits by the logical process of eliminating various alternatives.
- Read electronics schematics and recognize component symbols.
- Recognize actual components and circuits by comparison with a schematic.
- List good troubleshooting habits.
- Discuss safety measures and first-aid care.
- Describe how to isolate, localize, pinpoint, and remove trouble sources.
**B0602 Basic Troubleshooting Methods**

**Objectives:**
- Recognize trouble symptoms - know what they are, how to use them, and how to refine them.
- List the methods of quickly isolating trouble areas by separating what's right from what isn't.
- Describe the various troubleshooting techniques.
- Tell how to troubleshoot by comparison and by substitution.
- Explain where and how to use different troubleshooting methods, either separately or in tandem, to speed up the resolution of your troubleshooting assignments.
- Compare troubleshooting by signal injection, circuit disturbance, and shotgunning methods.

**B0603 Selecting Instruments for Troubleshooting**

**Objectives:**
- Discuss the different kinds of basic meters and oscilloscopes.
- Select the right kind of VOM, FETVOM, or DMM for a given job.
- Explain instrument response, circuit loading, accuracy, and other data.
- Demonstrate how to use a meter to make both out-of-circuit and in-circuit tests on several basic components.
- Read and explain both analog and digital readouts.
- Describe instrument specifications and explain how to interpret them.
- Define common oscilloscope and meter controls and their uses.

**B0604 Measurement Techniques in Troubleshooting**

**Objectives:**
- Measure AC and DC voltages and currents.
- Understand how instrument loading can affect tests and how to minimize loading effects.
- Make high-voltage measurements safely.
- Measure alternating current without opening the circuit.
- Set up and make AC (alternating current), DC (direct current) frequency, and time measurements with an oscilloscope.
- Use wattmeters, frequency counters, capacitor meters insulation testers and other special instruments found in industry.
- Test digital circuits using digital probes and pulse injectors.

**B0605 Support Services for Troubleshooting**

**Objectives:**
- Demonstrate good soldering techniques.
- Review the use of solder flux and heat sinks.
- Select and maintain solder tips.
- Describe the various desoldering methods.
- Show the proper care for desoldering irons.
- Discuss troubleshooting aids including special tools, sprays, extensions, clips, and cleaners.
- Explain troubleshooting strategies.
- Illustrate logical approaches to troubleshooting.

**B0606 Practical Troubleshooting Problems**

**Objectives:**
- Identify the various kinds of power supplies and list the troubles to be expected from each.
- Explain how ohmmeters, voltmeters, and oscilloscopes are used to locate power-supply troubles.
- Describe how regulators work, including what trouble symptoms they develop and how to cure them.
- Define how to test electrolytics, transistors, diodes, and other parts within and outside the circuit.
- Explain how to troubleshoot glitches, ripple, and transients.
- Explain the testing of digital circuits, including how it differs from and compares with, other kinds of troubleshooting.
- Test microprocessor inputs, outputs, and supply voltages and be able to find troubles in them and in other digital systems.

**Block B07 Pulse Circuits**

**Duration:** 42 hours (includes 2 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- Analog Circuit Measurement (Block A23)
- Troubleshooting Industrial Electrical, Electronic and Computer Systems (Block B26)

**What Students Learn:**
In this series of lessons, the trainee will become familiar with pulse techniques and their characteristics. The trainee will learn how RC time-constant effects are used in pulse generation. Solid-state and electron-tube pulse generators and the various types of waveforms are covered. The various types of waveshaping circuits are discussed along with the concepts of how timing, triggering, and synchronization are achieved. Practical industrial applications of pulse circuits and the techniques of troubleshooting are covered.
Components:
B0701  Pulse Techniques
B0702  Pulse Generators
B0703  Waveshaping Circuits
B0721  Progress Examination
B0704  Timing
B0705  Pulse Circuit Applications
B0706  Troubleshooting Pulse Circuits
B0722  Progress Examination
B0720  Progress Examination Booklet

Special Note:
• This program has been replaced by a new course, 086E18.

B0701
Pulse Techniques

Objectives:
• Describe the term pulse and how it differs from nonpulse waveforms.
• Name and explain six terms that specify pulse dimensions.
• List four ways that pulses are generated or developed.
• Describe the frequency content or makeup of square waves, rectangular waves, sawtooth, and triangular waves, spikes, and half sine waves.

B0702
Pulse Generators

Objectives:
• Review the main methods of generating pulses.
• Review the concept of time constant and its relationship to pulse circuits.
• Explain the response of differentiator and integrator circuits to sine waves and pulses.
• Discuss pulse generation by sine wave clipping.
• Describe how pulses are developed by the relaxation oscillator, multivibrators, and switching circuits.
• Describe the operation of the Schmitt trigger.

B0703
Waveshaping Circuits

Objectives:
• Explain the operation of circuits for forming square and rectangular waves, sawtooth waves and triangular waves.
• Tell how pulses are stretched, narrowed, widened, and otherwise shaped or reshaped.
• Discuss the response of pulses to capacitors, transformers, and inductors.
• Illustrate how a clamper is used to restore shape to a pulse or a pulse series.

B0704
Timing

Objectives:
• Discuss free-running and nonsynchronized pulses.
• Describe the 555 timer and name its applications.
• Show examples of using crystals for frequency stabilization.

B0705
Pulse Circuit Applications

Objectives:
• Review the uses of pulses in switching circuits.
• Tell how pulses are used in computers.
• Explain the concept of how pulses fits into data communication.
• Discuss digital audio and television techniques.
• Describe five uses of pulses in industry.

B0706
Troubleshooting Pulse Circuits

Objectives:
• Sketch typical oscilloscope waveforms for good pulses.
• Identify possible causes of trouble while examining photos or sketches of distorted pulses.
• Show how to use a logic probe in troubleshooting digital pulse circuits.
• Demonstrate the use of a pulse generator in circuit troubleshooting.
• Describe the steps to troubleshoot resistance welding and other industrial equipment using pulses.

Block B08
Logic Circuits

Duration:  42 hours (includes 2 tests)

Course Prerequisites:
Basic Industrial Math (Block X21)
Analog Circuit Measurement (Block A23)
Troubleshooting Industrial Electrical, Electronic and Computer Systems (Block B26)

What Students Learn:
In this block, the concepts of logic circuits will be presented. The trainee is shown how logic capability is achieved through relays. This approach will be illustrated by the use of ladder diagrams. The major emphasis in this block covers solid-state logic techniques supported by logic diagrams. The trainee is introduced to gates, number systems, binary arithmetic, hexadecimal numbers, and Karnaugh mapping. Also covered are various logic families such as RTL, TTL, ECL, DTL, and CMOS. The trainee will become familiar with the applications of logic circuits, including multivibrators, counters, storage and shift registers, and clocks.

Components:
B0801  Logic Circuit Fundamentals
B0802  Introduction to Number Systems
B0803  Logic Devices and Diagrams
B0821  Progress Examination
B0804  Logic Families
B0805  Applications of Logic Circuits
B0806  Troubleshooting Logic Circuits
B0822  Progress Examination
B0820  Progress Examination Booklet

Special Note:
• This program has been replaced by a new course, 086E18.
B0801

Logic Circuit Fundamentals

Objectives:
• Explain the principles of logic according to Aristotle and Bode; describe logic in electronic systems using correct vocabulary; describe the binary approach to electronic logic, how gates express logic, electronic logic systems.
• Describe the symbology of logic expressing logic concepts and principles, discuss practical uses for logic concepts, symbols of logic gates, concepts of logic circuitry, explain how to read logic circuitry diagrams and how to apply them to real circuitry.
• Describe logic devices in industry including kinds of devices that put logic concepts into operation, devices for combinational logic circuitry, devices for sequential logical circuitry and families of logic devices.
• Review the fundamentals that apply to logic systems, including diode hookups that perform logic functions, bipolar transistor logic, MOS transistor logic, open-collector logic circuits, saturated and nonsaturated logic operation, and ECL circuit concepts.
• Explain how to relate logic symbols to discrete circuitry; relate logic functions to monolithic logic devices and interconnect logic components and devices; describe logic circuit functions.

B0802

Introduction to Number Systems

Objectives:
• Discuss what a number system is; define numbering; explain why there is more than one system, describe applications for numbering concepts, number systems common to electronics, how number systems are put to work, concept of a numbering base and principles of positional value.
• Describe numbering including decimal and the base 10, how it came about and why it’s practical, how decimal numbering applies to metrics, how base-10 numbering works, positional values in base-10 numbering and manipulating base-10 numbers.
• Describe binary numbering including binary and the base 2, how binary numbering came about, what binary numbers are used for, how binary numbering applies to logic systems, how base-2 numbering works, positional values in base-2 numbering, and manipulating base-2 numbers.
• Describe octal numbering including octal and the base 8, how octal numbering came about, what octal numbers are used for, what is meant by octal, how octal numbering applies to industrial systems, how base-8 numbering works, positional values in base-8 numbering and manipulating base-8 numbers.
• Describe hexadecimal numbering including hexadecimal and the base 16, how hexadecimal numbering came into existence, what hex numbers are used for, notation conventions for hexadecimal numbers, how base-16 numbering works, positional values in base-16 numbers, manipulating base-16 numbers.

B0803

Logic Devices and Diagrams

Objectives:
• Describe AND gates: What AND does, construction of an AND gate, truth tables for AND devices and typical applications; show an understanding of diagrams using various AND devices.
• Describe NAND gates: What NAND does, construction of a NAND gate, truth tables for NAND devices and typical applications; show an understanding of diagrams using NAND devices.
• Describe OR gates: What OR does, construction of an OR gate, truth tables for OR devices and typical applications; show an understanding of diagrams using OR devices.
• Describe NOR gates: What NOR does, construction of a NOR gate, truth tables for NOR devices and typical applications; show an understanding of diagrams using NOR devices.
• Describe XOR gates: What XOR (EOR) does, construction of an XOR gate, truth tables for XOR devices and typical applications; show an understanding of diagrams using XOR devices.
• Describe XNOR gates: What XNOR does, construction of an XNOR gate, truth tables for XNOR devices and typical applications; show an understanding of diagrams using XNOR devices.
• Describe the symbology of Logic Devices including nomenclature and pinout diagrams - partial and complete - interpreting operation speed of logic devices, propagation delay, logic device fanout, input loading characteristics and noise figure.

B0804

Logic Families

Objectives:
• Describe RTL logic: How RTL is constructed, relevant specifications, typical applications, and diagrams.
• Describe DTL logic: How DTL is constructed, relevant specifications, typical applications, and diagrams.
• Describe TTL-T 2 L logic: How TTL is constructed, relevant specifications, typical applications, and diagrams.
• Describe CMOS, NMOS, PMOS, and HMOS logic: How MOS devices are constructed, relevant specifications, typical applications, and diagrams.
• Describe I 2 L logic: How I 2 L devices are constructed, relevant specifications, typical applications, and diagrams.
• Describe ECL logic: How ECL devices are constructed, relevant specifications, typical applications, and diagrams.
• Describe other logic families: How they are constructed, relevant specifications, typical applications, and diagrams.
• Describe sequential logic devices: How flip flops operate, how R-S flip-flops are made, how D-T flip-flops are made, truth tables for R-S and D-T flip-flops, and applications.
• Describe advanced sequential logic: What’s inside a J-K flip-flop, how a J-K operates, J-K truth table, and recent solid-state indicators.
• Describe display devices for logic systems: Light-emitting diodes, seven-segment LEDS, and more recent logic indicators.

B0805

Applications of Logic Circuits

Objectives:
• Explain simple logic circuits including divider networks, binary ladder, and magnitude comparator.
• Explain gates in logic circuits, understand simple binary decoding, figure out combinational arrangements, understand Boolean combination techniques, and three-state buffer drivers.
• List applications for sequential logic-latching and binary storage, registers, shift registers, binary multipliers, ripple counters, waveform timing in counters, half- and full-adders, decoder techniques, multiplexers and parallel serial converters.
• Understand arithmetic-logic unit: Show how to add, subtract, multiply and divide; explain the relationship of ALU in digital computers.
B0806

Troubleshooting Logic Circuits

Objectives:

- Identify what to test in logic circuitry: Source voltage levels for TTL, CMOS, ECL, purity of DC voltages, foil runs system grounds, steady-state logic values, timed logic streams.
- Identify the instruments for testing logic circuitry, DMM requirements; simple LED logic indicators, logic probes, with pulse latches, logic injector, triggered oscilloscope specifications.
- Describe the techniques for logic circuit testing including precautions with instrument connections, DMM measurement techniques; connecting and using a logic probe for steady-state logic tracing, pulse streams, and trap glitch pulses; where and when to use a logic pulser measuring logic high-time and low-time, timing of clock signals, verifying system grounds and bus analysis.
- Describe the technique for replacing logic devices including MOS-device precautions, selecting the right replacement, speed in logic devices, demounting logic components and remounting logic components.

Block B09

Linear and Digital Integrated Circuits

Duration: 42 hours (includes 2 tests)

Course Prerequisites:
Basic Industrial Math (Block X21)
Analog Circuit Measurement (Block A23)
Troubleshooting Industrial Electrical, Electronic and Computer Systems (Block B26)

What Students Learn:
This block tells how integrated circuits (ICs) evolved and the benefits and technological advancements made possible by them. How they are designed and constructed is explained, concentrating on the MOS types, and telling about the evolution of the small-scale, medium-scale, large-scale, and very-large-scale ICs. One lesson covers linear types of ICs and another covers digital types. A separate lesson covers logic-type ICs.

Components:
B0901 Linear and Digital Circuit Principles
B0902 Integrated Circuit Techniques
B0903 Linear Integrated Circuits
B0921 Progress Examination
B0904 Digital Integrated Circuits
B0905 Integrated Circuit Logic Systems
B0906 Troubleshooting IC Systems
B0922 Progress Examination
B0920 Progress Examination Booklet

Special Note:
- This program has been replaced by a new course, 086E18.

B0901

Linear and Digital Circuit Principles

Objectives:

- Explain the operating principles for linear devices: What is “linear” operation, curve characteristics in diodes, transfer curves in bipolar transistors, Class A amplifier operation. Classes B, AB, and C with linear devices, from bipolar to JFET to IGFET to metal-oxide-silicon and concepts in the evolution of linear ICs.
- Explain the operating principles for digital devices: What digital operation is and how it came about; advantages of digital operation (over linear), switching diodes and transistors, bipolar digital transistors, MOSFET technology for digital applications, and digital IC concepts.
- Describe the operating characteristics of linear ICs: What you learn from the specification sheet, explanation of major parameters, construction of linear ICs, connecting linear devices in practical circuits, transfer curves, what they mean to operation and densities of IC packaging.
- Describe the operating characteristics of digital ICs: What you learn from the specification sheet, explanation of major parameters, construction of digital ICs, connecting digital devices in practical circuits and densities of digital IC packaging.

B0902

Integrated Circuit Techniques

Objectives:

- Describe how integrated circuits are made including materials in linear ICs, manufacturing techniques for ICs, functions built into linear ICs, functions built into digital ICs, and how techniques affect operating characteristics.
- Understand data sheets and IC operation, read spec sheets and relate parameters to functions, describe transfer curves for linear IC devices, transfer curves for digital IC devices, and how ICs are selected for industrial purposes.
- Describe modern integrated circuits for industry; understand linear IC application principles, digital IC application principles, and hybrid IC application principles.
- Understand integrated circuit applications including typical uses for RTL, DTL, TTL, ECL, CMOS, NMOS, and PMOS.
- Describe IC packaging for industrial uses, package outlines, pinout conventions, effects of environment on packaging, and how environment affects mounting.
**B0903 Linear Integrated Circuits**

**Objectives:**
- Understand advanced linear operating concepts: Linear operation in solid-state devices, basic analog functions, analog functions in common use, and analog functions in industrial applications.
- Identify the uses of linear ICs in industry: Circuits for linear ICs, linear ICs in industrial research, control operations for linear ICs, and sensing and processing with linear ICs, how to select a linear IC for industrial purposes including input requirements and output capabilities.
- Identify circuit applications for linear ICs: Oscillators and frequency control, operational amplifiers, differential amplifiers, phase comparators, and other linear applications in industry; how to find more applications information.

**B0904 Digital Integrated Circuits**

**Objectives:**
- Understand advanced digital operating concepts: Digital operation in solid-state devices, basic digital functions, digital functions in common use and digital functions in industrial applications.
- Identify the uses of digital ICs in industry: circuits for digital ICs, digital ICs in industrial research, control operations for digital ICs, and sensing and processing with digital ICs; how to select a digital IC for industrial purposes including input requirements and output capabilities.
- Identify circuit applications for digital ICs: Clocks, oscillators and frequency control, analog-to-digital conversion, digital-to-analog conversion, processing digital sense signals, time phase relationships in digital operation and other digital applications in industry; how to find more applications information.

**B0905 Integrated Circuit Logic Systems**

**Objectives:**
- Understand logic diagrams for industrial equipment: Recognize various symbols, identify logic operations common to industrial purposes and how gate combinations are designed.
- Show how to use logic devices in industrial circuits: Interchangeability of logic gates, truth tables affected by gate material, simple flip flop latches, clocked flip flops, monostable and bistable multivibrators, and other pulse generators.
- Show how to interface logic devices including source requirements, buffering and fan-in, fan-out, three-state logic and its purposes and managing open-collector logic.
- Show how to use gates and flip-flops including AND, NAND, OR, NOR, exclusive-OR, exclusive-NOR; describe the effects of family on gate functioning - TTL, ECL, MOS.; explain memories in industrial equipment.
- Identify industrial equipment using logic concepts including industrial robotics, programmable controllers, computer-aided design systems, computer-aided manufacturing processes and industrial data-processing.

**B0906 Troubleshooting IC Systems**

**Objectives:**
- Explain the principles of testing integrated circuits: Verifying Vcc, Vss, Vdd, Vbb; how to identify pins, and reach them; adapters for IC testing; bent pins and cold joints; verifying inputs; verifying quality and timing of outputs, and multichannel testing.
- List the instruments for IC testing: Explain how to use a DMM for simplified testing, how to interpret logic probe indications, uses for pulse injection, clip-on logic analyzers for ICs, signature analysis as an IC test tool, oscilloscope testing in IC circuitry.
- Describe advanced IC troubleshooting methods including special jigs to save time, pretesting on unfamiliar equipment, storage scopes, and advanced equipment.
- Describe the techniques for replacing ICs: Desoldering, resoldering, sockets, precautions in handling ICs, and tools for removal and reinsertion.

**Block B10 Basic Industrial Computer Systems**

**Duration:** 35 hours (includes 2 tests)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Analog Circuit Measurement (Block A23)
- Logic Circuits (Block B08)
- Troubleshooting Industrial Electrical, Electronic and Computer Systems (Block B26)

**What Students Learn:**
This block describes the types of computers used in industry and explains the advantages and disadvantages of each type. Examples of applications for each type are provided. Some typical installations are explained. Special considerations in computer selection are covered. Technical discussions include computer fundamentals, digital and analog systems, and interfacing. Principles of troubleshooting logic circuits and ICs and IC equipment are covered.

**Components:**
- B1001 Industrial Computer Fundamentals
- B1002 Digital and Analog Systems
- B1003 Software and Programming
- B1021 Progress Examination
- B1004 Computer-Aided Control Systems
- B1005 Interfacing Principles
- B1022 Progress Examination
- B1020 Progress Examination Booklet

**B1001 Industrial Computer Fundamentals**

**Objectives:**
- Give an overview of industrial computer uses including a history of computing in industry, analog computer development, digital logic in computer development, advent of bit-slice “microprocessors,” monolithic microprocessors and LSI, and the microprocessor as the
Electrical and Electronics

heart of the industrial computer.

• Describe industrial computers: What goes on inside an industrial computer, what goes on outside an industrial computer, microcomputer on a single chip, readout displays for industrial computers, industrial computers without displays, how micro- and mini-computers suit industrial applications, and where mainframe computers fit into industrial operations.

• Give examples of computers at work in industry including computer-aided design, computer-guided machinery, computer-directed research and analysis, controlling industrial and chemical processes, failure analysis and maintenance, programmable controllers for materials handling, nondestructive testing, measurements, inventory and supply logistics, and project control, reporting, and modeling.

• List the software required for industrial computers and tell what is needed (for systems in the above examples), who supplies it, and requirements for writing software; explain the function of programmers, systems analysts and technicians; describe methods for developing and debugging software.

• Explain the future of computers in industry.

B1002
Digital and Analog Systems

Objectives:

• Give a detailed overview of analog computer development: Describe what analog computing is - underlying principles, examples of present-day analog computers, mechanical vs. electrical analogs and how analog computers fit into industry.
• Give a detailed overview of digital computer development: Describe what digital computing is - underlying principles, why digital computing has largely replaced early analog computers.
• Describe the principles of control as used in industry including sensing control variables, switching control, proportional control and its variants, three-mode control, loop concepts of controlling processes, and open and closed loops.
• Tell how analog control systems operate including measurement techniques, processing analog signals and applying analog control.
• Tell how digital control systems operate including the nature of digital signals, converting analog measurements to digital signals, processing digital signals, applying digital control and converting digital back to analog.

B1003
Software and Programming

Objectives:

• Discuss software for industrial systems: Define software, what systems need software, and give industrial software examples.
• Describe the types of industrial software: What is available, where does it originate, how to prepare your own software, ladder diagrams, BASIC-language programs, Boolean algebra for logic systems, and assembly language programs.
• Identify the symbology for controller programs including: The symbols used to portray ladder logic, BASIC-(beginners all purpose symbolic instruction code), how to apply Boolean algebra principles, and how to use assembly language.
• Write simple programs, using ladder logic, in BASIC, using Boolean algebra in assembly language.

B1004
Computer-Aided Control Systems

Objectives:

• Describe computer-aided design and computer-aided manufacturing: including what they are, who uses CAD and CAM and for what, and required hardware and software.
• Give a brief history of CAD and CAM.
• Explore the benefits of CAD and CAM: How they increase productivity, decrease costs, improve product quality, reduce project turnaround time and benefit personnel.
• Explain how to select and install CAD and CAM systems in industry: Identify applications for CAD and for CAM in circuit board design, integrated circuit design, hardwired circuit design, generating Numerical Control data, plant design and other possibilities.
• List sources of CAD and CAM information.

B1005
Interfacing Principles

Objectives:

• Explain the concept of interfacing and tell why interfacing hardware is needed: Describe serial interfacing, parallel interfacing and input-output categories.
• Understand analog to digital interfacing; explain when you need A to D, A to D methods, and applying A to D principles; describe sample and hold methods; explain why you need signal conditioning.
• Identify applications (closing the loop); making measurements, controlling machines, and controlling processes.
• Explain multiplexing and time sharing; tell why and when to multiplex, how to multiplex digital data and how to multiplex analog data.
• Explain communications standards: Review synchronous and asynchronous data; serial RS232C, RS442, RS423; parallel S100, 6800, IEEE488, IEEE583; review ASCII; long distance communications techniques; process control loop standards; sources for communications standards.

Block B11
Introduction to Microprocessors

Duration: 28 hours (includes 1 test)

Course Prerequisites:
Basic Industrial Math (Block X21)
Analog Circuit Measurement (Block A23)
What Students Learn:
This block provides an introduction to the fundamentals and uses of computers in business and industry. The trainee learns the basics of microprocessors, what they are comprised of, and how they are used in industry. Logic arithmetic, logic gates, and memory devices are described. This block describes the architecture or makeup of a microprocessor, how instruction or data enter a microprocessor, how such information is handled inside the microprocessor, and how it exists.

Components:
B1101 Introduction to Computers
B1102 Introduction to Microprocessor Applications
B1103 Microprocessor Basics, Part 1: Underlying Principles and Concepts
B1104 Microprocessor Basics, Part 2: Overview of What’s in a Microprocessor
B1121 Progress Examination
B1120 Progress Examination Booklet

B1101

Introduction to Computers

Objectives:
• Give an overview of how computers are used in industry and business.
• List the main types of computers.
• Name the important activities performed by people who work with computers.
• Explain how computers are selected and what must be considered before they are selected and installed.

B1102

Introduction to Microprocessor Applications

Objectives:
• Explain what microprocessors are and the kinds of work they do.
• Tell what makes it possible for them to accomplish so much.
• List some of the recent applications microprocessors are found in.

B1103

Microprocessor Basics, Part 1: Underlying Principles and Concepts

Objectives:
• Explain the importance of binary arithmetic in microprocessor work.
• Sketch the common logic circuits.
• Identify the output conditions for the different possible input conditions for logic gates.

B1104

Microprocessor Basics, Part 2: Overview of What’s in a Microprocessor

Objectives:
• Draw a block diagram of a basic microprocessor unit (MPU).
• Tell what bytes and bits are and how they enter and exit an MPU.
• Explain how the MPU identifies, sorts, and holds bytes.
• List some of the activities of the ALU work center.

Block B12

Microprocessor Applications

Duration: 96 hours (includes 2 tests)

Course Prerequisites:
Basic Industrial Math (Block X21)
Analog Circuit Measurement (Block A23)
Basic Electronic Circuits (Block B24)
Introduction to Microprocessors (Block B11)

What Students Learn:
This block of instruction provides the trainee with hands-on experience with an actual microprocessor. The circuits powering the microprocessor are described and the voltages that should be measured are given for comparison. Close-up exposure to clock signals, monitor routines and handlers, ROM and RAM, and registers is obtained. Introductory knowledge of how data and information are put into and read out of a microprocessor is provided. The principles of microprocessors is covered with numerous experiments on storing and reading programs in hexadecimal, running a program, examining RAM and ROM, writing into RAM, jumping and branching, vectoring, initializing, interrupt priorities, changing and canceling break-points, flow-charting, indexed addressing, offset functions, multiplication and division, precision adding and subtracting, and HOLD subroutine. Further discussions cover interfacing a microprocessor through serial and parallel ports, the common peripheral and accessory equipment, and interfacing with peripheral devices. The two lessons on troubleshooting discuss both software and hardware troubleshooting. Also discussed are how to design your own diagnostic program and debugging. The use of test instruments for troubleshooting is covered, including use of the oscilloscope, logic probe, logic analyzer, signature analyzer, and digital pulser probe. The trainee is instructed on how to check out ground integrity. The trainee learns about care against static charge, especially when working around out-of-circuit MOS devices. The final lesson covers other families of microprocessors including Motorola, Intel, and Texas Instruments. Emphasis throughout is on applying the principles while using the Microprocessor Trainer.

Special Note:
• This program has been replaced by a new course, 086E05.

Block B13

Electronic Instrumentation and Control

Duration: 63 hours (includes 2 tests)
Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Analog Circuit Measurement (Block A23)
Basic Electronic Circuits (Block B24)

What Students Learn:
This nine lesson block presents the fundamentals of electronic instrumentation and control systems as used in industry. The block begins with two lessons on physical properties and their measurement. This foundation enables the trainee to apply these principles in subsequent lessons covering: measuring instruments and signal processing, transducers, introduction to control systems, controllers, control system methods, data logging, transmission, display and control applications, maintenance, and troubleshooting.

Special Note:
- This program has been replaced by a new course, 086E17.

Block B14

Industrial Electronic Circuit Applications

Duration: 35 hours (includes 2 tests)
Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Analog Circuit Measurement (Block A23)
Logic Circuits (Block B08)
Basic Industrial Computer Systems (Block B10)

What Students Learn:
The purpose of this block is to relate electronic circuits and systems to typical industrial applications. Lessons cover such topics as numerical control (NC) systems, motor control and servo computer-aided control systems, transducers, supervisory and direct digital control systems, electronic instrumentation systems, programmable controller and robotic systems.

Components:
B1401 Interfacing Process Variables
B1402 Motor Control and Servo Systems
B1403 Numerical Control Systems
B1421 Progress Examination
B1404 Programmable Controllers
B1405 Industrial Robots
B1422 Progress Examination
B1420 Progress Examination Booklet

B1401

Interfacing Process Variables

Objectives:
- Show an understanding of process measurement and control; describe process variables, closed loop control, how to classify sensors, error source circuits.
- Compare computer control with traditional control; describe traditional closed loop control, SPC computer control, and DDC computer control; identify the advantages of computer control and its hardware/software.
- Describe temperature, pressure, flow, humidity, weight, and level; explain how each is measured and controlled; list the types of sensors used for each and identify the applications.
- Describe typical position sensors and their applications.
- Define analysis and speed; explain how to measure and control them; describe the sensors used and their applications.

B1402

Motor Control and Servo Systems

Objectives:
- Review of AC and DC motors: converting electric power to rotational power, DC motor concepts, electronic commutation, AC motor concepts; explain the concepts of work, load, torque, and slippage.
- Discuss how industrial motors are controlled: describe motor, control diagrams, and the principles of controlling motors; explain how speed and torque are sensed and indicate motor performance; explain how to process motor performance feedback and apply corrective signals to AC and DC motors.
- Discuss the principles of electronic servomechanisms including older analog systems, modern digital servo systems, positional sensing in rotational devices, reference signals, developing correction signals, applying correction signals, speed correction, phase correction, and programming industrial servo systems.
- Describe motor control systems: types still using gaseous-tube controllers, solid-state controllers, and servo systems; how to read motor-servo diagrams.

B1403

Numerical Control Systems

Objectives:
- Explain what is meant by numerical control including point-to-point control and contour control; compare absolute and incremental systems.
- Describe what makes up an NC system, what the controller does, some typical drives, and the servo components.
- Discuss the operation of an NC machine: data and control inputs, outputting control signals, closed vs. open loop, and ancillary features; identify the media for control programs: paper tape, magnetic tape and computers.
- Identify applications for NC: milling, drilling, reaming, counter boring and laping, spot facing, and boring.

B1404

Programmable Controllers

Objectives:
- State the basic purpose of a programmable controller and its relationship to computers and to robots.
- Show an understanding of a simple PC system: the block diagram, programmer (operator I/O), memory (PROM & ROM), and sequencer.
- Describe programming formats including Boolean algebra, and ladder logic.
Electrical and Electronics

• Explain flow charting and program coding.
• Describe interfacing: include analog input, analog output, and parallel I/O.
• Give a detailed description of a typical controller including operator I/O, memory, and sequencer.

B1405
Industrial Robots

Objectives:
• Give an overview of industrial robotics.
• Show an understanding of the make-up of an industrial robot including the controller, manipulator, and gripper.
• Explain how to classify industrial robots: low technology-LTR’s, medium technology MTR’s, and high technology-HTR’s.
• Give a detailed explanation of a typical LTR, MTR, and HTR including the controller, manipulator, and gripper.
• Identify present applications for industrial robots when press loading, die casting, welding, and others.
• List sources of additional information.

Block B15
Basic Industrial Electronic System Applications

Duration: 35 hours (includes 2 tests)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Analog Circuit Measurement (Block A23)
Logic Circuits (Block B08)
Basic Industrial Computer Systems (Block B10)
Industrial Electronic Circuit Applications (Block B14)

What Students Learn:
This block continues with a discussion on the types of computers used in industry. Technical discussions cover additional computer-aided control systems, including CAD and CAM, voltage regulation and frequency conversion, non-destructive testing of materials, resistance-welding controllers, electronic heating, and control of cranes, scales and materials handling.

Components:
B1501 Voltage and Frequency Controllers
B1502 Nondestructive Test Equipment
B1503 Resistance Welding Equipment
B1521 Progress Examination
B1504 Dielectric and Induction Heating
B1505 Cranes, Scales, and Materials Handling
B1522 Progress Examination
B1520 Progress Examination Booklet

B1501
Voltage and Frequency Controllers

Objectives:
• Describe an AC voltage control: give an overview of suitable active devices; understand the ON-OFF control; discuss how to use phase control.

B1502
Nondestructive Test Equipment

Objectives:
• State an overview of nondestructive testing.
• List the various types of nondestructive test methods including the magnetic particle method, the filtered particle method, the electrified particle method, the penetrant method, the ultrasonic method, the radiographic method, the eddy current method, and the stress method.
• Describe the principle of operation, procedure, and chemical and/or hardware requirements of each method.
• Cite the common precautions to be taken when working with nondestructive test equipment.

B1503
Resistance Welding Equipment

Objectives:
• Show an understanding of resistance welding; describe an overview of resistance welding basic block; explain the ignition, how to use high current SCR’s, and what the controller does; compare AC with DC welding.
• Calculate the welding duty cycle; squeeze, weld, hold, release, and slope control.
• Describe symbology: industrial versus electronic.
• Describe two typical industrial welders and their operation, power circuit, and controller circuit.

B1504
Dielectric and Induction Heating

Objectives:
• Describe dielectric heating; show an understanding of the principles of operation and the basic system block diagram; describe the types of equipment in use; explain the importance of proper operating frequency; discuss safety procedures and electrode types.
• Describe induction heating; show an understanding of the principles of operation and the basic system block diagram; describe the types of equipment in use; explain the importance of proper operating frequency and the uses for different coil forms.
• List applications for dielectric heating.
• List applications for induction heating.
• Describe a typical dielectric heating unit and a typical induction heating unit, including operation and a circuit description.
### B1505
**Cranes, Scales, and Materials Handling**

**Objectives:**
- Describe a typical crane; explain the functional block diagram; describe the types of motors used and why; analyze the controls section; know safety practices.
- Understand a typical electronic scale; explain the functional block diagram; describe the circuit analysis of a typical unit; explain the calibration procedures.
- Discuss specialized materials handling systems; explain the functional block diagram; analyze the controller section.

### B1602
**Analysis of Systems**

**Objectives:**
- Discuss the importance of understanding the operation before troubleshooting.
- Tell the use of a logical approach to troubleshooting.
- Determine the exact trouble before tracking down its cause.
- Show how to use manufacturers’ service manuals.
- How to use troubleshooting flowcharts.
- Measuring supply and power-source voltages.
- Checking input and output voltages.

### B1603
**Test Equipment Applications**

**Objectives:**
- List test instruments considered essential for troubleshooting.
- Name some special instruments for industrial troubleshooting.
- Demonstrate how to use digital multimeters, VOMs, and oscilloscopes.
- Explain the use of frequency meters and counters.
- Show how to use a logic probe and a logic analyzer.
- Name four types of precision instruments used in industry, and explain their use.

### B1604
**Safe Troubleshooting Practices**

**Objectives:**
- Explain your obligation to work safety.
- Tell how to form safe working habits around electricity.
- List precautions to observe when using tools.
- Discuss why faulty equipment is sometimes a safety hazard.
- Show how faulty grounds present special hazards.
- Describe special safety considerations in medical and hospital equipment.
- Describe first aid for electric shock using CPR.

### B1605
**Troubleshooting Industrial Systems, Part 1**

**Objectives:**
- Discuss checkout of power sources and supply voltages.
- State case histories of typical problems and how they were solved.
- Explain approaches to troubleshooting signal-level circuitry.
- Explain approaches to troubleshooting power-level circuitry.
- Tell how to handle “tough dogs” and intermittents.
**B1606**

*Troubleshooting Industrial Systems, Part 2*

**Objectives:**
- Discuss an approach to troubleshooting numerical control systems.
- Explain the major approach to troubleshooting programmable controllers.
- Describe ways to isolate problems in a chemical process control system.
- List important considerations in troubleshooting in hazardous locations.
- Review troubleshooting problems in the petro-chemical field.
- Discuss electronic equipment problems in the paper manufacturing industry.

**Block B22**

*Reactive Circuits*

**Duration:** 15 hours (includes 3 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- Analog Circuit Measurement (Block A23)

**What Students Learn:**
This block explains how electronic circuits, resistors, capacitors and inductors, work in DC and AC circuits. Methods for determining impedance, reactance and phase angle are introduced. The student will learn to recognize the resonant circuit condition and understand how these special circuits are used. Resonant circuit applications such as coupled circuit traps, filters and transmission lines are discussed. The student's troubleshooting skills are expanded. The concepts of impedance matching and maximum power transfer are explained.

**Special Note:**
- This updated course replaces Reactive Circuits, Block B02. Each study unit contains a progress exam.

**Components:**
- 086037 Reactance and Impedance
- 086038 Resonant Circuits
- 086039 Applications and Troubleshooting of Resonant Circuits

**086038**

*Resonant Circuits*

**Objectives:**
- Recognize the conditions required for series and parallel resonance.
- Cite the factors affecting capacitive reactance and inductive reactance in series and parallel circuits.
- Determine the resonant frequencies of LC series and LCR parallel circuits.
- Calculate the value of the quality (Q) factor and bandwith of a circuit.
- Describe the relationship between Q and bandwidth.
- Describe the practical uses for tuned circuits.

**086039**

*Applications and Troubleshooting of Resonant Circuits*

**Objectives:**
- Learn how to estimate voltage for troubleshooting AC and DC circuits.
- Explain the need for impedance matching and how it is accomplished.
- Identify the circuits for low-pass, high-pass, band-pass, band-reject and power-supply filters.
- Interpret a filter's characteristic curve.
- Determine cut-off frequency for various filters.
- Select the particular type of series or parallel-tuned circuit for certain applications.
- Explain how transmission lines are related to resonant circuits and waveguides.
- Explain how transmission lines are used as components in tuned circuits.

**Block B23**

*Analog Electronic Components*

**Duration:** 42 hours (includes 7 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- Analog Circuit Measurement (Block A23)

**What Students Learn:**
This seven unit block provides a detailed theory into the workings of common electronic components and circuits. Different types of diodes, transistors, switching devices and tubes are covered. The trainee learns to perform circuit measurement tests and troubleshooting techniques for each component.

**Special Note:**
- This updated course replaces Electronic Components, Block B03. Each study unit contains a progress exam.
**Components:**
086019  Basic Semiconductor Components: Diodes
086020  Basic Semiconductor Components: Transistors
086021  Switching Devices
086022  Electronic Sensors
086023  Special Rectifiers: Electron Tubes
086024  Optoelectronic and Fiber Optic Components
086040  Electronics Hardware

### 086019 Basic Semiconductor Components: Diodes

**Objectives:**
- Describe how diodes work in a rectifier and how to determine if they are working properly.
- Explain how different types of diodes function.
- List a variety of diode uses in electronic systems.
- List the characteristics that make a particular diode useful in a given situation.
- Know how a diode works with other components in an electronic circuit.
- Perform basic measurements in diode circuits, that will assist in troubleshooting tests.
- Select a proper diode for replacement in a circuit.

### 086020 Basic Semiconductor Components: Transistors

**Objectives:**
- Learn how transistors control the flow of electricity in a circuit.
- Describe the construction of bipolar transistors.
- Explain how the operation of bipolar transistors resembles that of the diode.
- Discuss how bipolar transistors can control and amplify current in a circuit.
- Describe the construction and operation of JFETs and MOSFETs.
- How to use an ohmmeter to perform basic tests on bipolar transistors.
- Perform basic troubleshooting measurements and calculations on circuits that contain amplifying devices.

### 086021 Switching Devices

**Objectives:**
- Learn how a switch changes:
  - voltage levels and current levels.
  - the DC polarity of the delivered voltage.
- the direction of direct current.
- from one delivered frequency to another.
- Describe how the above functions can be performed by mechanical switches or by electronic circuitry.
- List the advantages and disadvantages of various switch types and how they function.
- Analyze basic relay ladder diagrams.
- Explain how a diode can be used as a switch.
- Name some of the problems of diode switching.
- Describe how very rapid electronic switching is accomplished.
- Explain the circumstances in which a mechanical switch may be preferable to a rapid electronic switch.

### 086022 Electronic Sensors

**Objectives:**
- Learn how certain electronic components are used as sensors and as parts in control mechanisms.
- Explain what sensors and transducers do.
- Describe important thermoelectric effects.
- Learn how these types of transducers operate and the effects they cause; electromagnetic, electroacoustical, piezoelectric, photoelectric, and electromechanical.
- Explain the importance of a bridge circuit in certain types of electronic instrumentation.
- Describe how certain nonlinear resistors are used in circuits.
- Explain how certain components can be used as protection devices for circuits.
- Define the scientific terms stress and strain.

### 086023 Special Rectifiers: Electron Tubes

**Objectives:**
- Learn how electron tubes work and how to troubleshoot tubes when necessary.
- Identify the four different methods of obtaining electronic emission.
- Explain how vacuum tubes and gas-filled tubes operate.
- Learn how the following special purpose tubes work: Cathode Ray Tubes (CRTs), Transmitter Tubes, Image Orthicon Tubes, Vidicon Tubes.
- Describe how a triode uses a control grid to control electron flow.
- Explain why a screen grid is used in a tetrode.
- Describe the function of a suppressor grid in a pentode.
- Describe how electron beams are controlled in a cathode ray tube (CRT).
- Understand half-wave and full-wave rectification.
- How to select a diode for replacement in a circuit.
- Troubleshoot a half-wave rectifier power supply.
Optoelectronic and Fiber Optic Components

Objectives:
• An introduction to the high technology field of optoelectronics.
• Discuss the theory and applications of the components used in this field: compact discs, bar code readers, lasers, light emitting diodes (LEDs) and light-activated diodes (LADs).
• Explain why electronics and optics are natural partners.
• Identify the modern theories of light and the relationship to optoelectronic applications.
• Describe the basic theory of light communications.
• Learn how a fiber optic communications system works.
• Describe the operation of electron microscopes and their advantage over optical microscopes.
• Explain how fluorescent light and other light sources operate.

Electronics Hardware

Objectives:
• Learn the uses and applications of these components that are critical to the repair and maintenance of an analog circuit or system: fasteners, connectors, jacks, component sockets, cables, strain gages, relays, wires, heat shrink tubing, batteries and UPSs.
• How to construct a circuit board for a personal computer.
• Learn correct and safe soldering techniques.
• Understand surface mount technology.

Basic Electronic Circuits

Duration: 48 hours (includes 8 tests)

Course Prerequisites:
Basic Industrial Math (Block X21)
Analog Circuit Measurement (Block A23)
Analog Electronic Components (Block B23)

What Students Learn:
This block describes how components are grouped in industrial electronic circuits to perform particular functions or achieve certain circuit characteristics. The trainee will learn how power is supplied to and rectified for use in electronic equipment. The block also explains how signals are produced, transmitted, received, evaluated, and utilized in common industrial electronic applications. Biasing, circuit parameters, component selection (value and rating), and the respective advantages/disadvantages of each are covered.

Special Note:
• This updated course replaces Basic Electronic Circuits, Block B04.
  Each study unit contains a progress exam.

Components:
086041 Rectifiers and Power Supplies
086042 Amplifiers
086043 Oscillators
086044 Modulation and Detection Circuits
086054 Switching Circuits
086055 Logic Circuits

Rectifiers and Power Supplies

Objectives:
• Identify the basic types of rectifiers.
• Discuss the operation of various power supply filters.
• Cite the advantages for different rectifier connection schemes.
• Determine the values for a voltage divider.
• Explain how voltage dividers are used in power supplies.
• Determine the current through, and voltage across, nonlinear components, such as diodes.

Amplifiers

Objectives:
• Indicate the advantages of various classes of transistor amplifier operation.
• Calculate the dB gain of an amplifier circuit.
• Identify the several types of transistor amplifier circuits.
• Show the proper polarity for NPN and PNP transistor connections.
• Explain the methods used for biasing a transistor.
• Describe the types of distortion introduced by amplifiers.
• Explain how to troubleshoot amplifiers.

Oscillators

Objectives:
• Explain the differences between several types of oscillator circuits.
• Identify the feedback components of an oscillator circuit, including LC and RC types.
• Describe the flywheel effect and how it is produced.
• Indicate the principle difference between various oscillator circuits.
• Calculate the resonant frequency of an oscillator circuit.
• Describe the effects of temperature on crystal oscillators.
• Discuss various applications of oscillator circuits.
• Describe how a frequency synthesizer works.

Modulation and Detection Circuits

Objectives:
• Describe the various types of detector circuits.
• Explain the various forms of modulation.
• Calculate bandwidth of signals.
• Determine the frequencies resulting from combining or mixing two signals.
• Describe the advantages and disadvantages of pulse code modulation.
• Explain the operation and applications of phase locked loops.
• Indicate applications of detector and modulation circuits.
086054
Switching Circuits
Objectives:
• Match the output conditions for various gate circuits.
• Show how transistors are used as logic gates.
• Discuss the operation of flip flops.
• Name the applications of registers and memories.
• Indicate the proper output for a specific multivibrator circuit.

086055
Logic Circuits
Objectives:
• Work with number systems.
• Indicate the use of encoders and decoders.
• Convert decimal numbers to binary and hexadecimal numbers.
• Develop truth tables.
• Explain how adders, subtractors, and comparators are used.

086056
Gating and Counting Circuits
Objectives:
• Cite the use of arithmetic logic gates.
• Work with half-adder and full-adder circuits.
• Discuss the use of subtractor circuits.
• Identify the applications for decade and binary counters.
• Determine the modulus of a counter.

086057
Pulse and Digital Circuits
Objectives:
• Indicate the basic parts of a pulse waveform.
• Identify the difference between limiter and clamper circuits.
• Calculate the time constants for integrating and differentiator circuits.
• Describe the action of trigger circuits.
• Work with binary numbers.

Block B25
Electronic Systems
Duration: 48 hours (includes 8 tests)
Course Prerequisites:
Basic Industrial Math (Block X21)
DC Principles (Block A21)
Basic Electronic Circuits (Block B24)
What Students Learn:
In this block, the trainee will see how simple circuits are modified (enhanced, improved upon) to produce complex circuits and systems for industrial applications. This is an important subject. The trainee will now begin to see how two or more basic and complex circuits are tied together to create an industrial electronics system. The emphasis will be away from what the individual schematic looks like, but to a “functional block diagram” concept. The trainee is shown large-scale schematics of which particular functional circuits will be identified and discussed. These functional circuits are treated as “blocks,” then all tied together. The courses highlight the input and output conditions of an entire system and for each functional block.
Special Note:
• This updated course replaces Electronic Systems, Block B05. Each study unit contains a progress exam.
Components:
086045 Electronic Devices and Amplification
086046 Audio and RF Circuits
086047 Oscillators, Feedback, and Waveforms
086048 Electronic Power Supply Systems
086058 Industrial Amplification Systems
086059 Servo and Control Systems
086060 Pulse and Logic Circuits
086061 Programmable Controllers and Microprocessors

086045
Electronic Devices and Amplification
Objectives:
• Calculate the gain of an amplifier circuit.
• Calculate voltage, current, and impedance relationships in transformers.
• Convert power and voltage gain to decibels.
• Determine the resistance values needed in an impedance-matching pad.
• Identify the characteristics of amplifying devices in various configurations.

086046
Audio and RF Circuits
Objectives:
• Describe how sound intensity is measured.
• Compare the advantages of AM and FM transmissions.
• Describe how narrow band FM is used in industrial communications.
• Explain the advantages of coaxial cable over copper wire as a transmission medium.
• Describe how pushbutton dialing can be used in industrial systems.
• Explain the different methods used to assemble common emitter amplifiers.

086047
Oscillators, Feedback, and Waveforms

Objectives:
• Identify the basic types of oscillator circuits.
• Discuss the various feedback circuits used in oscillators.
• Identify particular types of oscillator output waveforms.
• Recognize specific applications of oscillator and waveform generator circuits.
• Understand how a phase-locked loop works as a frequency synthesizer.
• Explain how a 555 integrated circuit timer/oscillator produces a square wave.

086048
Electronic Power Supply Systems

Objectives:
• Explain the basic function of rectifiers.
• Describe how half-wave and full-wave rectifier circuits operate.
• Determine the output voltage from various rectifier circuits.
• Calculate the percentage of voltage regulation in a power supply.
• Explain the operation of filters and bleeder resistors in power supplies.
• Describe the purpose of a voltage divider network to the output of a power supply.
• Explain the operation of electronic power supplies.
• Describe the operation of several commonly used industrial power supplies.

086058
Industrial Amplification Systems

Objectives:
• Recognize the difference between a power and voltage amplifier.
• Work with V-MOS, BiFET, Darlington pair, push-pull, and complementary amplifiers.
• How to use amplifiers to obtain the desired phase angle relationship when wiring a two-phase induction motor.
• Analyze an OP-amp on the basis of the virtual ground or summing point.
• Understand how an amplifier introduces distortion and noise in an amplified signal.

086059
Servo and Control Systems

Objectives:
• Discuss the basic operation of servo systems.
• Relate the differences between open-loop and closed-loop systems.
• Identify commonly used symbols for servo system components and devices.
• Point out applications of servo systems in industry.
• Calculate the gain of a servo system.
• List the various types of servo systems and their basic purpose or function.

086060
Pulse and Logic Circuits

Objectives:
• State the various characteristics of pulse-generating circuits.
• Cite typical industrial applications of pulse generators.
• Indicate the advantages of various logic families.
• Discuss how digital control signals are processed.
• Develop a logic diagram using typical logic gate symbols.

086061
Programmable Controllers and Microprocessors

Objectives:
• Describe the typical industrial applications of programmable controllers.
• State the function of the various blocks of a microprocessor system.
• Indicate typical input/output (I/O) equipment and devices.
• Identify the commonly used programming languages.
• Develop a simple program.

Block B26
Troubleshooting Industrial Electrical, Electronic, and Computer Systems

Duration: 36 hours (includes 6 tests)
Course Prerequisite:
Analog Electronic Components (Block B23)

What Students Learn:
This troubleshooting block thoroughly covers the systems encountered in a modern plant or service facility, including the many machines controlled by personal computers (PCs). Malfunctions in modern systems are more likely to be resolved by replacing an entire module or subsystem, rather than troubleshooting specific circuit boards. Plant electricians must often interface with devices that are connected to, or controlled by, PCs or programmable logic controllers (PLCs).

The block examines the industrial components used to monitor or influence the manufacturing process. Study units specifically cover troubleshooting motor control circuits, solenoids, electronic displays, sensors, touch pads and other devices that are directly or indirectly controlled by a computer’s output and input signals. The last two units in the series cover the types of problems encountered by Instrumentation, PC, and Network technicians, relating to cables, connectors, power supplies and interference generated by other electrical equipment.
Special Note:
This new course replaces Troubleshooting Electronic Equipment and Systems, Block B06. Each study unit contains a progress exam.

Components:
086064 Industrial Electronic Troubleshooting
086065 Electronic Troubleshooting of Industrial Motor Controllers
086066 Troubleshooting Sensing Devices and Systems
086067 Troubleshooting Industrial Control Systems and Output Devices
086068 Troubleshooting Industrial Computer Systems and Software
086069 Industrial Computer Networks

086064

Industrial Electronic Troubleshooting

Objectives
• Explain why a safety inspection is the first inspection that should be made on a failed piece of equipment.
• Discuss how to make safety a part of all troubleshooting and repair procedures.
• Understand how to collect accurate data on trouble clues.
• Describe how to use system indicators to help you troubleshoot an electronic system problem.
• List the steps for proper basic troubleshooting, such as identifying failure trends, seeking obvious causes, and circuit board swapping.
• Describe how to perform advanced troubleshooting, such as using binary divide techniques and focusing on one of many failure possibilities.
• List the aptitude and attitude qualities needed to be a good industrial troubleshooter.

086065

Electronic Troubleshooting of Industrial Motor Controllers

Objectives
• Describe various methods of controlling the speed and direction of a DC motor.
• Explain the proper steps for troubleshooting a DC motor controller.
• List the various types of stepper motor drives and explain how to troubleshoot these systems.
• Define how DC servo systems operate and explain the normal test points for locating faults in these systems.
• List the types of adjustable frequency drives and explain how to troubleshoot their circuits.
• Describe how brushless servo systems operate and how to troubleshoot various problems with these systems.

086066

Troubleshooting Sensing Devices and Systems

Objectives
• Identify the components of a typical limit switch and describe how to test these devices.
• Describe the operation of pressure switches.
• Identify, the components of, and troubleshooting procedures for, temperature sensing devices and level indicators.
• Describe, the operation of, and troubleshooting methods for, proximity, ultrasonic, photoelectric, fiber optic, and laser sensors.
• Define the proper troubleshooting methods for sensors that are connected to input modules.

086067

Troubleshooting Industrial Control Systems and Output Devices

Objectives
• Describe the operation of relays and solenoids, and procedures for troubleshooting them.
• Explain how to troubleshoot across-the-line starters and contractors, including solid state controlled contactors.
• Explain the importance of arc suppression diodes and resistor and capacitor networks in output device circuits.
• Define the operation of, and repair methods for, simple numeric readouts.
• Explain how DC and AC output modules operate and how to troubleshoot them.
• Identify different types of closed loop control systems and methods to troubleshoot and repair them.
• Explain how to troubleshoot and repair human and machine interface systems.

086068

Troubleshooting Industrial Computer Systems and Software

Objectives
• Discuss the principle parts and memory types of a computer motherboard.
• Identify power supply components and ratings.
• Locate the main power supply fuse and identify the type of power supply by its connectors.
• Identify the various types of computer drive systems and their cables.
• List the repair and troubleshooting procedures for computer hardware and software problems.
• Describe the operation of, and troubleshooting procedures for, optical and radio frequency identification systems.
• Explain the purpose of vision system hardware and software, and the troubleshooting procedures for them.
**086069**

*Industrial Computer Networks*

**Objectives**
- Describe the methods of communication within networks.
- Explain the configurations of various types of industrial network systems.
- Identify and describe different types of network cables.
- Discuss various network protocols.
- Describe troubleshooting methods for networks.

**SLD1**

*How to Solder and Desolder*

**Duration:** 3 hours (includes 1 test)

**What Students Learn:**
- Selecting a Soldering Iron; Soldering Electronic Components; How to Desolder with a Solder Braid or a Desoldering Pump; Using Heat Sinks; Solving Troubleshooting Problems; Assemble and Solder Using the Practice Kit.

**Special Note:**
- Includes practice soldering kit.

**XK-100**

*Measurements Trainer*

**What Students Learn:**
- The XK-100 Measurements Trainer is a completely assembled, line-operated trainer designed for conducting hands-on experiments on basic electrical and electronic components and circuits. The trainer includes a basic meter with scales calibrated in ohms, milliamps, and AC and DC volts. In addition to a variable low-voltage power supply, the unit also contains a variable bias-voltage supply. For ease in setting up experiments, the Trainer has a general-purpose solderless connector block. A speaker produces an audible output for working with audio frequency. A variable audio-frequency generator in the Trainer can be used to test reactive components and make resonant frequency measurements.
- An XK-100 Operations and Test Manual (XK141) is furnished with each trainer. This manual provides a complete description of the Trainer's controls and output functions.
- In addition to AC and DC measurements, the Trainer can be used to illustrate how voltmeters and ammeters function, and how basic meter movements are connected to furnish different ranges. After completion of the course, the XK-100 can be converted into a functional Volthometer, with the addition of a low-cost kit.
- Individual experiment Parts Kits are required for each block of experiments. Trainers with their related Workbooks and Parts Kits, are available, on an optional basis, to support the following courseware:

<table>
<thead>
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<th>Workbooks</th>
<th>Parts Kits</th>
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<tbody>
<tr>
<td>A01</td>
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**XK-200**

*Digital Trainer*

**What Students Learn:**
- The XK-200 Digital Trainer is a completely assembled, battery-operated trainer, designed for conducting hands-on experiments on linear, pulse, digital, and logic circuits. The Trainer includes a self-contained dual-frequency clock generator, LED logic indicators, logic switches, and data switches, all of which are accessed by solderless connectors and jumpers. Also included is a general-purpose solderless connector block used for setting up and running experimental circuits. The Trainer accommodates both discrete components and DIP ICs and related devices. Operation of the Trainer requires four D-cell batteries (not supplied).
- Individual experiment Parts Kits are required for each block of experiments. The Trainer may be used later for building and checking out prototype circuits. Trainers, with their related Workbooks and Parts Kits, are available, on an optional basis, to support the following courseware:

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Air Conditioning and Refrigeration
Bearings, Seals, and Lubrication
Fluid Power and Hydraulics
Instrumentation and Process Control
Mechanical Engineering
Pipefitting
Pneumatics
Power Transmission Systems
Robotics
Small Engine Repair
Tanks, Pumps, and Boilers
<table>
<thead>
<tr>
<th>Subject Index</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mechanical Engineering</strong></td>
<td></td>
</tr>
<tr>
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</tr>
<tr>
<td>Engineering Mechanics, Part 4 (286039)</td>
<td>201</td>
</tr>
<tr>
<td>Fundamental Principles of Rigging Technology (286016)</td>
<td>200</td>
</tr>
<tr>
<td>Mechanical Calculations (5608)</td>
<td>207</td>
</tr>
<tr>
<td>Planning the Rigging Operation (286017)</td>
<td>200</td>
</tr>
<tr>
<td>Principles of Mechanics, Part 1 (286007)</td>
<td>199</td>
</tr>
<tr>
<td>Principles of Mechanics, Part 2 (286008)</td>
<td>199</td>
</tr>
<tr>
<td>Rigging: Lifting Equipment and Applications, Part 1 (286020)</td>
<td>201</td>
</tr>
<tr>
<td>Rigging: Lifting Equipment and Applications, Part 2 (286021)</td>
<td>201</td>
</tr>
<tr>
<td>Working with Rigging Tools, Part 1 (286018)</td>
<td>200</td>
</tr>
<tr>
<td>Working with Rigging Tools, Part 2 (286019)</td>
<td>200</td>
</tr>
<tr>
<td><strong>Pneumatics</strong></td>
<td></td>
</tr>
<tr>
<td>Air Compressors, Part 1 (286096)</td>
<td>204</td>
</tr>
<tr>
<td>Air Compressors, Part 2 (286097)</td>
<td>204</td>
</tr>
<tr>
<td>Hydraulic and Pneumatic Drawings (186046)</td>
<td>60</td>
</tr>
<tr>
<td>Pneumatic Instrumentation for the Technician (286M01)</td>
<td>205</td>
</tr>
<tr>
<td>Pneumatics (286098, 286099, 286100)</td>
<td>204</td>
</tr>
<tr>
<td><strong>Power Transmission Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Belt Power Transmission (2607A-B)</td>
<td>198</td>
</tr>
<tr>
<td>Cams (2605)</td>
<td>198</td>
</tr>
<tr>
<td>Gear Calculations (2243)</td>
<td>197</td>
</tr>
<tr>
<td>Gear Trains (2604)</td>
<td>198</td>
</tr>
<tr>
<td>Gearing (2446)</td>
<td>197</td>
</tr>
<tr>
<td>Link Mechanisms (2603)</td>
<td>198</td>
</tr>
<tr>
<td>Mechanical Power Transmission Part 1 (286101)</td>
<td>204</td>
</tr>
<tr>
<td>Mechanical Power Transmission Part 2 (286102)</td>
<td>204</td>
</tr>
<tr>
<td>Mechanical Power Transmission Part 3 (286103)</td>
<td>205</td>
</tr>
<tr>
<td>Predictive Maintenance: Vibration Analysis (286088)</td>
<td>62</td>
</tr>
<tr>
<td>Servomechanisms (2028A-B)</td>
<td>197</td>
</tr>
<tr>
<td>Vibration Analysis and Control (2511A-E)</td>
<td>198</td>
</tr>
<tr>
<td><strong>Robots</strong></td>
<td></td>
</tr>
<tr>
<td>Industrial Robotics:</td>
<td></td>
</tr>
<tr>
<td>Technology, Programming, and Applications (066902)</td>
<td>197</td>
</tr>
<tr>
<td><strong>Air Conditioning and Refrigeration</strong></td>
<td></td>
</tr>
<tr>
<td>Air Conditioning Systems (6084A-B)</td>
<td>207</td>
</tr>
<tr>
<td>Controls for Air Conditioning (006035)</td>
<td>197</td>
</tr>
<tr>
<td>Duct and Piping Design for Air Conditioning (2945)</td>
<td>206</td>
</tr>
<tr>
<td>Lithium Bromide Absorption System (014005)</td>
<td>197</td>
</tr>
<tr>
<td>Modern Refrigeration and Air Conditioning (G14003)</td>
<td>215</td>
</tr>
<tr>
<td>Principles of Heating, Ventilating, and Air Conditioning (G447A-B)</td>
<td>208</td>
</tr>
<tr>
<td>Principles of Refrigeration (5127C)</td>
<td>206</td>
</tr>
<tr>
<td>Refrigeration in Air Conditioning (5383)</td>
<td>206</td>
</tr>
<tr>
<td><strong>Pipefitting</strong></td>
<td></td>
</tr>
<tr>
<td>Domestic and Institutional Water Supply (5390)</td>
<td>270</td>
</tr>
<tr>
<td>Drainage Systems (4502)</td>
<td>268</td>
</tr>
<tr>
<td>High Pressure Pipefitting (2452)</td>
<td>198</td>
</tr>
<tr>
<td>Industrial Plumbing and Pipefitting (Block D20)</td>
<td>209</td>
</tr>
<tr>
<td>Insulation for Pipefitting (6814)</td>
<td>209</td>
</tr>
<tr>
<td>Insulation for Piping and Ducting (286047)</td>
<td>211</td>
</tr>
<tr>
<td>Joining and Assembling Pipes (286043)</td>
<td>210</td>
</tr>
<tr>
<td>National Standard Plumbing Code (286M06)</td>
<td>268</td>
</tr>
<tr>
<td>Pipefitting Practice (5581)</td>
<td>206</td>
</tr>
<tr>
<td>Pipes and Fittings (5886)</td>
<td>207</td>
</tr>
<tr>
<td>Pipes, Fittings, and Valves (286041)</td>
<td>210</td>
</tr>
<tr>
<td>Pipework (5386)</td>
<td>206</td>
</tr>
<tr>
<td>Piping: Drawings, Materials, and Parts (186047)</td>
<td>60</td>
</tr>
<tr>
<td>Plumbing and Pipefitting Tools (6463)</td>
<td>209</td>
</tr>
<tr>
<td>Plumbing and Pipefitting Tools (286042)</td>
<td>210</td>
</tr>
<tr>
<td>Plumbing Drawing (6211)</td>
<td>335</td>
</tr>
<tr>
<td>Plumbing Fixtures and Appliances (286045)</td>
<td>210</td>
</tr>
<tr>
<td>Plumbing Plans, Specifications, and Inspection (4516)</td>
<td>269</td>
</tr>
<tr>
<td>Reading Piping Prints (6732)</td>
<td>209</td>
</tr>
<tr>
<td>Sanitary Plumbing Fixtures (4515A-B)</td>
<td>269</td>
</tr>
<tr>
<td>Supporting, Installing, and Testing Pipes (286044)</td>
<td>210</td>
</tr>
<tr>
<td>The Trades of Plumbing and Pipefitting (286040)</td>
<td>210</td>
</tr>
</tbody>
</table>
**Mechanical Maintenance**

**Tanks, Pumps, and Boilers**

- Cold Water Supply (5384) ................................................................. 206
- Condensers (6553) .................................................................................. 209
- Hot Water Supply (5385) ........................................................................ 206
- Pressure Vessel and Tank Print Reading (6691) ....................................... 209
- Pumps, Part 1 (286001) ......................................................................... 199
- Pumps, Part 2 (286002) ......................................................................... 199
- Pumps, Part 3 (286003) ......................................................................... 199
- Steam Boiler Operation and Maintenance (6734) .................................. 209
- Tanks and Pumps (5389) ........................................................................ 206
- Tanks, Pumps, and Boilers (286046) ....................................................... 210

**Troubleshooting**

- Maintenance and Troubleshooting (Block X07) .................................... 54
- Maintenance and Troubleshooting (Block X27) .................................... 61
- Predictive Maintenance (286087) ......................................................... 61
- Predictive Maintenance: Vibration Analysis (286088) .......................... 62
- Predictive Maintenance: Advanced Topics (286089) .......................... 62
- Preventive Maintenance (286085) ......................................................... 61
- Preventive Maintenance Techniques (286086) ..................................... 61
- Problem Solving and Troubleshooting (186073) ................................ 46
- Quality Concepts: Terminology for Management (186035) ................ 45
- Quality Concepts: Tools and Applications (186036) .......................... 45

**Small Engine Repair**

- Servicing Outdoor Power Equipment, Part 1 (089029) ......................... 357
- Servicing Outdoor Power Equipment, Part 2 (089030) ......................... 357
- Small Engine Disassembly (089022) ..................................................... 357
- Small Engine Electrical Systems (089020) ......................................... 356
- Small Engine Fuel Systems (089021) .................................................... 356
- Small Engine Ignition Systems (089019) ............................................. 356
- Small Engine Lubrication and Cooling Systems (089018) ................... 356
- Small Engine Parts and Operation (089017) ........................................ 356
- Small Engine Reassembly (089025) ...................................................... 357
- Small Engine Rebuild, Part 1 (089023) ............................................... 357
- Small Engine Rebuild, Part 2 (089024) ............................................... 357
**Recommended Career/Apprentice Curricula**

- Mechanical Maintenance/Fluid Power Systems Technician
- Mechanical Maintenance/Power Transmission Systems Technician
- Air Conditioning and Refrigeration Mechanic/Air Conditioning and Refrigeration Apprentice
  - Boilermaker Apprentice
  - Millwright/Millwright Apprentice
  - Pipefitter/Pipefitter Apprentice
  - Multicraft Maintenance Mechanic

**Recommended Topical Programs**

- Hydraulic Systems Maintenance Specialist
- Production Maintenance Mechanic
  - Boiler Inspector
  - Stationary Firer
- Production Operator for Process Manufacturing
- Field Service Technician: Mechanical Knowledge and Skills Training
Mechanical Maintenance/Fluid Power Systems Technician

This Mechanical Maintenance Skills curriculum provides trainees with the coursework materials required to enable them to perform the tasks associated with a Fluid Power Systems Technician. This print-based curriculum has been developed to meet the subject requirements of either an apprenticeship or an organization’s skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

The Fluid Power Systems Technician curriculum starts with comprehensive training in pre-technical study and fundamental industrial skill courses. It progresses into mechanical maintenance principles and applications, fluid power and hydraulic systems, pneumatic systems, and industrial robotics systems. Operations and maintenance skills are emphasized in this curriculum. This curriculum is appropriate for entry level and experienced workers alike.

Specific plants may have unique skill and training needs derived from their operations and equipment. To fit some of these needs, representative course outlines have been suggested for this program in the instrumentation and process control, machinist and metalworking, industrial pipefitting, and introductory welding trades areas. An Electrical Maintenance Skills curriculum is suggested for those plants initiating a cross training program. The Fluid Power Systems Technician curriculum can be combined with the Power Transmission Systems Technician curriculum to form a comprehensive mechanical maintenance skills program.

Upon completion of this curriculum, students will be able to:
- Locate, identify, and interpret legends, linetypes, parts symbols, and types of drawings used in reading mechanical shop prints.
- Identify, describe, remove, replace, install, and maintain common types of bearings and seals.
- Match lubrication methods and materials to their applications and identify their implementation and maintenance requirements.
- Explain the principles of fluid power, fluid flow, and fluid symbols and diagrams.
- Explain hydraulic pumping principles and how the common types of hydraulic pumps, motors, and peripheral devices work.
- Troubleshoot and maintain hydraulic circuits and systems.
- Explain the properties of air, the basic laws of gases, and pneumatic principles.
- Identify, describe, maintain, and troubleshoot the basic components of a pneumatic system.
- Describe the applications, components, and technology used in a basic industrial robot system.

### Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Technical Foundation Skills</strong></td>
<td></td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186023</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
</tr>
<tr>
<td>Fluid Measurement</td>
<td>186025</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
<tr>
<td>Quality Concepts: Tools and Applications</td>
<td>186036</td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
<tr>
<td>Material Handling Safety</td>
<td>186006</td>
</tr>
<tr>
<td>Reading Prints and Schematics</td>
<td>Block X25</td>
</tr>
<tr>
<td>Introduction to Print Reading</td>
<td>186080</td>
</tr>
<tr>
<td>Print Reading Symbols and Abbreviations</td>
<td>186081</td>
</tr>
<tr>
<td>Dimensioning and Tolerancing</td>
<td>186082</td>
</tr>
<tr>
<td>Print Reading Applications</td>
<td>186083</td>
</tr>
<tr>
<td>Building Drawings</td>
<td>186043</td>
</tr>
<tr>
<td>Electrical Drawings and Circuits</td>
<td>186044</td>
</tr>
<tr>
<td>Electronic Drawings</td>
<td>186045</td>
</tr>
<tr>
<td>Hydraulic and Pneumatic Drawings</td>
<td>186046</td>
</tr>
<tr>
<td>Piping: Drawings, Materials, and Parts</td>
<td>186047</td>
</tr>
<tr>
<td>Welding Symbols</td>
<td>186048</td>
</tr>
<tr>
<td>Sheet Metal Basics</td>
<td>186049</td>
</tr>
<tr>
<td>Sketching</td>
<td>186050</td>
</tr>
<tr>
<td>Hand and Power Tools</td>
<td>Block X24</td>
</tr>
<tr>
<td>Common Hand Tools, Part 1</td>
<td>186052</td>
</tr>
<tr>
<td>Common Hand Tools, Part 2</td>
<td>186053</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 1</td>
<td>186068</td>
</tr>
<tr>
<td>Electric Drilling and Grinding Tools</td>
<td>186054</td>
</tr>
<tr>
<td>Power Cutting Tools</td>
<td>186055</td>
</tr>
<tr>
<td>Pneumatic Hand Tools</td>
<td>186056</td>
</tr>
<tr>
<td>Plumbing and Pipefitting Tools</td>
<td>286042</td>
</tr>
<tr>
<td>Electricians’ Tools</td>
<td>006026</td>
</tr>
<tr>
<td>Tool Grinding and Sharpening</td>
<td>186057</td>
</tr>
<tr>
<td>Woodworking Hand Tools</td>
<td>186058</td>
</tr>
<tr>
<td>Routers, Power Planers, and Sanders</td>
<td>186059</td>
</tr>
<tr>
<td>Jacks, Hoists, and Pullers</td>
<td>186060</td>
</tr>
<tr>
<td>Bench Work, Part 3</td>
<td>5004C</td>
</tr>
<tr>
<td>Preventive Maintenance</td>
<td>286085</td>
</tr>
<tr>
<td>Preventive Maintenance Techniques</td>
<td>286086</td>
</tr>
</tbody>
</table>
**Mechanical Maintenance Applications**

- Principles of Mechanics, Part 1 .............................................. 286007
- Principles of Mechanics, Part 2 .............................................. 286008
- Bearings and Seals, Part 1 ....................................................... 286093
- Bearings and Seals, Part 2 ....................................................... 286094
- Lubrication, Part 1 ................................................................. 286091
- Lubrication, Part 2 ................................................................. 286092
- Mechanical Power Transmission Part 1 .................................... 286101
- Mechanical Power Transmission Part 2 .................................... 286102
- Mechanical Power Transmission Part 3 .................................... 286103
- Properties of Materials ............................................................. 686005

**Hydraulic and Pneumatic Systems – Operations and Maintenance**

- Hydraulic Power Basics .......................................................... 286060
- Hydraulic Components:
  - Actuators, Pumps and Motors .............................................. 286061
  - Conductors, Conditioners and Fluids ................................... 286062
  - Hydraulic Power System Control ......................................... 286063
  - Interpreting Hydraulic System Schematics ........................... 286064
  - Hydraulic Power System Troubleshooting .......................... 286065
  - Pumps, Part 1 ................................................................. 286001
  - Pumps, Part 2 ................................................................. 286002
  - Pumps, Part 3 ................................................................. 286003
  - Fluid Mechanics, Part 1 .................................................... 286010
  - Fluid Mechanics, Part 2 .................................................... 286011
  - Fluid Mechanics, Part 3 .................................................... 286012
  - Pneumatics, Part 1 .......................................................... 286098
  - Pneumatics, Part 2 .......................................................... 286099
  - Pneumatics, Part 3 .......................................................... 286100
  - Air Compressors, Part 1 .................................................... 286096
  - Air Compressors, Part 2 .................................................... 286097
- Industrial Robotics: Technology, Programming, and Applications ........................................ 066902
- Predictive Maintenance ......................................................... 286087
- Predictive Maintenance: Vibration Analysis ........................... 286088
- Predictive Maintenance: Advanced Topics ............................ 286089
- Industrial Plumbing and Pipefitting ....................................... Block D20
  - The Trades of Plumbing and Pipefitting .............................. 286040
  - Pipes, Fittings, and Valves ............................................... 286041
  - Plumbing and Pipefitting Tools (included above) ................ 286042
  - Joining and Assembling Pipes .......................................... 286043
  - Supporting, Installing, and Testing Pipes .......................... 286044
  - Plumbing Fixtures and Appliances .................................... 286045
  - Tanks, Pumps, and Boilers .............................................. 286046
  - Insulation for Piping and Ducting ..................................... 286047
- Fundamentals of Welding, Part 1 ............................................ 286025
- Fundamentals of Welding, Part 2 ............................................ 286066
- Safe Handling of Pressurized Gases and Welding ..................... 186004

Estimated Curriculum Duration: 651 hours.
Number of Exams: 86.

**Optional: Instrumentation and Process Control Skills**

- Heat, Part 1 ............................................................................. 686001
- Heat, Part 2 ............................................................................. 686002
- Pneumatic Instrumentation for the Technician ...................... 286001
- Control Technology for Technicians ..................................... 286002
- Distributed Control Systems, Part 1 ..................................... 086084
- Distributed Control Systems, Part 2 ..................................... 086085
- Distributed Control Systems, Part 3 ..................................... 086086
- Principles of Automatic Process Control Instruments ............ 6305A-B
- Automatic Process Control Valves ....................................... 6307

**Process Pressure Measuring and Control Instruments** ........................................................................... 6309A-B
**Fluid Flow Measuring and Control Instruments** ........................................................................... 6308A-B
**Temperature Measuring and Control Instruments** ........................................................................... 6306A-B
**Liquid Level Measuring and Control Instruments** ........................................................................... 6338A-B

Estimated Duration: 210 hours.
Number of Exams: 29.

**Optional: Machinist – Metal Working Skills Courseware**

- Industrial Materials and Components ................................... Block X06
  - Metal Processing .................................................................. X0601
  - Ferrous Metals ..................................................................... X0602
  - Nonferrous Metals ................................................................ X0603
  - Identification of Metals ....................................................... X0604
  - Nonmetallic Materials .......................................................... X0605
  - Plastics, Elastomers, and Composite Materials ....................... X0606
  - Wood Products ...................................................................... X0607
- Fasteners .................................................................................. X0608
- Paints and Adhesives ............................................................... X0609
- Introduction to Pumps and Compressors ................................. X0610
- Introduction to Bearings and Seals .......................................... X0611
- Introduction to Power Transmission ......................................... X0612
- Basic Machining Skills ........................................................... Block X08
  - Practical Shop Math, Part 1 .................................................. X0801
  - Practical Shop Math, Part 2 .................................................. X0802
  - Practical Shop Measurement ................................................ X0803
  - Safe Shop Practices ............................................................. X0804
  - Properties and Classifications of Metals ............................... X0805
- Using Shop Drawings, Process, and Routing Sheets, Part 1 ........ X0806
- Using Shop Drawings, Process, and Routing Sheets, Part 2 ....... X0807
- Layout ..................................................................................... X0808
- Metal Cutting and Machine Tooling, Part 1 ............................ X0809
- Metal Cutting and Machine Tooling, Part 2 ............................ X0810
- Metal Cutting Machinery, Part 1 ............................................ X0811
- Metal Cutting Machinery, Part 2 ............................................ X0812
- Fundamentals of Grinding ...................................................... X0813
- CNC Machine Tool Features and Applications ......................... X0814
- Machine Shop Safety ............................................................. 186007
- Fundamentals of Grinding ...................................................... 386016
- Lathes, Part 1 .......................................................................... 386036
- Lathes, Part 2 .......................................................................... 386037
- Lathes, Part 3 .......................................................................... 386038
- Lathes, Part 4 .......................................................................... 386039
- Lathes, Part 5 .......................................................................... 386040
- Drilling ..................................................................................... 3521A-B
- CNC Technology and Programming ........................................ 066903

Estimated Duration: 287 hours.
Number of Exams: 29.

**Recommended Cross Training:**

**Introduction to Electrical Maintenance**

- DC Principles ........................................................................... Block A21
  - Nature of Electricity ............................................................. 086001
  - Circuit Analysis and Ohm’s Law .......................................... 086002
  - Capacitors and Inductors ....................................................... 086003
  - Magnetism and Electromagnetism ....................................... 086004
  - Conductors, Insulators, and Batteries .................................. 086005
  - DC Motors and Generator Theory ....................................... 086006

**Optional Laboratory Experiment:**

- Electronic Simulation Software ........................................... 086080
- Experiments with Basic DC Theory – Lab Manual .................. 086087
- AC Principles .......................................................................... Block A22
  - Alternating Current ............................................................. 086007
  - Alternating Current Circuits ............................................... 086008
  - Inductors in AC Circuits ...................................................... 086009
Transmission Systems Technician curriculum can be combined with the transmission systems. An Electrical Maintenance Skills curriculum is and the operations of the machinery and equipment used in power progresses through mechanical maintenance principles and applications, perform in this trade area.

Tasks associated with a print-with the courseware materials required to enable them to perform the (excluding optional lab experiments).

Estimated Duration: 220 hours
Number of Exams: 41.

**Mechanical Maintenance/ Power Transmission Systems Technician**

This Mechanical Maintenance Skills curriculum provides trainees with the courseware materials required to enable them to perform the tasks associated with a Power Transmission Systems Technician. This print-based curriculum has been developed to meet the subject requirements of either an apprenticeship program or an organization’s skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

The Mechanical Maintenance curriculum starts with comprehensive training in pre-technical and foundation industrial skills courses. It progresses through mechanical maintenance principles and applications, and the operations of the machinery and equipment used in power transmission systems. An Electrical Maintenance Skills curriculum is suggested for those plants initiating a cross training program. The Power Transmission Systems Technician curriculum can be combined with the Fluid Power Systems Technician curriculum to form a comprehensive Mechanical Maintenance skills program.

Upon completion of this curriculum, students will be able to:
- Match lubrication methods and materials to their applications and identify their implementation and maintenance requirements.
- Explain the common types, components, operating principles, and maintenance procedures for belt drive systems, chain drive systems, clutches, shafts, gears, and electric and hydraulic servo motors.
- Analyze, diagnose, and correct sources of vibration in power transmission machinery.

**Base Curriculum**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Technical Foundation Skills</strong></td>
<td></td>
</tr>
<tr>
<td>Basic Industrial Math ..................................................................................</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction ...............................................................................</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division .......................................................................</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles .........................................</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System ................................................................................................</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas .......................................................................................................</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra ...............................................................................</td>
<td>186013</td>
</tr>
<tr>
<td><strong>Practical Measurements</strong> .......................................................................</td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement ................................................................</td>
<td>186021</td>
</tr>
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<td>Tool Grinding and Sharpening ......................................................................</td>
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**Mechanical Maintenance Applications**
Principles of Mechanics, Part 1 ................................................. 286007
Principles of Mechanics, Part 2 .................................................. 286008
Bearings and Seals, Part 1............................................................ 286093
Bearings and Seals, Part 2............................................................ 286094
Lubrication, Part 1 ...................................................................... 286091
Lubrication, Part 2 ...................................................................... 286092
Properties of Materials ............................................................... 686005

**Power Transmission Systems – Operations and Maintenance**
Mechanical Power Transmission Part 1 ........................................ 286101
Mechanical Power Transmission Part 2 ........................................ 286102
Mechanical Power Transmission Part 3 ........................................ 286103
Belt Power Transmission ............................................................. 2607A-B
Gearing ..................................................................................... 2446
Servomechanisms ..................................................................... 2028A-B
Predictive Maintenance ............................................................. 286087
Predictive Maintenance: Vibration Analysis.............................. 286088
Predictive Maintenance: Advanced Topics............................... 286089
Vibration Analysis and Control .................................................. 2511A-E

Estimated Curriculum Duration: 493 hours.
Number of Exams: 66.

**Recommended Cross Training:**
**Electrical Maintenance**
DC Principles ............................................................................ Block A21
Nature of Electricity ...................................................................... 086001
Circuit Analysis and Ohm’s Law .................................................. 086002
Capacitors and Inductors ............................................................ 086003
Magnetism and Electromagnetism .............................................. 086004
Conductors, Insulators, and Batteries ........................................ 086005
DC Motors and Generator Theory ............................................. 086006

Optional Laboratory Experiment:
Electronic Simulation Software ................................................. 086000
Experiments with Basic DC Theory – Lab Manual ..................... 086007
AC Principles ............................................................................. Block A22
Alternating Current .................................................................... 086007
Alternating Current Circuits ....................................................... 086008
Inductors in AC Circuits ............................................................. 086009
Capacitors in AC Circuits ............................................................ 086010
Transformers ............................................................................. 086011
Alternators ................................................................................. 086012
Electrical Energy Distribution .................................................... 086013
Rectification and Basic Electronic Devices ................................. 086014
Experiments with Basic AC Theory – Lab Manual ..................... 086018
Analog Circuit Measurement ...................................................... Block A23
Basic Test Equipment .................................................................. 086025
Troubleshooting with Volt-Ohm-Millamp Meters (VOMs) ............ 086026
Using Basic Oscilloscopes .......................................................... 086027
Experiments in Electrical Measurements – Lab Manual .......... 086069
Electrical Safety for the Trades .................................................... 186005
Electrical Equipment ................................................................... Block A24
Conductors and Insulators in Industry ....................................... 086070
Working with Conduit ............................................................... 086071
Electrical Boxes ............................................................ Block A25
Industrial Enclosures and Raceways ........................................ 086072
Connecting Electrical Equipment, Part 1 ................................. 086074
Connecting Electrical Equipment, Part 2 ................................. 086075
Industrial Fuses .......................................................................... 086076
Industrial Circuit Breakers ......................................................... 086077
Plugs, Receptacles, and Lampholders ....................................... 086078
Industrial Switches ..................................................................... 086079

Industrial Relay Ladder Logic .................................................... 086080
Industrial Relays, Contractors, and Solenoids ......................... 086081
Electrical Wiring Practices .......................................................... 086082
Data, Voice, and Video Cabling .................................................. 086083

**Recommended Cross Training:**
**Motor Control and Electronics Troubleshooting**
Industrial DC Motors ................................................................. 086051
Industrial AC Motors ................................................................. 086052
Controlling Industrial Motors ..................................................... 086053
Motor Control Fundamentals ...................................................... 086054
(for Programmable Logic Controllers) ...................................... 006010
Industrial Motor Control ............................................................ 086055
(for Programmable Logic Controllers), Part 1 ........................... 006011
Industrial Motor Control ............................................................ 086056
(for Programmable Logic Controllers), Part 2 ........................... 006012
Analog Electronic Components .................................................. Block B23
Basic Semiconductor Components: Diodes ......................... 086019
Basic Semiconductor Components: Transistors ..................... 086020
Switching Devices ...................................................................... 086021
Electronic Sensors ..................................................................... 086022
Special Rectifiers: Electron Tubes ............................................ 086023
Optoelectronic and Fiber Optic Components ............................ 086024
Electronics Hardware ............................................................... 086040
Troubleshooting Industrial Electrical, Electronic, and Computer Systems .................................................. Block B26
Industrial Electronic Troubleshooting ....................................... 086064
Electronic Troubleshooting of Industrial Motor Controllers .... 086065
Troubleshooting Sensing Devices and Systems ....................... 086066
Troubleshooting Industrial Control Systems and Output Devices .......................................................... 086067
Troubleshooting Industrial Computer Systems and Software .... 086068
Industrial Computer Networks .................................................. 086069

Estimated Duration: 348 hours
(excluding optional lab experiments).
Number of Exams: 59.

**Air Conditioning and Refrigeration Mechanic/ Air Conditioning and Refrigeration Apprentice**

The Air Conditioning and Refrigeration Mechanic Apprentice curriculum provides apprentices with the study materials that enable them to perform the tasks associated with these trades. This program has been designed to meet the subject requirements set forth in the standards established by the Bureau of Apprenticeship and Training (BAT). When combined with on-the-job training, the program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

Upon completion of this program, students will be able to:
- Select proper protective clothing, eye protection, and equipment for a particular task.
- Demonstrate safe practices when using common hand and power tools.
- Apply basic concepts for reading drawings used in the field of construction and maintenance.
- Discuss the fundamentals of refrigeration and identify refrigeration tools and materials.
- Describe the installation and servicing of the components for different types of air conditioning and refrigeration systems.
- Explain basic ventilation requirements, and air distribution and cleaning techniques.
- Identify and describe the servicing of refrigerant controls and air conditioning controls, circuits, and instruments.
- Select pipe made of the proper type of material, based upon a particular application.
- Discuss the methods used to join and assemble different kinds of pipe joints.

### Base Curriculum

<table>
<thead>
<tr>
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<tr>
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<td>Multiplication and Division</td>
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<td>186073</td>
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<td>Industrial Safety</td>
<td>Block X23</td>
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<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
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<td>Working Safely with Chemicals</td>
<td>186002</td>
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<td>Fire Safety</td>
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<td>Safe Handling of Pressurized Gases and Welding</td>
<td>186004</td>
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<td>186005</td>
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<td>186036</td>
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<td>186053</td>
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<td>186068</td>
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<td>186081</td>
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<td>186082</td>
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<td>186083</td>
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<td>186044</td>
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<td>186047</td>
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### Boilermaker Apprentice Overview

The Boilermaker Apprentice curriculum provides apprentices with the study materials that enable them to perform this trade. The program has been designed to meet the subject requirements set forth in the educational standards prepared by the Bureau of Apprenticeship and Training (BAT) and for the test required for the Black Seal License. The courses cover most of the theory and the operation of equipment used by tradespeople responsible for commercial heating systems. When combined with on-the-job training, the program will give apprentices a comprehensive understanding of the skills and knowledge they will need to perform in this trade area.

Upon completion of this program, students will be able to:
- Select the hand tools necessary for a particular job.
- Measure lengths and distances.
- Discuss basic wiring procedures.
- Describe oxyacetylene torch operation.
- Discuss the selection of welding electrodes.
- Describe the process for inspection and testing of welds.
- Discuss the proper rigging procedure for lifting steel.
- Discuss drawings and sketches.
- Select the arc welding equipment for a particular job.
- Select the proper hand tools.
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<td>186010</td>
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<td>X0211</td>
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<td>186001</td>
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<td>Block X25</td>
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<td>186080</td>
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<td>186082</td>
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<tr>
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<td>186083</td>
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<td>186043</td>
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<td>186044</td>
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<td>186045</td>
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<td>186047</td>
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<td>186048</td>
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<td>186049</td>
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<td>286094</td>
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<td>286101</td>
</tr>
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<td>DC Principles</td>
<td>Block A21</td>
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<td>Circuit Analysis and Ohm’s Law</td>
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<td>086003</td>
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<td>086004</td>
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<td>Experiments with Basic DC Theory – Lab Manual</td>
<td>086087</td>
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<td>Block A22</td>
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<td>Electrical Energy Distribution</td>
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<td>Rectification and Basic Electronic Devices</td>
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<td>Experiments with Basic AC Theory – Lab Manual</td>
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<td>286001</td>
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<td>286100</td>
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<td>Air Compressors, Part 1</td>
<td>286096</td>
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<td>286097</td>
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<td>Pressure Vessel and Tank Print Reading</td>
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<td>Types of Steam Generators</td>
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<td>2598A-B</td>
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<td>Pressure Parts for Steam Generators</td>
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<td>Steam Generator Settings, Ducts, and Stacks</td>
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<td>Arc Welding of Low Carbon Steel</td>
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<td>Inspection and Testing of Welds</td>
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Fundamental Principles of Rigging Technology ................. 286016
Planning the Rigging Operation ............................................. 286017
Working with Rigging Tools, Part 1 ........................................ 286018
Working with Rigging Tools, Part 2 ........................................ 286019
Rigging: Lifting Equipment and Applications, Part 1 ............ 286020
Rigging: Lifting Equipment and Applications, Part 2 ............ 286021
Gas Tungsten Arc Welding Fundamentals ......................... 286035
Gas Metal Arc Welding Fundamentals ................................. 286059
Nondestructive Testing of Castings ................................. 5961

Print Reading and Drawings
Reading Shop Prints, Part 1 .................................................. 386043
Reading Shop Prints, Part 2 .................................................. 386044
Drafting Kit .............................................................................. 1200M
Geometrical Drawing (includes 5 plates) ............................. 5544A-B
Elements of Projection Drawing (includes 5 plates) ............. 5649
Development of Surfaces (includes 7 plates) ....................... 5399

Estimated Curriculum Duration: 1,178 hours
(excluding optional lab experiments).
Number of Exams: 110.

Millwright/ Millwright Apprentice

The Millwright Apprentice curriculum provides apprentices with the study materials that enable them to perform the tasks associated with this trade. The program has been designed to meet the subject requirements set forth in the standards established by the Bureau of Apprenticeship and Training (BAT). When combined with on-the-job training, this program will give trainees the comprehensive skills and knowledge they will need to perform the tasks associated with in-plant maintenance.

Upon completion of this program, students will be able to:

- Read a shop drawing.
- Work with basic mathematics.
- Discuss the use of various hand tools.
- Describe the equipment used to move machines.
- Discuss different lubricating systems.
- Explain how to redirect air or hydraulic lines.
- Explain the types of air compressors.
- Describe sheet metal forming.
- Describe typical valves and piping fitting.
- Explain the setup of an oxyacetylene torch.
- Explain the difference in pumps.
- Describe common mechanical power transmissions.
- Describe how to detect and replace worn bearings and seals.
- Discuss the fabrication of machine guards.
- Describe the various types of welding procedures.
- Explain the machining of rewelded parts.
- Explain how to drill, weld, and machine metal to make temporary repairs.
- Handle preventive maintenance and troubleshooting procedures and schedule equipment downtime.

Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
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<tr>
<td>Pre-Technical and Basic Industrial Skills</td>
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<td>Multiplication and Division ............................. 186009</td>
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<td>Fractions, Percents, Proportions, and Angles ..................... 186010</td>
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<td>Working Safely with Chemicals ............................. 186002</td>
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<td>Jobs, Companies, and the Economy: Basic Concepts for Employees ......................................... 186034</td>
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<td>Quality Concepts: Tools and Applications ..................... 186036</td>
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<td>Precision Measuring Instruments, Part 1 ..................... 186068</td>
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<td>Pneumatic Hand Tools ......................................... 186056</td>
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<td>Electricians’ Tools ............................................ 006026</td>
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<td>Tool Grinding and Sharpening ............................. 186057</td>
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<td>Woodworking Hand Tools ...................................... 186058</td>
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<td>Routers, Power Planers, and Sanders ...................... 186059</td>
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<td>Jacks, Hoists, and Pullers ...................................... 186060</td>
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<td>Safe Shop Practices ........................................... X0804</td>
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<td>Properties and Classifications of Metals ....................... X0805</td>
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<td>Using Shop Drawings, Process, and Routing Sheets, Part 1 ........................ X0806</td>
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<td>Metal Cutting and Machine Tooling, Part 1 .................... X0809</td>
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<td>CNC Machine Tool Features and Applications .................. X0814</td>
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Pipefitter/pipefitter Apprentice

The Pipefitter Apprentice curricula provide apprentices with the study materials that enable them to perform the tasks associated with this trade. This program has been designed to meet the subject requirements set forth in the standards established by the Bureau of Apprenticeship and Training (BAT). When combined with on-the-job training, these programs provide trainees with the comprehensive skills and knowledge they will need to perform in these trade areas.

Upon completion of this program, students will be able to:

- Select proper protective clothing, eye protection, and equipment for a particular task.
- Demonstrate safe practices when using common hand and power tools.
- Apply basic concepts for reading drawings used in the fields of construction and maintenance.
- Discuss the methods used to join and assemble different kinds of pipe joints.
- Describe the procedures for laying out, supporting, and testing piping systems.
- Describe basic maintenance for tanks, pumps, and plumbing fixtures.
- Explain the proper techniques for gas and arc welding and cutting.
- Discuss the fundamentals of refrigeration and identify refrigeration tools and materials.
- Identify and describe the components of different types of refrigeration, heating, and air conditioning systems.

### Base Curriculum

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<td>186026</td>
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<td>186031</td>
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<td>Working Safely with Chemicals</td>
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This course is designed for the trades person who is being trained for both mechanical and electrical maintenance duties. The training focuses on pipingfiting, HVAC, and electrical equipment and systems. This course outline can be custom assembled for the needs of any individual by adding the related study units found in the applicable subject index.

Upon completion of this program, students will be able to:
- Perform multi-craft tasks associated with in-plant maintenance.
- Read shop prints and electrical blueprints.
- Identify the tools, equipment, and skills used in industrial plumbing, pipingfiting, and HVAC.
- Understand DC and AC principles and components including motors, controllers, and PLC’s.
- Install and test electrical wires, circuits, and equipment using the correct equipment, materials, and procedures for safe operation.

### Base Curriculum

#### Course Title Number

**Pre-Technical Foundation Skills**

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<td>Working Safely with Chemicals</td>
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<td>Safe Handling of Pressurized Gases and Welding</td>
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<td>Plumbing and Pipefitting</td>
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<td>Electrical Safety</td>
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<td>Metric System</td>
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**Pipefitting and HVAC**

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<td>Industrial Plumbing and Pipefitting</td>
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<td>Supporting, Installing, and Testing Piping</td>
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<td>Pressure Piping</td>
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<td>Insulation for Piping and Ducting</td>
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<td>Domestic and Institutional Water Supply</td>
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<td>Cold Water Supply</td>
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<td>Sanitary Plumbing Fixtures</td>
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<td>Insulation for Piping and Ducting</td>
<td>289053</td>
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<td>Arc Welding Equipment</td>
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<td>Gas Metal Arc Welding Fundamentals (GMAW or Mig)</td>
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<td>Principles of Heating, Ventilating, and Air Conditioning</td>
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<td>National Fuel Gas Code</td>
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### Mechanical Maintenance

- Plumbing Fixtures and Appliances ........................................... 286045
- Tanks, Pumps, and Boilers ...................................................... 286046
- Insulation for Piping and Ducting ............................................ 286047

- Pipefitting Practice ................................................................. 5581
- Principles of Heating, Ventilating, and Air Conditioning .... 6447A-B
- Air Conditioning Systems ....................................................... 6084A-B

### Electrical Maintenance Skills

#### DC Principles
- Nature of Electricity ................................................................. 086001
- Circuit Analysis and Ohm’s Law .............................................. 086002
- Capacitors and Inductors ....................................................... 086003
- Magnetism and Electromagnetism .......................................... 086004
- Conductors, Insulators, and Batteries ..................................... 086005
- DC Motors and Generator Theory .......................................... 086006

#### AC Principles
- Alternating Current ................................................................. 086007
- Alternating Current Circuits .................................................... 086008
- Inductors in AC Circuits ........................................................ 086009
- Capacitors in AC Circuits ....................................................... 086010
- Transformers ........................................................................... 086011
- Alternators .............................................................................. 086012
- Electrical Energy Distribution .............................................. 086013
- Rectification and Basic Electronic Devices ............................ 086014

#### Experiments with Basic AC Theory – Lab Manual
- Volt-Ohm-Milliammeter Equipment ........................................ 086026
- Using Basic Oscilloscopes ...................................................... 086027

### Optional Laboratory Experiment:

- Electronic Simulation Software .............................................. 086800
- Experiments with Basic DC Theory – Lab Manual ................... 086087

### Electrical Equipment

- Conductors and Insulators in Industry .................................... 086070
- Working with Conduit ............................................................. 086071
- Electrical Boxes ........................................................................ 086072
- Industrial Enclosures and Raceways ....................................... 086073
- Connecting Electrical Equipment, Part 1 ............................... 086074
- Connecting Electrical Equipment, Part 2 ............................... 086075
- Industrial Fuses ........................................................................ 086076
- Industrial Circuit Breakers ..................................................... 086077
- Plugs, Receptacles, and Lampholders ..................................... 086078
- Industrial Switches ................................................................... 086079
- Industrial Relay Ladder Logic ................................................ 086080
- Industrial Relays, Contactors, and Solenoids ......................... 086081
- Reading Electrical Schematic Diagrams ................................. 006022
- Electrical Blueprint Reading ................................................... 006036
- Electrical Lamps, Part 1 ........................................................... 006031
- Electrical Lamps, Part 2 ........................................................... 006032
- Lighting Control ................................................................. 006033
- Electrical Heating .................................................................... 006034
- Electrical Grounding .............................................................. 086001
- Electrical Wiring Practices ..................................................... 086002
- Data, Voice, and Video Cabling .............................................. 086016
- National Electrical Code (NEC Code and Textbook Course) .... 5177EM
- Transformers ........................................................................... 4040

### Basic Semiconductor Components

- Basic Semiconductor Components: Transistors ..................... 086020
- Switching Devices .................................................................... 086021
- Electronic Sensors ................................................................. 086022
- Special Rectifiers: Electron Tubes .......................................... 086023
- Optoelectronic and Fiber Optic Components ......................... 086024
- Electronics Hardware ............................................................ 086040

### Motors, Controllers, and Troubleshooting

- Industrial DC Motors ............................................................... 086051
- Industrial AC Motors ............................................................... 086052
- Controlling Industrial Motors ................................................ 086053
- Motor Control Fundamentals (for Programmable Logic Controllers) ......................................................... 006010
- Industrial Motor Control (for Programmable Logic Controllers), Part 1 ......................................................... 006011
- Industrial Motor Control (for Programmable Logic Controllers), Part 2 ......................................................... 006012
- Industrial Motor Applications ................................................ 4341
- Control Technology for Technicians ...................................... 286M04
- Distributed Control Systems, Part 1 ...................................... 086084
- Distributed Control Systems, Part 2 ...................................... 086085
- Distributed Control Systems, Part 3 ...................................... 086086
- Predictive Maintenance ........................................................ 286087
- Predictive Maintenance: Vibration Analysis ......................... 286088
- Predictive Maintenance: Advanced Topics ......................... 286089
- Troubleshooting Industrial Electrical, Electronic, and Computer Systems ......................................................... Block B26
- Industrial Electronic Troubleshooting .................................... 086064
- Electronic Troubleshooting of Industrial Motor Controllers ................................................................. 086065
- Troubleshooting Sensing Devices and Systems .................... 086066
- Troubleshooting Industrial Control Systems and Output Devices ................................................................. 086067
- Troubleshooting Industrial Computer Systems and Software ................................................................. 086068
- Industrial Computer Networks ............................................. 086069

### Number of Exams: 129.

Estimated Curriculum Duration: 873 hours

(excluding optional lab experiments)
Hydraulic Systems Maintenance Specialist

This topical program provides trainees with the courseware that covers a working knowledge of fluid power concepts, and the operations and maintenance of hydraulic systems and pumps. In addition to supporting the people working in mechanical maintenance, this program can be used to cross train electrical and electronics maintenance specialists.

Upon completion of this program, students will be able to:

- Explain the principles of fluid power, fluid flow, and fluid symbols and diagrams.
- Explain hydraulic pumping principles and how the common types of hydraulic pumps, motors, and peripheral devices work.
- Troubleshoot and maintain hydraulic circuits and systems.

**Base Program**

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Estimated Program Duration: 152 hours.
Number of Exams: 20.

Production Maintenance Mechanic

This topical program provides trainees with the courseware covering the theory and instructional skills to perform maintenance functions on production line equipment. The training is designed for production and maintenance staff workers in a discrete manufacturing operation. The program covers broad subject and skill courses to develop a person cross trained in technical foundation skills, electrical principles, motors and machines, fluid power and hydraulics, and mechanical power transmission machinery.

Upon completion of this program, students will be able to:

- Explain how voltage, current, and resistance are related by Ohm's Law.
- Use electrical measuring instruments for troubleshooting.
- Explain the construction and operation of motors, generators, and transformers.
- Perform the important steps for general maintenance and troubleshooting techniques using the required tools.
- Identify, describe, remove, replace, install, and maintain common types of bearings and seals.
- Match lubrication methods and materials to their applications and identify their implementation and maintenance requirements.
- Explain the principles of fluid power, fluid flow, and fluid symbols and diagrams.
- Explain hydraulic pumping principles and how the common types of hydraulic pumps, motors, and peripheral devices work.
- Troubleshoot and maintain hydraulic circuits and systems.
- Use the skills required for maintaining and operating the components found in a basic mechanical power transmission system.
- Use the related principles and applications - appropriate to the electrical, hydraulic, and mechanical skill areas - in the installation, operation, and maintenance of production line equipment and machinery.

**Base Program**

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<td>Working Safely with Chemicals</td>
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Addition and Subtraction ..................................................... 086008
Multiplication and Division ................................................... 086009
Fractions, Percent, Proportions, and Angles ........................ 086010
Metric System ........................................................................ 086011
Formulas ................................................................................ 086012
Introduction to Algebra .......................................................... 086013
Practical Measurements .......................................................... Block X22
Linear and Distance Measurement ........................................ 086021
Bulk Measurement .................................................................. 086022
Temperature Measurement .................................................... 086023
Energy, Force, and Power ...................................................... 086024
Fluid Measurement ................................................................ 086025
Problem Solving and Troubleshooting ................................... 086073
Jobs, Companies, and the Economy: Basic Concepts .......................... for Employees ......................................................... 086034
Quality Concepts: Tools and Applications .............................. 086036
Applied Geometry .................................................................... X0211
Practical Trigonometry ............................................................ X0212
Reading Prints and Schematics ............................................... Block X25
Introduction to Print Reading .................................................. 086080
Print Reading Symbols and Abbreviations .............................. 086081
Dimensioning and Tolerancing .............................................. 086082
Print Reading Applications ...................................................... 086083
Building Drawings .................................................................. 086043
Electrical Drawings and Circuits ............................................. 086044
Electronic Drawings ................................................................. 086045
Hydraulic and Pneumatic Drawings ........................................ 086046
Piping: Drawings, Materials, and Parts ................................... 086047
Welding Symbols ..................................................................... 086048
Sheet Metal Basics ................................................................. 086049
Sketching .................................................................................. 086050
Hand and Power Tools ............................................................ Block X24
Common Hand Tools, Part 1 .................................................... 186051
Common Hand Tools, Part 2 .................................................... 186052
Precision Measuring Instruments, Part 1 ............................... 186053
Electric Drilling and Grinding Tools ......................................... 186054
Power Cutting Tools ................................................................. 186055
Pneumatic Hand Tools ............................................................. 186056
Plumbing and Pipefitting Tools ............................................... 286042
Electricians’ Tools ................................................................. 006026
Tool Grinding and Sharpening .................................................. 186057
Woodworking Hand Tools ....................................................... 186058
Routers, Power Planers, and Sanders ...................................... 186059
Jacks, Hoists, and Pullers .......................................................... 186060
Bench Work, Part 3 ................................................................ 5004C
Mechanical Calculations .......................................................... 5608

**Electrical Principles**

DC Principles ................................................................. Block A21
Nature of Electricity ............................................................... 086001
Circuit Analysis and Ohm’s Law .............................................. 086002
Capacitors and Inductors ....................................................... 086003
Magnetism and Electromagnetism ........................................... 086004
Conductors, Insulators, and Batteries ................................. 086005
DC Motors and Generator Theory ........................................... 086006

**Optional Laboratory Experiment:**

Electronic Simulation Software ............................................... 086800
Experiments with Basic DC Theory – Lab Manual .................. 086807
AC Principles ................................................................. Block A22
Alternating Current .............................................................. 086007
Alternating Current Circuits .................................................. 086008
Inductors in AC Circuits ......................................................... 086009
Capacitors in AC Circuits ......................................................... 086010
Transformers ........................................................................ 086011
Alternators ........................................................................... 086012
Electrical Energy Distribution ................................................. 086013
Rectification and Basic Electronic Devices ............................. 086014
Experiments with Basic AC Theory – Lab Manual ................. 086088
Analog Circuit Measurement .................................................. Block A23
Basic Test Equipment ........................................................... 086025
Troubleshooting with Volt-Ohm-Millamp Meters (VOMs) .... 086026
Using Basic Oscilloscopes ...................................................... 086027
Experiments in Electrical Measurements – Lab Manual ...... 086089
Electrical Safety for the Trades ............................................. 186005
Electrical Equipment, Part 1 .................................................. 006027
Electrical Equipment, Part 2 .................................................. 006028
Electrical Wiring Practices ..................................................... 086029
Data, Voice, and Video Cabling ............................................. 086030

**Maintenance and Troubleshooting Techniques**

Preventive Maintenance ...................................................... 286085
Preventive Maintenance Techniques ...................................... 286086

**Electrical Skills Maintenance**

Industrial DC Motors ....................................................... 086051
Industrial AC Motors ......................................................... 086052
Controlling Industrial Motors ............................................... 086053
Electrical Grounding ............................................................ 086054
Transformers ........................................................................... 4040
Industrial Motor Applications ............................................... 4341
Motor Control Fundamentals (for Programmable Logic Controllers) ......................................................... 006010
Industrial Motor Control (for Programmable Logic Controllers), Part 1 ......................................................... 006011
Industrial Motor Control (for Programmable Logic Controllers), Part 2 ......................................................... 006012
Analog Electronic Components ............................................. Block B23
Basic Semiconductor Components: Diodes ......................... 086019
Basic Semiconductor Components: Transistors .................. 086020
Switching Devices ................................................................. 086021
Electronic Sensors ................................................................. 086022
Special Rectifiers: Electron Tubes .......................................... 086023
Optoelectronic and Fiber Optic Components ......................... 086024
Electronics Hardware ............................................................ 086040
Troubleshooting Industrial Electrical, Electronic, and Computer Systems ......................................................... Block B26
Industrial Electronic Troubleshooting ...................................... 086064
Electronic Troubleshooting of Industrial Motor Controllers ......................................................... 086065
Troubleshooting Sensing Devices and Systems .......................... 086066
Troubleshooting Industrial Control Systems and Output Devices ......................................................... 086067
Troubleshooting Industrial Computer Systems and Software ......................................................... 086068
Industrial Computer Networks ............................................... 086069

**Hydraulic and Pneumatic Systems Maintenance**

Hydraulic Power Basics ...................................................... 286060
Hydraulic Components ........................................................ 286061
Hydraulic Components: Actuators, Pumps and Motors ......... 286062
Hydraulic Components: Conductors, Conditioners and Fluids ......................................................... 286063
Boiler Inspector

The Boiler Inspector topical program prepares trainees with the needed theory and skills used in this field. This program covers the fundamentals of thermodynamics, and the design and operation of boilers and related equipment, such as pumps and compressors. Upon completion, the trainee will be qualified to inspect boilers, which includes verifying the safety of boilers and other equipment used in the generation of steam. Many manufacturing organizations, utilities, insurance companies, and underwriters' associations employ boiler inspectors.

Upon completion of this program, students will be able to:

- Know the types and component parts of steam generators used in industry and utilities, and how they function.
- Describe the properties of fluids and gases (steam) and how they are related to the operations of tanks, boilers, generators, and pumps.
- Inspect, maintain, and repair steam boilers.

### Base Program

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Estimated Program Duration: 592 hours.
Number of Exams: 64.
# Stationary Firer

The objective of the *Stationary Firer* topical program is to prepare the trainee to be a firer in a steam plant or electric power plant. The program covers basic mathematics, mechanical maintenance, and boiler firing, operation, maintenance, and testing. The courses have been assembled to meet the educational subject requirements set forth in the test for the Black Seal License.

Upon completion of this program, students will be able to:

- Know the types and component parts of steam generators used in industry and utilities, and how they function.
- Describe the properties of fluids and gases (steam) and how they are related to the operations of tanks, boilers, generators, and pumps.
- Inspect, maintain, and repair steam boilers.

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<td>Conductors, Insulators, and Batteries .......................................................</td>
<td>686005</td>
</tr>
<tr>
<td>Alternating Current ......................................................................................</td>
<td>686007</td>
</tr>
<tr>
<td>Alternating Current Circuits .......................................................................</td>
<td>686008</td>
</tr>
<tr>
<td>Logarithms ....................................................................................................</td>
<td>5254</td>
</tr>
</tbody>
</table>

Estimated Program Duration: 582 hours.
Number of Exams: 63.

# Production Operator for Process Manufacturing

This topical program provides trainees with the related coursework that covers the educational and technical concepts used in a typical process manufacturing operation. The training is designed for production line workers who have operator and control responsibilities. Key courses include the principles of electricity, instrumentation and process control equipment, chemistry, statistical quality control, and an introduction to maintenance and troubleshooting techniques.

Upon completion of this program, students will be able to:

- Understand the theory of how DC and AC circuits, components, and machinery function.
- Use the related mechanical principles and applications in the implementation, operation, and maintenance of instrumentation and process control systems.
- Learn how mechanical, hydraulic, and pneumatic components used in control systems convert measurements into useful data or appropriate system responses.
- Explain the classification and theories of chemistry, chemical elements and components, and how they are applied in an industrial production environment.
- Describe the use of statistical concepts and control charts in monitoring a manufacturing process.
- Apply quality and inventory control concepts to a manufacturing operation.
- Describe the basic preventive maintenance procedures for electrical and mechanical components, including scheduling downtime for equipment and using common troubleshooting skills, tools, and techniques.
# Field Service Technician: Mechanical Knowledge and Skills Training

This topical program provides field service technicians with both the technical concepts and skills techniques to troubleshoot power transmission, fluid power, pneumatic and process control systems. The training builds upon the pre-technical and business knowledge learned in the Field Service Technician Core Knowledge and Skills program described in Resource 2, Foundation Skills.

Upon completion of this program, students will be able to:

- Explain the common types, components, operating principles, and maintenance procedures for belt drive systems, chain drive systems, clutches, shafts, gears, electric and hydraulic servo motors.
- Explain hydraulic pumping principles and how the common types of hydraulic pumps, motors, and peripheral devices work.
- Describe the applications, components, and technology used in a basic industrial robot system.
- Discuss the operation of a control system and their relationship to computers and robots.

## Base Program

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventive Maintenance</td>
<td>286085</td>
</tr>
<tr>
<td>Preventive Maintenance Techniques</td>
<td>286086</td>
</tr>
<tr>
<td>Pumps, Part 1</td>
<td>286001</td>
</tr>
<tr>
<td>Pumps, Part 2</td>
<td>286002</td>
</tr>
<tr>
<td>Pumps, Part 3</td>
<td>286003</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 1</td>
<td>186068</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 2</td>
<td>186069</td>
</tr>
<tr>
<td>Bearings and Seals, Part 1</td>
<td>286093</td>
</tr>
<tr>
<td>Bearings and Seals, Part 2</td>
<td>286094</td>
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<tr>
<td>Lubrication, Part 1</td>
<td>286091</td>
</tr>
<tr>
<td>Lubrication, Part 2</td>
<td>286092</td>
</tr>
<tr>
<td>Principles of Mechanics, Part 1</td>
<td>286007</td>
</tr>
<tr>
<td>Principles of Mechanics, Part 2</td>
<td>286008</td>
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<tr>
<td>Link Mechanisms</td>
<td>2603</td>
</tr>
<tr>
<td>Gearing</td>
<td>2446</td>
</tr>
<tr>
<td>Gear Trains</td>
<td>2604</td>
</tr>
<tr>
<td>Cams</td>
<td>2605</td>
</tr>
<tr>
<td>Mechanical Power Transmission Part 1</td>
<td>286101</td>
</tr>
<tr>
<td>Mechanical Power Transmission Part 2</td>
<td>286102</td>
</tr>
<tr>
<td>Mechanical Power Transmission Part 3</td>
<td>286103</td>
</tr>
<tr>
<td>Belt Power Transmission</td>
<td>2607A-B</td>
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<tr>
<td>Hydraulic Power Basics</td>
<td>286060</td>
</tr>
<tr>
<td>Hydraulic Components: Actuators, Pumps, and Motors</td>
<td>286061</td>
</tr>
<tr>
<td>Hydraulic Components: Conductors, Conditioners, and Fluids</td>
<td>286062</td>
</tr>
<tr>
<td>Hydraulic Power System Control</td>
<td>286063</td>
</tr>
<tr>
<td>Interpreting Hydraulic System Schematics</td>
<td>286064</td>
</tr>
<tr>
<td>Hydraulic Power System Troubleshooting</td>
<td>286065</td>
</tr>
<tr>
<td>Pneumatics, Part 1</td>
<td>286098</td>
</tr>
<tr>
<td>Pneumatics, Part 2</td>
<td>286099</td>
</tr>
<tr>
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<td>286100</td>
</tr>
<tr>
<td>Air Compressors, Part 1</td>
<td>286096</td>
</tr>
<tr>
<td>Air Compressors, Part 2</td>
<td>286097</td>
</tr>
<tr>
<td>Servomechanisms</td>
<td>2028A-B</td>
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<tr>
<td>Pneumatic Instrumentation for the Technician</td>
<td>286M01</td>
</tr>
<tr>
<td>Control Technology for Technicians</td>
<td>286M04</td>
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<tr>
<td>Distributed Control Systems, Part 1</td>
<td>086084</td>
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<tr>
<td>Control Technology for Technicians</td>
<td>286M04</td>
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<tr>
<td>Pneumatic Instrumentation for the Technician</td>
<td>286M01</td>
</tr>
<tr>
<td>Servomechanisms</td>
<td>2028A-B</td>
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<tr>
<td>Pneumatic Instrumentation for the Technician</td>
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<td>Control Technology for Technicians</td>
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<tr>
<td>Distributed Control Systems, Part 1</td>
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**006035**

**Controls for Air Conditioning**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Fundamentals of Control Systems; Plants, Distribution Systems and Units; Control of Temperature, Humidity, Pressure, Ventilation, and Air Cleaning; Pneumatic, Electric, and Electronic Control Systems; Planning the Control System; Miscellaneous Installations.

**Special Note:**
- This updated course replaces, *Controls for Air Conditioning*, course 6636.

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**014005**

**Lithium Bromide Absorption System**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
- Modern Refrigeration and Air Conditioning (G14003)

**What Students Learn:**
- Introduction to Absorption Refrigeration; Basic Principles of the Lithium Bromide System; Chemical Characteristics; Apparatus Components and their Function; Absorption Cycle; Arrangement of Cycle Components; Purge Systems; De-Crystallization; Capacity Control; Operation Maintenance.

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**066902**

**Industrial Robotics: Technology, Programming, and Applications**

**Duration:** 45 hours (includes 3 tests)

**Course Prerequisites:**
- Electronic Systems (Block B25)
- Industrial Electronic Circuit Applications (Block B14)

**What Students Learn:**
- Fundamentals of Robot Technology, Programming, and Applications; Control Systems and Components; Robot Motion Analysis and Control; Robot End Effectors; Sensors in Robots; Machine Vision.
- Robot Technology: The Robot and its Peripherals; Robot Programming; Robot Languages; Artificial Intelligence.
- Applications Engineering for Manufacturing; Robots Cell Design and Control; Economic Analysis for Robotics; Robot Applications in Manufacturing; Material Transfer and Machine Loading/ Unloading; Processing Operations; Assembly and Inspection; An Approach for Implementing Robotics; Safety, Training, Maintenance, and Quality Issues; Social and Labor Issues; Robotics Technology of the Future.

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**2028A-B**

**Servomechanisms**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
- AC Principles (Block A22)
- Basic Electronic Circuits (Block B24)

**What Students Learn:**
- Part 1 (2028A). Basic Concepts of Automatic Control Systems and Servomechanisms, Electric and Hydraulic Servo Motors and Drive Systems; Types of Servo Amplifiers; Characteristics of DC Servo Motors; Feedback Devices, such as Potentiometers, Synchros, and Resolvers; Error Detectors; Operational Amplifiers; Performance Criteria for Servo Systems.
- Part 2 (2028B). Introduction to Machines Controlled by Servos; Types of Control Operations; Performance Requirements for the Basic Applications; Drive Systems, including Input, Feedback, and Amplifying Elements; Servo Errors, Gain, Stability, Accuracy, and Linearity Requirements and Limitations; Testing and Adjusting Servos.

**Special Note:**
- Covers subject at an advanced, in-depth level.

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**2243**

**Gear Calculations**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Kinds of Gears: Spur Gears; Spur-Gear Calculations in Circular-Pitch System and in Diametral-Pitch System; Involute System; Form of Helical Gear; Helical-Gear Calculations; Bevel Gears; Laying Out Bevel Gears; Spiral-Bevel Gears; Worms and Worm Gears; Worm-Gear and Worm Calculations; Spiral Gears; Spiral-Gear Calculations.

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**2446**

**Gearing**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Engineering Mechanics, Parts 1-4 (286036-286039)

**What Students Learn:**
- Rolling Curves and Surfaces; Spur Gearing; Proportions of Gear Teeth; Calculations of Spur Gears; Involute Systems; Cycloidal or Rolled-Curve System; Construction of Tooth Profiles; Helical Gearings; Spiral or Screw Gearings; Worms and Worm Gears; Bevel and Spiral Bevel Gears; Gear Cutting; Milling; Straight Hobs; Taper Hobs; Gear Finishing.
2452

High Pressure Pipefitting

Duration: 10 hours (includes 1 test)

What Students Learn:
Design and Arrangement; Pipe Calculations; Pipes; Valves and cocks; Separators and Steam Traps.

2511A-E

Vibration Analysis and Control

Duration: 50 hours (includes 5 tests)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Physics, Parts 1-2 (686003-686004)

What Students Learn:
Part 1 (2511A), Introduction to the Use of Vibration in the Maintenance of Machinery; Vibratory Motion; Characteristics of Vibration; Causes of Machine Vibration.
Part 2 (2511B), Vibration Measurement; Introduction to Instrumentation Analysis; Recording Data; Identification and Diagnosis; Vibration Tolerances.
Part 3 (2511C), Vibration Correction; Balancing Sources of Unbalance; Static Unbalance; Dynamic Unbalance; Single and Two-Plane Balancing; Balance Tolerances.
Part 4 (2511D), Theory of Isolation; Requirements; Materials; Interpretation of Data; Evaluation of Results.
Part 5 (2511E), Types of Instrumentation; Advantages and Disadvantages; Application and Maintenance.

Special Note:
• Course 2511B-E, (parts 2-5) covers subject at an advanced, in-depth level.

2539A-E

Hydraulic and Pneumatic Power Transmission

Duration: 50 hours (includes 5 tests)

Course Prerequisite:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)

What Students Learn:
Part 1 (2539A), Introduction to Fluid Power; Symbols and Drafting Practices; Hydraulic Fluids, Glossary of Terms.
Part 2 (2539B), Pumps and Compressors; Hydraulic and Pneumatic Motors; Head and Energy in Hydraulic Pump Systems; Basic Hydraulic Pump and Motor Calculations.
Part 3 (2539C), Power Cylinders and Rams; Reservoirs and System Components; Conductors and Connectors for Fluid Power Systems; Filtration of Fluids; Fluid Temperature Control.
Part 4 (2539D), Pressure-Control Valves; Flow-Control Valves; Directional-Control Valves; Fluid Power Accumulators.
Part 5 (2539E), Servo Systems; Circuit Design; Maintenance and Troubleshooting.

Special Note:
• This course has been replaced by study units 286060 through 286065.

2603

Link Mechanisms

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Engineering Mechanics, Parts 1-4 (286036-286039)
Elementary Mechanical Drawing (5434)

What Students Learn:
Definition of Terms; Plane Motion of a Rigid Body; Levers; Linkages; Quick-Return Mechanism; Straight Line and Parallel Motions; Kinematics of Link Mechanisms; Graphical Determination of Velocity; Graphical Determination of Acceleration; Kinematic Analysis.

2604

Gear Trains

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Gearing (2446)

What Students Learn:
Use of Trains; Velocity Ratio of Train Gears; Compound Gearing; Speed Change Gearing; Epicyclic Gears; Planetary Gear Trains; Reversing Mechanism; Ratchet Mechanisms.

2605

Cams

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Plane Trigonometry (2309A-B)
Elementary Mechanical Drawing (5434)

What Students Learn:
General Classification; Uses of Cams; Types of Cams; Fundamentals of Cam Motion; Basic Curves; Combination Curves; Cam Size Determination; Cam Profiles by Calculation.

2607A-B

Belt Power Transmission

Duration: 20 hours (includes 2 tests)

Course Prerequisite:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)

What Students Learn:
Part 1 (2607A), General Considerations on Belt Drives; Basic Theory of Belt Power Transmission; Types of Belt Drives; Application of V-Belt Drives; Application of Flat Belt Drives; Belt Drive Installation and Maintenance; Appendix.
Part 2 (2607B), Application of Special Belt Drives; Additional Considerations in Belt Drive Applications; New Developments in Belt Drives.
286001

**Pumps, Part 1**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Hydraulic Components: Actuators, Pumps, and Motors (286061)

**What Students Learn:**
Modern Centrifugal Pumps; Operating Principles of Pumps; Classifications and Types of Pumps; Fundamental Pump Terms: pressure, vapor pressure, head, losses, cavitation, net positive suction head, specific speed, viscosity; Centrifugal Pump Performance Curves; Types of Pumping System Curves.

**Special Notes:**
- This updated course replaces course 2530A.
- The entire course consists of study units 286001, 286002, and 286003.

286002

**Pumps, Part 2**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Hydraulic Components: Actuators, Pumps, and Motors (286061)

**What Students Learn:**
Construction details of Centrifugal Pumps; Applications of Centrifugal Pumps; Installation and Maintenance of Centrifugal Pumps; Troubleshooting problems associated with Centrifugal Pump Operation.

**Special Notes:**
- This updated course replaces course 2530A.
- The entire course consists of study units 286001, 286002, and 286003.

286003

**Pumps, Part 3**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Hydraulic Components: Actuators, Pumps, and Motors (286061)

**What Students Learn:**
Rotary Pumps: classifications, installation and operating principles; Reciprocating Pumps: classifications, installation and operating principles; Power Pumps: Applications of Rotary and Reciprocating Pumps; Troubleshooting Rotary and Reciprocating Pumps.

**Special Notes:**
- This updated course replaces course 2530B.
- The entire course consists of study units 286001, 286002, and 286003.

286007

**Principles of Mechanics, Part 1**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Basic Industrial Math (Block X21)  
Practical Measurements (Block X22)  
Practical Geometry and Trigonometry (5567)

**What Students Learn:**
Matter and Energy; Scope of Mechanics; Forms of Matter; Forms of Energy; Physical Properties of Bodies; Motion of Bodies; Velocity; Acceleration and Retardation; Weight and Mass; Work and Energy; Coordinate Systems; Precision in Computations; Newton's Laws of Motion; Uniform Motion; Variable Motion.

**Special Notes:**
- This updated course replaces course 6426A.
- The entire course consists of study units 286007-286008.

286008

**Principles of Mechanics, Part 2**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Basic Industrial Math (Block X21)  
Practical Measurements (Block X22)  
Practical Geometry and Trigonometry (5567)

**What Students Learn:**
Friction; Nature of Friction; Sliding Friction; Rolling Friction; Machine Elements; Levers; Inclined Plane; Wedges and Screw Threads; Wheel and Axle; Tackle; Pulleys; Gearing; Belts and Chains; Simple Harmonic Motion Centrifugal Force.

**Special Notes:**
- This updated course replaces course 6426B.
- The entire course consists of study units 286007-286008.

286010

**Fluid Mechanics, Part 1**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Introduction to Algebra, Geometry, and Trigonometry (Block X02)  
Logarithms (5254)  
Plane Trigonometry (2309A-B)

**What Students Learn:**
Physical Properties of Fluids; Intensity of Pressure; Water Pressures on Simple Immersed Surfaces; Buoyancy; Specific Gravity of Solids; Flow of Liquids Through Pipes; Losses of Head in Pipes; Bernoulli's Theorem; Venturi Meters.

**Special Notes:**
- This updated course replaces 5459A.
- The entire course consists of study units 286010, 286011, and 286012.
**286011**

**Fluid Mechanics, Part 2**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Logarithms (5254)
Plane Trigonometry (2309A-B)

**What Students Learn:**
Resultant Forces Due to Liquid Pressure; Forces on Complex Surfaces; Graphic Representation of Pressures; Location of Center of Pressure; Uniform Flow of Water Through Pipes; Hydraulic Grade Line; Use of Chezy-Darcy Formula; Use of Hazen-Williams Formula; Design of Pipes; Discharge Through Orifices and Fittings.

**Special Notes:**
- This updated course replaces 5459B.
- The entire course consists of study units 286010, 286011, and 286012.

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**286012**

**Fluid Mechanics, Part 3**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Logarithms (5254)
Plane Trigonometry (2309A-B)

**What Students Learn:**
Nonuniform Flow of Water in Pipes with Nozzles; Compound Pipes in Series and in Parallel; Flow of Fluids Other Than Water; Reynolds Number; Flow of Water in Open Channels; Design of Channels; Rate of Discharge Through Weirs.

**Special Notes:**
- This updated course replaces 5459C.
- The entire course consists of study units 286010, 286011, and 286012.

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**286016**

**Fundamental Principles of Rigging Technology**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Introduction to Rigging; Basic Mechanisms Used in Rigging; Weight and Center of Gravity.

**Special Notes:**
- This updated course replaces course 5030A.
- The entire course consists of study units 286016, 286017, 286018, 286019, 286020 and 286021.

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**286017**

**Planning the Rigging Operation**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Equalizing and Distributing Loads; Reasons for and Examples of Load Equalization and Distribution; Basic Methods of Equalizing and Distributing Loads; Planning and Executing a Rigging Job; What You Must Know Before Starting a Sample Rigging Operation; Safety in Rigging; Rigging Hazards; How to Reduce Hazards.

**Special Notes:**
- This updated course replaces course 5030B.
- The entire course consists of study units 286016, 286017, 286018, 286019, 286020 and 286021.

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**286018**

**Working with Rigging Tools, Part 1**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Working with Wire Rope, Fiber Ropes, and Chains; Explains the Proper Handling and Care of These Common Rigging Tools; Details Correct Rope Splicing and End-Attachment Procedures.

**Special Notes:**
- This updated course replaces course 5030C.
- The entire course consists of study units 286016, 286017, 286018, 286019, 286020 and 286021.

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**286019**

**Working with Rigging Tools, Part 2**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Rigging Tools; Slings; Hoists; Reeving, Pushing and Supporting Equipment; Cribbing; Scaffolds and Ladders.

**Special Notes:**
- This updated course replaces course 5030D.
- The entire course consists of study units 286016, 286017, 286018, 286019, 286020 and 286021.
286020

Rigging: Lifting Equipment and Applications, Part 1

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Understand the basic principles of crane safety.
- Identify the more common types of cranes and their components.
- Identify and give the functions of the various parts of a truck-type mobile crane.
- Know how to use crane rating charts.
- Select the correct mobile crane attachment for a particular function.
- Describe in general how to set up a boom.
- Select a suitable crane if given a set of specific lift conditions and crane capacity rating tables.

**Special Notes:**
- This updated course replaces course 5030E.
- The entire course consists of study units 286016, 286017, 286018, 286019, 2860020 and 286021.

286021

Rigging: Lifting Equipment and Applications, Part 2

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Describe the various types of limited travel cranes.
- Distinguish between the functions of derricks in common use.
- Identify the importance of two types of specialty cranes.
- Understand why certain cranes were used in various lifting situations.

**Special Notes:**
- This updated course replaces course 5030F.
- The entire course consists of study units 286016, 286017, 286018, 286019, 2860020 and 286021.

286036

Engineering Mechanics, Part 1

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Logarithms (5254)
- Plane Trigonometry (2309A-B)

**What Students Learn:**
- Scope of Engineering Mechanics; Branches of Engineering Mechanics; Statics; Newton's Laws; Representation of Forces; Combining Collinear Forces; Combining Concurrent Forces; Combining Noncurrent Forces; Center of Gravity of Simple Body; Center of Gravity of Composite Body.

**Special Notes:**
- This updated course replaces 2560A.
- The entire course consists of study units 286036, 286037, 286038, and 286039.

286037

Engineering Mechanics, Part 2

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Logarithms (5254)
- Plane Trigonometry (2309A-B)

**What Students Learn:**
- Bodies at Rest; Free Body Diagrams; Balanced Concurrent Forces; Balanced Noncurrent Forces; Equilibrium involving Friction; Characteristics of Friction; Bodies on Level Surfaces; Bodies on Inclined Surfaces.

**Special Notes:**
- This updated course replaces 2560B.
- The entire course consists of study units 286036, 286037, 286038, and 286039.

286038

Engineering Mechanics, Part 3

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Logarithms (5254)
- Plane Trigonometry (2309A-B)

**What Students Learn:**
- Branches of Dynamics; Kinematics and Kinetics; Translation and Rotation; Translation along a Straight Path; Translation along a Curved Path; Angular Motion of a Straight Line; Motion of a Particle on a Rotating Line; Rolling of a Single Body; General Plane Motion of a Particle in a Typical Mechanism.

**Special Notes:**
- This updated course replaces 2560C.
- The entire course consists of study units 286036, 286037, 286038, and 286039.

286039

Engineering Mechanics, Part 4

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Logarithms (5254)
- Plane Trigonometry (2309A-B)

**What Students Learn:**

**Special Notes:**
- This updated course replaces 2560D.
- The entire course consists of study units 286036, 286037, 286038, and 286039.
286060
Hydraulic Power Basics

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Introduction to Fluid Power (Block Y01)

What Students Learn:
Introduction to Hydraulic Power; Physical Principles of Hydraulic Power
and Energy; Pascal’s Law; Bernoulli’s Principle; Work and Power;
Horsepower and Loss; Hydraulic Power Systems; Basic Components of
Hydraulic Systems; Basic Hydraulic System Accessories; Fittings and
Couplings; Characteristics of Hydraulic Systems; Comparing Power
Systems; Requirements for Hydraulic Systems; Properties of Hydraulic
Fluid; Fluid Storage, Handling, and Maintenance; Filters and Strainers;
Heat Exchangers; Eliminating Air; Examples of Hydraulic Systems;
Proportional Displacement; Hydraulic System Operation; Working
Safely with Hydraulic Systems.

Special Note:
• The entire course consists of study units 286060, 286061, 286062,
  286063, 286064 and 286065.

286061
Hydraulic Components: Actuators, Pumps, and Motors

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Introduction to Fluid Power (Block Y01)

What Students Learn:
Actuator Design, Detail, and Operation; Linear Actuators; Hydraulic
Actuator Components; Rotary Actuators; Pumping Principles; Slippage;
Pump Classifications; Gear Pumps; Vane Pumps; Double Pumps; Gear
and Vane Pump Lubrication and Capabilities; Piston Pumps; Screw-type
Pumps; Supercharging Pumps; Variable-displacement Pump Control
Fundamentals; Hydraulic Motors; Comparing Pumps and Motors; Gear
Motors; Screw Motors; Vane Motors; Piston Motors; Abutment-type
Motors; Losses through Fluid Motors; Deceleration and Braking.

Special Note:
• The entire course consists of study units 286060, 286061, 286062,
  286063, 286064 and 286065.

286062
Hydraulic Components: Conductors, Conditioners, and Fluids

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Introduction to Fluid Power (Block Y01)

What Students Learn:
Reservoirs and System Components; Types of Reservoirs; Reservoir
Volume; Reservoir Components; Reservoir Interior Care and Auxiliary
Tanks; Reservoir in Use; Practical Tips for Reservoir Selection and
Maintenance; Conductors, Fittings, and Seals; Maintenance Tips for
Conductors, Fittings, and Seals; Choice of Conductor Size and Materials;
Types of Heat Exchangers; Automatic Temperature Control; Effective
System Cooling Tips; Accumulators; Circuits Using Accumulators;
Accumulator Safety; Hydraulic Fluids; Petroleum-based Fluids; Viscosity;
Demulsibility; Oxidation Stability; Lubricating Value; Corrosion and
Rust Prevention; Fire-resistant Fluids.

Special Note:
• The entire course consists of study units 286060, 286061, 286062,
  286063, 286064 and 286065.

286063
Hydraulic Power System Control

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Introduction to Fluid Power (Block Y01)

What Students Learn:
Explain the Function of Control Components in a Typical Hydraulic
System; Identify Control Valves by Pressure, Flow, or Directional Type;
Explain the Operating Principles and Typical Internal Parts of Pressure,
Flow, and Directional Valves; Interpret Schematic Symbols which
represent Control Valve Configurations.

Special Note:
• The entire course consists of study units 286060, 286061, 286062,
  286063, 286064 and 286065.

286064
Interpreting Hydraulic System Schematics

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Introduction to Fluid Power (Block Y01)

What Students Learn:
Typical Schematic Layout; Recognizing Standard Schematic Symbols;
Interpreting Control Configuration from Schematic Symbols; Evaluating
System Operating Characteristics from Schematics.

Special Note:
• The entire course consists of study units 286060, 286061, 286062,
  286063, 286064 and 286065.

286065
Hydraulic Power System Troubleshooting

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Introduction to Fluid Power (Block Y01)

**What Students Learn:**
Sizing Components to meet Requirements; Measuring and Evaluating System Operation; Assessing Motor and Pump Capacity and Performance; Special System Control including Servos and Pressure, Temperature, and Limit Switches; Performing Periodic Maintenance and Analyzing Inspection Information; Troubleshooting System Faults; Typical Hydraulic System Faults and Failures.

**Special Note:**
- The entire course consists of study units 286060, 286061, 286062, 286063, 286064 and 286065.

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### 286093

**Bearings and Seals, Part 1**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Understand what friction is and how bearings help reduce it.
- Explain the difference between plain and antifriction bearings.
- List the different types of plain bearings.
- Understand the characteristics of plain bearings.
- Know the importance of proper handling and installation of bearings.
- Recognize the importance of proper bearing lubrication.
- List the different materials used to make plain bearings and how material type affects their use.
- Explain how to prevent premature bearing failure.

**Special Notes:**
- This updated course replaces course 2602.
- The entire course consists of study units 286093 and 286094.

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### 286091

**Lubrication, Part 1**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Describe the various types of friction.
- Discuss how materials wear.
- List the various functions lubricants perform in industry.
- Explain how lubricants reduce friction.
- Classify lubricants depending upon their composition, properties, and additives.
- Understand why certain lubricants are chosen for certain tasks.
- Explain how to safely handle and store lubricants.

**Special Notes:**
- This updated course replaces course 2531A.
- The entire course consists of study units 286091 and 286092.

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### 286092

**Lubrication, Part 2**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Explain how to manually apply various types of lubricants in an industrial environment.
- Describe total-loss lubrication.
- Identify a nonloss lubrication system's components and describe their operation.
- Explain how to maintain a nonloss lubrication system.
- Identify the proper lubrication procedures to use for special industrial applications including sealed bearings, oil-impregnated bearings and food-processing plants.
- Explain how lubricant-conditioning systems work and how to maintain them.
- Describe how automatic lubrication systems work and how to maintain them.
- List the tasks involved in preventive and predictive lubrication maintenance.

**Special Notes:**
- This updated course replaces course 2531B.
- The entire course consists of study units 286091 and 286092.

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### 286094

**Bearings and Seals, Part 2**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Identify the various elements used in antifriction bearings.
- Properly identify and correct problems in antifriction bearings.
- Choose the proper seal.
- Choose and apply the proper lubricants for seals and antifriction bearings.
- Understand the need for clearance and tolerances in bearings.
- Identify the various parts of a seal.

**Special Notes:**
- This updated course replaces course 2602.
- The entire course consists of study units 286093 and 286094.

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### 286095

**Fasteners**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Identify the types and properties of fastener material.
- Describe the components of threaded fastener systems including bolts, nuts, screws and washers.
- Discuss the anchoring systems used in industry.
- Identify rivets and riveting tools.
- Describe other non-threaded fasteners including keys, pins and retaining rings.
- Display fastener installation techniques including tensioning, torquing and lubrication.
- Discuss how to troubleshoot fastener failure.

**Special Note:**
- This updated course replaces 2542.
286096

Air Compressors, Part 1

Duration: 10 hours (includes 1 test)

What Students Learn:
- Types of Compressors; Types of Comparison; Centrifugal Compressors; Axial-Flow Compressors; Construction Details of Centrifugal and Axial-Flow Compressors; Performance Curves; Installation and Performance Tests.

Special Notes:
- This updated course replaces courses 2626A and 286013.
- The entire course consists of study units 286096-286097.

286097

Air Compressors, Part 2

Duration: 10 hours (includes 1 test)

What Students Learn:
- Reciprocating Compressors; Cylinder and Piston Arrangements; Construction Details of Various Types; Selection, Installation, and Operation of Reciprocating Compressors; Rotary Compressors; Construction Details; Lobe Compressors; Screw Compressors; Troubleshooting Rotary Compressors.

Special Notes:
- This updated course replaces courses 2626B and 286014.
- The entire course consists of study units 286096-286097.

286098

Pneumatics, Part 1

Duration: 10 hours (includes 1 test)

What Students Learn:
- Pneumatic system components
- Operating characteristics of pneumatic systems and how they compare to hydraulic systems
- Calculating force produced by a pneumatic cylinder
- Schematic symbols that represent pneumatic components
- General applications of pneumatic systems
- Fundamental relationships between pressure, volume, and temperature

286099

Pneumatics, Part 2

Duration: 10 hours (includes 1 test)

What Students Learn:
- Sizing pneumatic cylinders and air motors
- Determine operating characteristics of a specific pneumatic system by reviewing its schematic diagram
- Specify conductor and receiver sizes to meet system requirements
- Interpreting system failure modes to determine probable cause
- Maintenance requirements

286100

Pneumatics, Part 3

Duration: 10 hours (includes 1 test)

What Students Learn:
- Electrical components and systems used to control pneumatic systems
- Logic functions and corresponding electrical connections for electrically controlled pneumatic components
- Relay logic diagrams for simple electro-pneumatic systems
- Specifying correct sensors and transducers
- Calculating physical loads that actuators and motors must carry
- Understand how PLCs control pneumatic systems

286101

Mechanical Power Transmission, Part 1

Duration: 10 hours (includes 1 test)

What Students Learn:
- Physical principles that govern mechanical power transmissions
- Identify type of shaft misalignment and select coupling to compensate for it
- Coupling types, including resilient and metallic, components, and their functions
- Belt-drive system configurations, components, and applications
- Computing speed ratios
- Installing, servicing, and troubleshooting various types of belt drives

Special Note:
This three-study-unit course replaces and expands on 286015.

286102

Mechanical Power Transmission, Part 2

Duration: 10 hours (includes 1 test)

What Students Learn:
- Various chain drive configurations and their unique operating characteristics
- Install chain coupling links and setting chain tension
- Interpret chain drive system ratings
- Servicing and lubricating Chain Drives
- Brake and clutch types, applications, and rating systems
- Selecting multimedia drives
- Predictive-maintenance for mechanical power transmission systems

Special Note:
This three-study-unit course replaces and expands on 286015.
**286103 Mechanical Power Transmission, Part 3**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Gear types and their operating characteristics
- Removing or mounting a gear from its shaft
- General dimensions in gearing and gear-drive systems
- Interpret gear and gearbox ratings
- Recognize different types of gearboxes and explain the applications for which each suited
- Selecting lubricants and lubricating gearboxes

**Special Note:**
This three-study-unit course replaces and expands on 286015.

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**286M04 Control Technology for Technicians**

**Duration:** 45 hours (includes 9 tests)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)
Introduction to Algebra, Geometry, and Trigonometry (Block X02)

**What Students Learn:**
This course introduces the fundamentals of control system components and operation. Students will learn how a control system works and how its operating characteristics can be interpreted from schematics and ladder logic diagrams. The course will explain how mechanical, hydraulic, pneumatic, electrical, and electronic components used in control systems measure parameters. These measurements are then converted into useful data or the appropriate control system response. The course discusses the use of feedback loops and their applications in real-world control systems. The student will understand how electronic systems are combined to deliver their acceptable data “signals” to computers. In conclusion, the student will learn how PLCs are used throughout industry to control complex systems.

**Part 1 (286076).** Lesson 1 - Introduction to Control Systems
- Represent a control system with a block diagram.
- Recognize various control system types including open loop, closed loop, analog, and digital.
- Describe how servomechanisms work.

Lesson 2 - Op Amps and Signal Conditioning
- Explain how microprocessors are integrated into, and interface with, control systems.
- Evaluate and design op-amp and related signal conditioning circuits to be used in control systems.

Lesson 3 - Control System Switching Devices
- Describe the operating principles of, and applications for, relays, transistors, rectifiers, triacs and other switching devices.

Lesson 4 - Mechanical Control Systems
- Explain how mechanical components are designed into, and operate within, control systems.

Lesson 5 - Control System Sensors
- Evaluate the function of sensors in a given control system.
- Understand how sensors work to provide data in control systems.

**Part 2 (286077).** Lesson 6 - DC and Stepper Motors in Control Systems
- Explain how DC motors operate.
- Select a motor based on mechanical and performance requirements.
- Describe how DC motor control systems work.
- Understand how stepper motors and their driver circuits work.

Lesson 7 - AC Motors in Control Systems
- Explain how AC motors operate.
- Select a motor based on mechanical and performance requirements.
- Describe how AC motor control systems work.

Lesson 8 - Control System Actuators and Feedback Principles
- Recognize the applications for, and operating characteristics of, electric, hydraulic, and pneumatic linear actuators.
- Describe the operating principles of control valves and other components in hydraulic and pneumatic systems.

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**286M01 Pneumatic Instrumentation for the Technician**

**Duration:** 35 hours (includes 7 tests)

**Course Prerequisites:**
Basic Industrial Math (Block X21)

**What Students Learn:**
Lesson 1 - Pneumatic Instrumentation for Industry:
- Instrument Systems; How Fluid Power Works; Pneumatic Instruments; Link Mechanisms: Components and Adjustments; Calibration Standards, Procedures and Programs.

Lesson 2 - Pressure and Liquid Level Measuring Instruments:
- Principles of Pressure; Sensing Pressure; Bourbon Elements; Compensation and Calibration; Liquid-Level Instruments; Differential Pressure Instruments: Manometers, Bellows and Diaphragm Instruments, Displaces.

Lesson 3 - Flow-Measuring Instruments:
- Principles of Operation; Orifice Flow; Meter Types and Mechanisms; The Square-Root Problem; Integrators.

Lesson 4 - System Components, Part 1:
- Self-Balancing Instruments; Error Detectors; Pilot Valves; Relay Functions and Variations; Moment-Balance Pressure, Temperature and Differential-Pressure Transmitters; Moment Balance Positioners.

Lesson 5 - System Components, Part 2:
- True Force-Balance Instruments, Transmitters and Positioners; Motion-Balance Principle and Applications; Angle Motion-Balance Positioners; Linear Motion-Balance Instruments.

Lesson 6 - Pneumatic System Control, Part 1:
- Control Valve Maintenance; Control Theory and Fundamental Controllers; Gain, Feedback and Response.

Lesson 7 - Pneumatic System Control, Part 2:
- Controller Functions, Types and Components, Range and Gain Mechanisms; Foxboro, Honeywell, Taylor, and Fisher and Porter Controllers; Universal Controllers; Process Control.

**Special Note:**
- This course consists of a textbook and supplemental study guide.
• Differentiate between proportional, integral, differential, and fuzzy logic control systems.
Lesson 9 - Relay Logic and PLCs
• Explain how to tune a process control system.
• Understand how analog and digital control circuits work.
• Explain the operation of relays, counters, and sequencers.
• Understand how PLCs work.
• Interpret ladder logic diagrams.

Special Note:
• This course consists of a textbook and two supplemental study guides. We recommend the course be purchased in its entirety. However, if needed due to targeted training, study guides (Parts 1 & 2) can be purchased separately, with or without the textbook. Note that the textbook is required for the Part 1 study guide. Call Customer Service for pricing and ordering information.

5384
Cold Water Supply
Duration: 10 hours (includes 1 test)
What Students Learn:
Measuring Water Service; Service Connections; Water Supply; Pneumatic Water Supply; Pressure and Suction-Tank Connections; Fire-Protection Systems.

5385
Hot Water Supply
Duration: 10 hours (includes 1 test)
What Students Learn:
Principles of Water Heating; Fire-Heated Water Heaters; Steam-Heated Water Heaters; Electric Water Heaters; Water Heating by Transfer; Storage Tanks and Temperature Control; Details of Hot Water Systems; Sizing Hot Water Piping.

5386
Pipework
Duration: 10 hours (includes 1 test)
Course Prerequisite:
Industrial Plumbing and Pipefitting (Block D20)
What Students Learn:
Cast-Iron Soil Pipe; Lead Pipe; Ferrous Pipe; Brass Pipe and Copper Tubing; Nonmetallic Piping.

5389
Tanks and Pumps
Duration: 10 hours (includes 1 test)
What Students Learn:
Classification of Tanks; Pressure Tanks; Kinds of Pumps; Centrifugal Pumps; Pump Priming and Jet Pumps; Special Pumps; Selection of Pumps; Servicing of Pumps.

5581
Pipefitting Practice
Duration: 10 hours (includes 1 test)
Course Prerequisite:
Industrial Plumbing and Pipefitting (Block D20)
What Students Learn:
Pipework Details; Anchoring and Supporting Pipes; Installing Heating Systems; Radiator Connections; Brass and Copper Piping; Methods of Pipe Welding; Piping in Refrigeration; Employees, Tools, and Materials.
5608  
**Mechanical Calculations**

*Duration:* 10 hours (includes 1 test)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- Practical Measurements (Block X22)

**What Students Learn:**
- Power Transmission; Pulleys; Flat Belts; V Belts; Gears; Cams and Levers; Calculations; Slide Rule, Relative Speeds of Pulleys and Gears, Sizes of Pulleys and Gears; Textile Motors; Adjustable-Speed Drives; Calculation of Constants; Calculations for Levers; Accuracy in Calculations.

5886  
**Pipes and Fittings**

*Duration:* 10 hours (includes 1 test)

**Course Prerequisite:**
- Industrial Plumbing and Pipefitting (Block D20)

**What Students Learn:**
- Piping; Pipefittings; Valves; Pipe Supports.

6084A-B  
**Air Conditioning Systems**

*Duration:* 20 hours (includes 2 tests)

**What Students Learn:**

6305A-B  
**Principles of Automatic Process Control Instruments**

*Duration:* 20 hours (includes 2 tests)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Heat, Parts 1-2 (686001-686002)
- Electricity (4210A-C)
- Control Technology for Technicians (286M04)

**What Students Learn:**
- Part 1 (6305A). Automation; Nature of Control Systems; Control Action; Self-Powered Controllers; Powered Controllers.
- Part 2 (6305B). Powered Controllers; Controller Settings; Failure of Automatic Control Systems; Cascade Control Systems; Glossary.

6306A-B  
**Temperature Measuring and Control Instruments**

*Duration:* 20 hours (includes 2 tests)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Heat, Parts 1-2 (686001-686002)
- Electricity (4210A-C)
- Control Technology for Technicians (286M04)
- Principles of Automatic Process Control Instruments (6305A-B)

**What Students Learn:**
- Part 2 (6306B). Types of Filled Thermal Systems; Bourdon Element; Temperature Compensation; Resistance Temperature Detectors; Radiation Pyrometry; Types of Radiation Pyrometers; Methods of Temperature Control.

6307  
**Automatic Process Control Valves**

*Duration:* 10 hours (includes 1 test)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Heat, Parts 1-2 (686001-686002)
- Electricity (4210A-C)
- Control Technology for Technicians (286M04)
- Principles of Automatic Process Control Instruments (6305A-B)

**What Students Learn:**
- Importance of Control Valves; Types and Construction Features of Various Control Valves; Types of Valve Motors; Application of Valve Motors and Control Valves; Basic Function of Valve Positioner; Applications of Valve Positioners; Definition of Control Valve Rangeability and Valve Coefficient; Sizing of Control Valves for Liquid, Gas, and Steam.
6308A-B

**Fluid Flow Measuring and Control Instruments**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Heat, Parts 1-2 (686001-686002)
- Electricity (4210A-C)
- Control Technology for Technicians (286M04)
- Principles of Automatic Process Control Instruments (6305A-B)
- Automatic Process Control Valves (6307)

**What Students Learn:**
- Part 1 (6308A). Introduction to Fluid Flow; Standard Primary Elements; Additional Primary Elements; Measurements; Selection of Primary Elements; Proper Application of Primary Elements; Locating Primary Elements; Use of Straightening Vanes.
- Part 2 (6308B). Mechanical Flowmeters; Bellows- and Diaphragm-Actuated Manometers; Other Types of Meters; Flow Measurement.

6338A-B

**Liquid Level Measuring and Control Instruments**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Heat, Parts 1-2 (686001-686002)
- Electricity (4210A-C)
- Control Technology for Technicians (286M04)
- Principles of Automatic Process Control Instruments (6305A-B)
- Automatic Process Control Valves (6307)

**What Students Learn:**
- Part 1 (6338A). Visual Indicators such as Sight Gages; Buoyancy Level Controllers, both of the Moving Float and Displacement Type; Static- and Differential-Pressure Level Controllers; Gamma Radiation Level Controllers.
- Part 2 (6338B). Temperature-Sensitive Level Controllers and the Electrical Conductivity Type of Level Controller; Explanations of the Special Requirements of Liquid-Level Control with Emphasis on Control of Hazardous Types of Liquids and Selection of Level Controls for Various Types of Process Applications.

6309A-B

**Process Pressure Measuring and Control Instruments**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Heat, Parts 1-2 (686001-686002)
- Electricity (4210A-C)
- Control Technology for Technicians (286M04)
- Principles of Automatic Process Control Instruments (6305A-B)

**What Students Learn:**
- Part 1 (6309A). Pressure Measuring Considerations; Pressure Measuring Devices, such as Manometers, Draft Gages, Inverted BELTS, Differential Elements, Bellows, and Diaphragm Devices; Bourdon Tube; Spiral and Helical Pressure Meters; Chemical Pressure Gages; Pressure Indicators and Recorders.
- Part 2 (6309B). Calibration Standards and Methods, including Details of Dead Weight Tester, Test Gages, and Gage Errors; Pressure Measuring and Control Instruments and Equipment; Process Pressure Application Considerations; Automatic Control of Process Pressure; Selection of Pressure Instruments for Process-Pressure Applications.

6447A-B

**Principles of Heating, Ventilating, and Air Conditioning**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- Practical Measurements (Block X22)

**What Students Learn:**
- Part 2 (6447B). Weight and Pressure of Gases; Energy, Motion, and Air Velocities; Air and Air Mixtures; Air Movements and Ventilation; Air Conditions and Air Conditioning.
6463

**Plumbing and Pipefitting Tools**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Industrial Plumbing and Pipefitting (Block D20)

**What Students Learn:**
Small Hand Tools; Tools for Drilling and Sawing; Tools for Joining and Cutting Pipe; Threading Tools; Pipe-Holding Devices; Lead-Working Tools; Tools for Working Soil Pipe; Tools and Shop Equipment.

6553

**Condensers**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)
Practical Geometry and Trigonometry (5567)
AC Principles (Block A22)

**What Students Learn:**
Purpose and Theory of Condensers; Classification and Service of Condensers; Condenser Auxiliaries; Condenser Details; Cooling Condensing Water; Condenser Calculation; Condenser Selection Consideration; Condenser Management.

6691

**Pressure Vessel and Tank Print Reading**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)
Practical Geometry and Trigonometry (5567)
Elements of Print Reading (6719A-B)

**What Students Learn:**
Steam Generating Plants; Reservoirs and Standpipes; Miscellaneous Structures for Holding Various Liquids and Gases; Actual Industry Drawings used as Samples.

6734

**Steam Boiler Operation and Maintenance**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)

**What Students Learn:**
Boiler Room Management; Details of Operation; Boiler Inspection; Boiler Maintenance, Cleaning, and Repair.

6814

**Insulation for Pipefitting**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Industrial Plumbing and Pipefitting (Block D20)

**What Students Learn:**
Types of Insulation; Insulation against Heat Loss and Heat Gain; Insulation to Prevent Condensation.

Block D20

**Industrial Plumbing and Pipefitting**

**Duration:** 40 hours (includes 8 tests)

**What Students Learn:**
The eight lessons in this block provide the trainee with the skills and knowledge needed to perform those tasks associated with the trades of plumber and pipefitter. The program includes coverage of the most widely accepted materials used for pipe, fittings, and valves. The trainee will learn how to use the tools of the trades, with an emphasis on safety. In addition, the methods used to join pipe, and the procedures for supporting, installing, and testing piping systems, are discussed in detail. Common plumbing fixture installation and maintenance, along with a review of tanks, pumps, and boilers, are covered.

**Special Note:**
- This updated course replaces *Industrial Plumbing and Pipefitting*, Block D10. Each study unit contains a progress exam.

**Components:**
- 286040 The Trades of Plumbing and Pipefitting
- 286041 Pipes, Fittings, and Valves
- 286042 Plumbing and Pipefitting Tools
- 286043 Joining and Assembling Pipes
- 286044 Supporting, Installing, and Testing Pipes
- 286045 Plumbing Fixtures and Appliances
- 286046 Tanks, Pumps, and Boilers
- 286047 Insulation for Piping and Ducting
286040

The Trades of Plumbing and Pipefitting

Objectives:
• Identify the differences between “plumbing” and “pipefitting.”
• Discuss the basic concepts of codes and standards.
• Relate information about the different types of mechanical systems in buildings.
• Demonstrate basic skills for blueprint reading.
• Identify the terms: blueprints, architectural drawings, working drawings, manufacturers’ specifications and job specifications.
• Relate the basic concepts of blueprint reading.
• Use a measuring scale.
• Identify symbols and abbreviations used on working drawings.
• Locate specifications pertaining to a specific material or system.
• Explain how different types of plumbing and piping systems are categorized.

286041

Pipes, Fittings, and Valves

Objectives:
• Identify and classify the different types of material that are used to manufacture pipes, fittings, and valves.
• List the characteristics of the various types of pipes, fittings, and valves available.
• Classify and identify pipe “markings.”
• Know how to “read” a fitting for ordering purposes.
• Identify the various types of valves and know their components.
• Perform basic valve maintenance and know proper installation techniques.
• Select and specify pipes, fittings, and valves for a particular application.

286042

Plumbing and Pipefitting Tools

Objectives:
• Identify the various tools available for various tasks by appearance.
• Demonstrate your knowledge of job safety and tool safety.
• Identify the tools required to join and assemble pipes of different material composition.
• Determine when and how to use pipe-joint assembly tools.
• Identify the tools required to perform layout, cutting, and boring tasks.
• Identify the tools needed for testing and maintaining piping systems.
• Determine when and how to use finishing, testing, and maintenance tools for piping systems.

286043

Joining and Assembling Pipes

Objectives:
• List necessary precautions to be taken when working with materials or procedures to join pipes.
• Cut pipe lengths manufactured from the various pipes materials, as required by a piping system layout.
• Prepare and assemble the various pipe joints you learned earlier.
• Identify the materials, tools, and equipment needed for pipe.
• Perform basic pipe-welding tasks.

286044

Supporting, Installing, and Testing Pipes

Objectives:
• Lay out, install, and align a piping system either inside a building or underground.
• Properly support a piping system using the various available methods, taking into account thermal expansion and contraction.
• Identify methods and materials used to protect piping installations.
• Calculate pipe offsets to avoid obstructions when laying out and installing a piping system.
• Test different types of piping systems for defective materials or faulty workmanship.

286045

Plumbing Fixtures and Appliances

Objectives:
• Recognize trade terms used to categorize and describe plumbing components.
• Identify the different types of plumbing fixtures, trim, appliances, and appurtenances.
• Explain the procedures used for installing plumbing fixtures and trim.
• Discuss common maintenance problems and corrective action for plumbing components.

286046

Tanks, Pumps, and Boilers

Objectives:
• Identify and classify the various available tanks.
• Specify and size round and rectangular tanks, and sumps, for a particular application.
• Identify different pumps and know pump principles.
• Discuss pump installation, start-up, and maintenance procedures.
• List the characteristics of boilers and discuss their classifications.
• Identify boiler accessories and know basic boiler maintenance.
Insulation for Piping and Ducting

Objectives:
- Identify and understand the function and types of different piping and ducting insulation materials.
- Select the proper insulation type, material, and thickness for a given piping system.
- Properly cut, form, and install insulation and shielding to piping and ducting.

Y0102
The Physics of Fluid Power

Objectives:
- Describe the physical concepts of force, torque, energy, work, and power as they relate to fluid power system output, and describe their relationships.
- Apply physical principles, such as the Law of Conservation of Energy and Pascal’s Law, to fluid power systems.
- Identify the components of fluid systems that generate force and torque.
- Describe the roles and relationships of pressure, resistance, and inefficiency, and discuss their effect on fluid system performance.
- Explain the features and benefits of energy transmission and control by means of fluid power.

Y0103
Transmission and Storage of Energy by Fluid Power, Part 1

Objectives:
- Describe how a maintenance technician must analyze and repair an overall fluid power system by diagnosis of the individual component parts.
- Define the characteristics of fluids.
- Describe the differences between liquid and gas system behavior as it relates to power level, speed, cost, efficiency, and maintenance.
- Discuss the selection criteria for commonly used fluids, and describe current equipment trends that have been affected by fluid considerations.
- Identify fluid system connectors and conductors, and discuss their selection and maintenance.
- Describe the two major categories of output actuators, and the service and maintenance requirements for the devices most commonly applied.
- Discuss the performance characteristics and pressure ratings for each category of device and the recommended service and maintenance.

Introduction to Fluid Power

Objectives:
- Introduce the basic principles of fluid power and describe their practical application in the generation, transmission, control, and distribution of energy.
- Establish a basic vocabulary of the terms used within fluid power.
- Build an awareness of the size, shape, and function of generic fluid power systems and their components.
- Recognize the graphic symbols used to represent primary system components.
- Use three conventional systems that graphically portray fluid power systems.
- Identify five of the physical properties of fluid power, and discuss their impact.
- Describe the process of energy generation, transmission, storage, control, and delivery by means of a fluid power system.
- Describe the application of system components and discuss their behavior in relation to overall system performance.

Introduction to Fluid Power

Components:
- Y0101 Introduction to Fluid Power
- Y0112 Progress Examination
- Y0102 The Physics of Fluid Power
- Y0122 Progress Examination
- Y0103 Transmission and Storage of Energy by Fluid Power, Part 1
- Y0123 Progress Examination
- Y0104 Transmission and Storage of Energy by Fluid Power, Part 2
- Y0124 Progress Examination
- Y0105 The Components of Fluid Power, Part 1
- Y0125 Progress Examination
- Y0106 The Components of Fluid Power, Part 2
- Y0126 Progress Examination
- Y0107 The Components of Fluid Power, Part 3
- Y0127 Progress Examination
- Y0108 A Summary of Fluid Power
- Y0128 Progress Examination
Y0104
Transmission and Storage of Energy by Fluid Power, Part 2
Objectives:
• Discuss the devices used for energy transmission and storage - accumulators, receivers, pressure vessels, pumps, and compressors.
• Describe how fluid power amplifiers - boosters and intensifiers - operate.
• Describe how control and interface systems are designed and how they manage the transmission of energy by means of fluid power.
• Identify directional controls, pressure controls, flow controls, special flow control systems and proportional controls, and how these systems work.
• Understand the principles of viscosity, lubricity, friction, inertia, and heat as related to fluid power systems.

Y0105
The Components of Fluid Power, Part 1
Objectives:
• Discuss the characteristics of fluids (gases and liquids) and their impact on system performance.
• Describe the critical influence of connectors and conductors, and relate the most common variables to system performance.
• Explain the differences between linear and rotary actuator systems, and discuss common and differing influences of fluid compatibilities, construction, performance characteristics, ratings, and service recommendations.
• Understand how pneumatic receivers and pneumatic pressure vessels operate.
• Understand how hydraulic accumulators and hydraulic receivers operate and are maintained.

Y0106
The Components of Fluid Power, Part 2
Objectives:
• Discuss typical industrial pumps and compressors and explain basic designs and service considerations, such as fluid compatibility, displacement, compression ratio, heat of compression, and suction pressure.
• Explain the theory of pressure intensification and discuss the designs of boosters and intensifiers that are applied to achieve the objectives of amplified pressures.
• Discuss the critical design considerations that identify the devices specific to directional, pressure, and flow control.
• Describe the relationship of each device category to the objectives of integration and overall system parameters.

Y0107
The Components of Fluid Power, Part 3
Objectives:
• Discuss the critical design considerations that are relevant to proportional and servo control systems and the specific devices that enable their performance.
• Describe fluid conditioning and storage devices, and discuss their function and contribution to successful fluid system performance.
• Explain the theory of operation and use of heat exchangers in hydraulics, and discuss their limited use in pneumatic systems.
• Discuss the design and application considerations relative to pressure gauges, flow monitoring devices, pulsation dampers, shock absorbers, gauge snubbers, air-bleed vents, and other common performance enhancements.
• Describe the relationship of each category of devices to the total system, with regard to the objectives of integration and overall system parameters.

Y0108
A Summary of Fluid Power
Objectives:
• Develop a workable understanding of overall fluid power systems design and performance applications.
• Discuss fluid power as a means of controlling and powering motion and process.
• Describe energy transfer by means of fluid power systems.
• Describe typical problems, identify the most common causes, and prescribe initial steps to analyze and correct these problems.
• Work comfortably and safely in the industrial environment with a demonstrated awareness of fluid systems, common devices, and the potential hazards of incorrect maintenance practices.
• Focus on product applications and problem solving within the following devices:
  - Pneumatic lubrication circuits
  - Hydraulic filtration circuits
  - Hydraulic pump control circuits
  - Automated process control circuits
  - Using pneumatically timed sequential control
  - Using pneumatic moving part logic
  - Hydraulic pump assist circuits
  - Special purpose I/O interfaces

Block Y02
Studies in Hydraulics
Duration: 44 hours (includes 11 tests)
Course Prerequisite:
Introduction to Fluid Power (Block Y01)
What Students Learn:
Studies in Hydraulics has been developed to provide an in-depth understanding of the specific performance characteristics and behavioral patterns of hydraulic systems and components. For the entry-level trainee, a discussion of key terms, definitions, physics concepts and the principles relating to energy transmission, start the course. Emphasis is then placed upon the skills necessary to the operation and proper
servicing of hydraulic equipment and its functional components—actuators, pumps, control valves, and integrated systems. Attention is given to the important skills required to perform major repair, planned and crisis maintenance, and overhaul. Like the prerequisite course, Introduction to Fluid Power, this course can be beneficial to an apprentice, at the entry or skilled worker level and the mechanical maintenance staff. It will fit well in a mechanical cross training program developed for electrical or multi-crafted workers.

**Components:**

Y0201 The Language of Hydraulics
Y0221 Progress Examination
Y0202 Physics of Hydraulics
Y0222 Progress Examination
Y0203 Hydraulic Transmission of Energy
Y0223 Progress Examination
Y0204 Linear Actuators
Y0224 Progress Examination
Y0205 Rotary Actuators
Y0225 Progress Examination
Y0206 Hydraulic Pumps
Y0226 Progress Examination
Y0207 Hydraulic Reservoirs, Coolers, and Filters
Y0227 Progress Examination
Y0208 Directional Control for Hydraulic Applications
Y0228 Progress Examination
Y0209 Pressure Control Valves
Y0229 Progress Examination
Y0210 Flow Control Valves
Y0230 Progress Examination
Y0211 Hydraulic Proportional and Servo Control
Y0231 Progress Examination

**Y0203**

**Hydraulic Transmission of Energy**

**Objectives:**
- Discuss the function of liquids in hydraulic systems.
- Discuss linear and rotary actuators and their applications.
- Discuss pressure amplifiers, boosters, and accumulators as they apply to hydraulic systems.
- Recognize and describe various types of pumps.
- Describe the energy conversion and control devices of the hydraulic system.
- Discuss hydraulic rotary actuator and motor selection considerations as they relate to displacement, angular velocity, side load, maximum torque, and maximum pressure ratings.
- Apply formulas and common conversion factors to estimate the size and ratings of a variety of hydraulic system components, based on the cycle requirements of rotary actuators or motors.
- Discuss the application of a variety of accessories that are commonly used to enhance the performance and efficiency of hydraulic rotary actuators, and to extend the useful service life of the actuator devices and related equipment.

**Y0204**

**Linear Actuators**

**Objectives:**
- Discuss the conversion of fluid energy to mechanical energy in hydraulic linear actuators.
- Define linear actuator operating characteristics, with specific emphasis on direction, speed, force, and duration.
- Discuss selection criteria for linear actuators, and identify standard diameters, stroke ranges, rod sizes and configurations, ports, and performance options.
- Discuss linear actuator design characteristics, including performance specifications, ratings, and expectations.
- Describe the effect of cylinder mounting and alignment on performance.
- Discuss ways to improve performance and extend useful life.

**Y0205**

**Rotary Actuators**

**Objectives:**
- Examine the concepts of rotary motion, and the special category of hydraulic hardware commonly used to propel, control, or position rotary loads.
- Discuss the application of hydraulic rotary actuators as point-of-use energy converters (converting fluid energy to rotary mechanical torque), and describe the benefits of directly coupling the power generator to the load.
Y0206

Hydraulic Pumps

Objectives:
• Define pumping as it relates to industrial and commercial hydraulics.
• Discuss pump designs and the performance characteristics of the most popular designs used in contemporary systems and applications.
• Discuss suction (pump inlet) considerations and their impact on the selection of a specific pump design.
• Discuss reservoir location, fluid compatibility, air entrainment, condensation (water ingestion), filtration, and other system components as they relate to pump designs and applications.
• Describe pumping trends relating to fluid resources, filtration, water-containing fluids, hydrostatic systems, and process management applications.

Y0207

Hydraulic Reservoirs, Coolers, and Filters

Objectives:
• Describe the effects of hydraulic fluids on overall system performance, with emphasis on additives, fluid conditioning, and fluid maintenance.
• Discuss hydraulic reservoir design, performance expectations and routine service, and maintenance requirements.
• Describe trends in monitoring and instrumentation which augment hydraulic automation.
• Discuss filtration, its varied impacts and the devices commonly applied in conventional hydraulics.
• Discuss the application of coolers (heat exchangers) and their contribution to system stability.

Y0208

Directional Control for Hydraulic Applications

Objectives:
• Define functional control and relate the typical hydraulic functions to directional control devices.
• Discuss valve designs for hydraulic directional control and the performance expectations for each design.
• Describe valve mounting patterns and service practices and relate their performance benefits.
• Discuss performance characteristics and valve ratings with regard to pressure, volume, and shock.
• Describe special valve designs and applications unique to hydraulic systems.
• Compare direct-acting and pilot-operated designs and behavioral expectations.
• Describe volumetric (flow) capacities and rating practices.
• Discuss the parameters and practices used in valve sizing.
• Discuss valve response times and relate these to hydraulic system responses.

Y0209

Pressure Control Valves

Objectives:
• Define the term pressure control and discuss the extensive applications of pressure (fluid) actuated devices in the control of hydraulic systems.
• Discuss the application of braking valves in hydraulic motor circuits.
• Discuss the application of counterbalance valves in vertical and heavily loaded hydraulic cylinder circuits.
• Explain the use of pressure-reducing valves and discuss their special contribution to hydraulic system performance.
• Discuss relief valves and relate their specific function to their location in a circuit, including direct-acting and pilot-actuated designs.
• Describe the function of sequence valves and discuss their application in traditional systems.
• Describe the application and special functions of unloading and unloading/relief valves in conventional hydraulics.
• Discuss a variety of special purpose pressure controls and describe their specific function in conventional hydraulics.

Y0210

Flow Control Valves

Objectives:
• Define flow (rate) control and discuss its impact on system performance, operating characteristics and design specifications.
• Discuss fixed and variable orifice devices and their attributes and selection.
• Describe variable and multiple-flow rate systems, and discuss the common methods of approaching such systems with regard to control and adjustability.
• Define and discuss the concepts of flow control devices in meter-in, meter-out, bleed-off, and three-port flow control applications.
• Discuss what is meant by motorized flow control and discuss the two target benefits of these provisions.
Y0211

Hydraulic Proportional and Servo Control

Objectives:
- Differentiate between digital and analog control characteristics as they relate to hydraulics.
- Define the terms proportional control and servo control as they pertain to hydraulic applications and devices.
- Discuss the behavior of discrete devices relative to integrated systems for the management of direction, intensity, and speed.
- Describe potential system conversions from discrete devices and step logic to motion management and programmed modulation in response to error detection.
- Define open and closed loop control and the instrumentation monitoring of system performance or deviation as a means of managing the process.
- Narrate a sequence statement using the language of discrete logic.
- Discuss present hydraulic technology and plans for future advancements in the field and describe some of the differences in tasks for technicians in troubleshooting and servicing leading edge technology in hydraulics.

G14003

Modern Refrigeration and Air Conditioning

Duration: 152 hours (includes 19 tests)

Course Prerequisites:
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)

What Students Learn:
Part 1 (H14003). Introduction to Refrigeration:
Lesson 1: Refrigeration and Air Conditioning Concepts
- Conduction and Convection Heat Transfer; Matter and Gas Laws; Refrigeration Process and Components; Handling Refrigerants.
Lesson 2: Safety, Tools, and Equipment
- Pressure Vessels and Piping; Electricity and Moving Machinery Hazards; Refrigerant Contact and Inhalation Effects; Properly Moving Heavy Objects; Hand Tools and Specialized Service Equipment.
Lesson 3: Fasteners, Tubing, and Piping
- Identification and Application of Fasteners; Hanging and Connecting Tubing, Piping and Ducts; Types of Tubing; Solderless Terminals and Wire Connectors.
Lesson 4: System Evacuation, Refrigerants, and System Charging
- System Evacuation Theory, Tools, and Procedures; Leak Detection and System Cleaning; Environmental Effects and Chemical Composition of Refrigerants; Refrigerant Charging Processes.
Lesson 5: Calibrating Instruments, Basic Electricity, and Magnetism
- Charging, Calibration, and Test Tools; Electrical Fundamentals; Electrical Measurement Instruments; Introduction to Electric Circuits and Components.

Part 2 (I14003). Refrigeration Systems:
Lesson 6: Automatic, Electronic, and Programmable Controls
- Temperature Sensing Devices and Components; Pressure and Flow Control Devices; Various Troubleshooting Diagrams; Understanding and Troubleshooting Controls and Control Circuits; Types and Uses of Various Controls.
Lesson 7: Types and Designs of Electric Motors
- Motor Components and Applications; Motor Mounts; Drives and Starters; Troubleshoot and Diagnose Various Motor Failures.

Part 3 (J14003). Refrigeration Servicing:
Lesson 8: Commercial Refrigeration Components
- Refrigeration Temperatures; Various Types and Functions of Evaporators and Condensers; Refrigeration System Maintenance; Types and Functions of Compressors and Expansion Devices.
Lesson 9: Special Commercial Refrigeration Components, Applications, and Troubleshooting
- Various Commercial Refrigeration Control Devices; Function of Refrigeration System Accessory; Selecting a Commercial Refrigeration System; Defrost Process; Various Types of Ice-making and Vending Machines; Differences Between Land, Sea and Air Cargo Refrigeration; Proper Troubleshooting Techniques and Procedures; Special Refrigerated Applications.

Part 4 (K14003). Cooling and Heating:
Lesson 10: Basic Heating Systems
- Types and Functions of Electric Heaters; Components of an Electric Forced-Air Heating System; Preventative Maintenance and Troubleshooting of Electric Heaters and Central Electrical Heating Systems; Types of Gas Furnaces and Their Fuels; Components of a Gas-Fired Forced-Air Furnace; Preventative Maintenance and Troubleshooting of Gas-Fired Furnaces; Identify Fuel Oils; Components of an Oil-Fired Forced-Air Furnace; Preventative Maintenance and Troubleshooting of Oil-Fired Furnaces; Safety Practices Related to Electric, Gas, and Oil Heating Systems.
Lesson 11: Additional Heating Systems and Air Quality
- Operation and Components of Hydronic Heating Systems; Troubleshooting and Preventative Maintenance of Hydronic Heating Systems; Air Quality Problems, Causes, and Treatments; Types and Maintenance of Humidifiers.
Lesson 12: Comfort, Air Conditioning, and Air Distribution
- Variations in Comfort Levels; Psychrometric Charts; Dry-Bulb and Wet-Bulb, Total Heat, and Other Heat Transfers Topics; Equipment and Systems for Air Distribution and Control.
Lesson 13: Controls, Operating Conditions, and Troubleshooting
- Function and Placement of Various Air Conditioning Control Devices; Residential Air Conditioning Systems; Old and New Control Systems; Effects of Relative Humidity on Air Conditioning Systems; Various Grades of Equipment; Tools and Instruments Needed to Troubleshoot an Air Conditioning System.
Lesson 14: All-Weather Systems
- Year-Round Air Conditioning; Calculate Airflow in Ductwork; Various Types of All-Weather Systems; Reverse-Cycle Refrigeration; Types of Heat Pumps and Their Troubleshooting Procedures; Operating Principles of Geothermal Heat Pumps.
Part 5 (L14003). Chilled Water Systems and Domestic Appliances

Lesson 15: Domestic Appliances

• Characteristics, Components, and Operation of a Refrigerator; Operation of an Ice Maker; Types of Defrost Systems; Freezer Types and Components; Procedures for Safely Moving and Servicing Freezers; Characteristics and Types of Room Air Conditioning Units; Installation Procedures for Air Conditioning Units; Components, Operation, Functions and Servicing of Air Conditioning Systems.

Lesson 16: Chilled-Water Cooling Systems

• Types, Characteristics, and Components of Chilled-Water Air Conditioning Systems; Operation and Function of Chilled-Water System Components; Preventive Maintenance, Troubleshooting Techniques, and Servicing Procedures for Chilled-Water Cooling Systems.

Special Notes:

• This updated course replaces Modern Refrigeration and Air Conditioning, course A14003. Call Customer Service for pricing and serial numbers if you need to order study guide(s) with or without the textbook.

• This course consists of a textbook and five supplemental study guides. We recommend the course be purchased in its entirety. However, if needed due to targeted training, study guides (Parts 2-5) can be purchased separately, with or without the textbook. Note that the textbook is required for the Part 1 study guide. Call your Training Consultant of Customer Service for pricing and ordering information.
Basic Machine Shop Skills
  Grinding
  Lathes
  Metal Cutting
  Milling
  NC/CNC
  Polymers
Statistical Process and Quality Control
Tool and Die Making
Welding
<table>
<thead>
<tr>
<th>Basic Machine Shop Skills</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Machining Skills (Block X08)</td>
<td>248</td>
</tr>
<tr>
<td>Bench Work (5004A-C)</td>
<td>241</td>
</tr>
<tr>
<td>Energy, Force, and Power (186024)</td>
<td>57</td>
</tr>
<tr>
<td>Geometric Dimensioning and Tolerancing (386E01)</td>
<td>240</td>
</tr>
<tr>
<td>Hand and Power Tools (Block X24)</td>
<td>57</td>
</tr>
<tr>
<td>Industrial Materials and Components (Block X06)</td>
<td>246</td>
</tr>
<tr>
<td>Inspection of Shop Products (5962)</td>
<td>243</td>
</tr>
<tr>
<td>Jobs, Companies, and the Economy: Basic Concepts for Employees (186034)</td>
<td>45</td>
</tr>
<tr>
<td>Machine Shop Safety (186007)</td>
<td>71</td>
</tr>
<tr>
<td>Manufacturing Processes (186075-78)</td>
<td>230</td>
</tr>
<tr>
<td>Nontraditional Machine Technologies (386029)</td>
<td>237</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 1 (186068)</td>
<td>230</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 2 (186069)</td>
<td>230</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 3 (186072)</td>
<td>230</td>
</tr>
<tr>
<td>Quality Concepts: Tools and Applications (186036)</td>
<td>45</td>
</tr>
<tr>
<td>Reading Shop Prints (386043, 386044)</td>
<td>239</td>
</tr>
<tr>
<td>Toolholding Systems (386028)</td>
<td>236</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grinding</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylindrical Grinding, Part 1 (386010)</td>
<td>236</td>
</tr>
<tr>
<td>Cylindrical Grinding, Part 2 (386011)</td>
<td>236</td>
</tr>
<tr>
<td>Fundamentals of Grinding (386016)</td>
<td>236</td>
</tr>
<tr>
<td>Surface Grinding, Part 1 (386012)</td>
<td>236</td>
</tr>
<tr>
<td>Surface Grinding, Part 2 (386013)</td>
<td>236</td>
</tr>
<tr>
<td>Tool Grinding (386017)</td>
<td>236</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lathes</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic Screw Machines (3530A-B)</td>
<td>235</td>
</tr>
<tr>
<td>CNC Turning (386041)</td>
<td>238</td>
</tr>
<tr>
<td>Lathes, Part 1 (386036)</td>
<td>238</td>
</tr>
<tr>
<td>Lathes, Part 2 (386037)</td>
<td>238</td>
</tr>
<tr>
<td>Lathes, Part 3 (386038)</td>
<td>238</td>
</tr>
<tr>
<td>Lathes, Part 4 (386039)</td>
<td>238</td>
</tr>
<tr>
<td>Lathes, Part 5 (386040)</td>
<td>238</td>
</tr>
<tr>
<td>Turret Lathe Tools and Setups (2213)</td>
<td>231</td>
</tr>
<tr>
<td>Turret Lathes (3525A)</td>
<td>235</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metal Cutting</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broaching (6091)</td>
<td>243</td>
</tr>
<tr>
<td>Drilling (3521A-B)</td>
<td>235</td>
</tr>
<tr>
<td>Common Thermal Cutting Processes (286028)</td>
<td>232</td>
</tr>
<tr>
<td>Fundamentals of Metal Cutting (386030)</td>
<td>237</td>
</tr>
<tr>
<td>Gas Cutting (6275A-B)</td>
<td>244</td>
</tr>
<tr>
<td>Jig and Fixture Making (5100)</td>
<td>242</td>
</tr>
<tr>
<td>Jig and Fixture Making, Part 2 (386049)</td>
<td>239</td>
</tr>
<tr>
<td>Jigs and Fixtures (5099)</td>
<td>241</td>
</tr>
<tr>
<td>Layout (3501)</td>
<td>234</td>
</tr>
<tr>
<td>Pattern Making (6427A-F)</td>
<td>245</td>
</tr>
<tr>
<td>Shapers, Slotters, and Keyseaters (2222)</td>
<td>231</td>
</tr>
<tr>
<td>Sheet Metal Basics (186049)</td>
<td>6.1</td>
</tr>
<tr>
<td>Sheet Metal Hand Processes (6712A-B)</td>
<td>245</td>
</tr>
<tr>
<td>Sheet Metal Machine Processes (6716)</td>
<td>245</td>
</tr>
<tr>
<td>Sheet Metal Work (2176)</td>
<td>231</td>
</tr>
</tbody>
</table>

| Tool Dressing (3194) | 234 |

<table>
<thead>
<tr>
<th>Milling</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boring Mills (5636A)</td>
<td>243</td>
</tr>
<tr>
<td>CNC Milling (386042)</td>
<td>239</td>
</tr>
<tr>
<td>Milling Machine Cutting Tools (386032)</td>
<td>237</td>
</tr>
<tr>
<td>Milling Machine Fundamentals (386031)</td>
<td>237</td>
</tr>
<tr>
<td>Milling Machine Indexing and Spiral Work (386035)</td>
<td>238</td>
</tr>
<tr>
<td>Milling Machine Practice and Operation, Part 1 (386033)</td>
<td>237</td>
</tr>
<tr>
<td>Milling Machine Practice and Operation, Part 2 (386034)</td>
<td>237</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NC/CNC</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNC Milling (386042)</td>
<td>239</td>
</tr>
<tr>
<td>CNC Technology and Programming (066903)</td>
<td>239</td>
</tr>
<tr>
<td>CNC Turning (386041)</td>
<td>238</td>
</tr>
<tr>
<td>Nontraditional Machine Technologies (386029)</td>
<td>237</td>
</tr>
<tr>
<td>Numerical Control for Machining (5041)</td>
<td>241</td>
</tr>
<tr>
<td>Numerical Control Milling and Drilling (5042)</td>
<td>241</td>
</tr>
<tr>
<td>Numerical Control Turning (5043)</td>
<td>241</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Polymers</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Plastics: Materials, Properties and Manufacturing (686E1)</td>
<td>246</td>
</tr>
<tr>
<td>Plastic Adhesives and Coatings (5001)</td>
<td>240</td>
</tr>
<tr>
<td>Plastics: Films, Sheets, Foams, and Laminates (5002)</td>
<td>240</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Statistical Process and Quality Control</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality Concepts: Tools and Applications (186036)</td>
<td>45</td>
</tr>
<tr>
<td>Quality Concepts: Terminology for Management (186035)</td>
<td>45</td>
</tr>
<tr>
<td>Quality Control for the Technician (386E02)</td>
<td>240</td>
</tr>
<tr>
<td>Quality Control of Manufactured Products (2590)</td>
<td>232</td>
</tr>
<tr>
<td>Statistical Quality Control (2521A-E)</td>
<td>232</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tool and Die Making</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dies and Die Making (5101A-B)</td>
<td>242</td>
</tr>
<tr>
<td>Dies and Die Making, Part 3 (386048)</td>
<td>239</td>
</tr>
<tr>
<td>Forging Dies (3199)</td>
<td>234</td>
</tr>
<tr>
<td>Fundamentals of Tool Design (386E04)</td>
<td>235</td>
</tr>
<tr>
<td>Gage Making (5098)</td>
<td>241</td>
</tr>
<tr>
<td>Gear Making (5532A-B)</td>
<td>243</td>
</tr>
<tr>
<td>Hardening and Tempering (3195)</td>
<td>234</td>
</tr>
<tr>
<td>Heat Treatment (3541A-D)</td>
<td>235</td>
</tr>
<tr>
<td>Jigs and Fixtures (5099)</td>
<td>241</td>
</tr>
<tr>
<td>Jigs and Fixture Making (5100)</td>
<td>242</td>
</tr>
<tr>
<td>Jigs and Fixture Making, Part 2 (386049)</td>
<td>239</td>
</tr>
<tr>
<td>Making Forging Dies (3197)</td>
<td>234</td>
</tr>
<tr>
<td>Nondestructive Testing of Castings (5961)</td>
<td>243</td>
</tr>
<tr>
<td>Toolholding Systems (386028)</td>
<td>236</td>
</tr>
<tr>
<td>Toolmaking (2540A-C)</td>
<td>232</td>
</tr>
<tr>
<td>Toolmaking, Part 4 (386049)</td>
<td>239</td>
</tr>
<tr>
<td>Transfer Devices for Machine Tools (6569A-B)</td>
<td>245</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Welding</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arc Welding Equipment, Part 1 (286032)</td>
<td>233</td>
</tr>
<tr>
<td>Arc Welding Equipment, Part 2 (286033)</td>
<td>233</td>
</tr>
<tr>
<td>Arc Welding Equipment, Part 3 (286053)</td>
<td>233</td>
</tr>
<tr>
<td>Topic</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Arc Welding of Alloy Steels and Iron (5250)</td>
<td>243</td>
</tr>
<tr>
<td>Arc Welding of Low Carbon Steel (5249A-B)</td>
<td>242</td>
</tr>
<tr>
<td>Arc Welding of Nonferrous Metals and Overlaying (5251)</td>
<td>243</td>
</tr>
<tr>
<td>Common Thermal Cutting Processes (286028)</td>
<td>232</td>
</tr>
<tr>
<td>Fabrication of Pipe by Welding (6278A-B)</td>
<td>245</td>
</tr>
<tr>
<td>Fundamentals of Welding, Part 1 (286025)</td>
<td>232</td>
</tr>
<tr>
<td>Fundamentals of Welding, Part 2 (286066)</td>
<td>234</td>
</tr>
<tr>
<td>Gas Metal Arc Welding Fundamentals</td>
<td>234</td>
</tr>
<tr>
<td>(GMAW or Mig) (286059)</td>
<td></td>
</tr>
<tr>
<td>Gas Tungsten Arc Welding Fundamentals</td>
<td>233</td>
</tr>
<tr>
<td>(GTAW or Tig) (286035)</td>
<td></td>
</tr>
<tr>
<td>Gas Welding Equipment (6272A-B)</td>
<td>244</td>
</tr>
<tr>
<td>Gas Welding Techniques (6276A-C)</td>
<td>244</td>
</tr>
<tr>
<td>Inspection and Testing of Welds (5160)</td>
<td>242</td>
</tr>
<tr>
<td>Practical Metallurgy for Welders (6152A-B)</td>
<td>244</td>
</tr>
<tr>
<td>Safe Handling of Pressurized Gasses and Welding (186004)</td>
<td>71</td>
</tr>
<tr>
<td>Safety in Welding and Cutting (6154)</td>
<td>244</td>
</tr>
<tr>
<td>Shielded Metal Arc Welding Techniques, Part 1 (286030)</td>
<td>233</td>
</tr>
<tr>
<td>Shielded Metal Arc Welding Techniques, Part 2 (286031)</td>
<td>233</td>
</tr>
<tr>
<td>Welding Symbols (186048)</td>
<td>60</td>
</tr>
</tbody>
</table>
Recommended Career/Apprentice Curricula

- Machinist/Machinist Apprentice
- Tool and Die Maker/Tool and Die Maker Apprentice
- Plastics Process Technician
- Welder/Welder Apprentice
- Pattern Maker Apprentice

Recommended Topical Programs

- Basic Metal Cutting Specialist
- Operator of Milling Machines, Lathes, Grinding Machines, and NC/CNC Equipment
- Industrial Maintenance Welder
- Industrial Distributor: Knowledge and Skills Training
Machine Technologies
Curricula

Machinist/
Machinist Apprentice

The Machinist Apprentice curriculum provides apprentices with the study materials that enables them to perform the tasks associated with this trade. It is appropriate for trainees who need a complete understanding of the machine shop.

The program has been designed to meet the subject requirements set forth in the standards established by the Bureau of Apprenticeship and Training (BAT). When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

Upon completion of this program, students will be able to:

- Read a shop drawing.
- Select the proper metal alloy.
- Work with basic mathematics, algebra, geometry, and trigonometry.
- Calculate the proper speeds and feeds for different materials.
- Describe the sequence of operations to complete a job.
- Discuss the hardening and tempering of steel.
- Describe the setup and operation of standard machine tools such as the lathe, grinder, milling machine, and drill press; also broaches, boring mills, and planers.
- Select the proper speeds and feeds for cutting metal.
- Explain the various shapes of cutting tools.
- Discuss the setup and operation of numerically controlled machine tools.

Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Technical and Basic Industrial Skills</strong></td>
<td></td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>186006</td>
</tr>
<tr>
<td>Block X21</td>
<td></td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
<tr>
<td>Applied Geometry</td>
<td>X0211</td>
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<tr>
<td>Practical Trigonometry</td>
<td>X0212</td>
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<tr>
<td>Print Reading Symbols and Applications</td>
<td>186081</td>
</tr>
<tr>
<td>Dimensioning and Tolerancing</td>
<td>186082</td>
</tr>
<tr>
<td>Reading Shop Prints, Part 1</td>
<td>386043</td>
</tr>
<tr>
<td>Reading Shop Prints, Part 2</td>
<td>386044</td>
</tr>
</tbody>
</table>

Geometric Dimensioning and Tolerancing | 386E01 |
Bench Work | 5004A-C |
Precision Measuring Instruments, Part 1 | 186068 |
Precision Measuring Instruments, Part 2 | 186069 |
Precision Measuring Instruments, Part 3 | 186072 |
Jobs, Companies, and the Economy: Basic Concepts for Employees | 186034 |
Quality Concepts: Tools and Applications | 186036 |

**Machining, Metal Working, and NC/CNC**

Fundamentals of Metal Cutting | 386030 |
Machine Shop Safety | 186007 |
Metal Processing | X0601 |
Ferrous Metals | X0602 |
Nonferrous Metals | X0603 |
Identification of Metals | X0604 |
Layout | 3501 |
Drilling | 3521A-B |
Lubrication, Part 1 | 286091 |
Lubrication, Part 2 | 286092 |
Fasteners | 286095 |
Milling Machine Fundamentals | 386031 |
Milling Machine Cutting Tools | 386032 |
Milling Machine Practice and Operation, Part 1 | 386033 |
Milling Machine Practice and Operation, Part 2 | 386034 |
Milling Machine Indexing and Spiral Work | 386035 |
Lathes, Part 1 | 386036 |
Lathes, Part 2 | 386037 |
Lathes, Part 3 | 386038 |
Lathes, Part 4 | 386039 |
Lathes, Part 5 | 386040 |
Automatic Screw Machines | 3530A-B |
Turret Lathes | 3525A |
Turret Lathe Tools and Setsups | 2213 |
Fundamentals of Grinding | 386016 |
Cylindrical Grinding, Part 1 | 386010 |
Cylindrical Grinding, Part 2 | 386011 |
Surface Grinding, Part 1 | 386012 |
Surface Grinding, Part 2 | 386013 |
Inspection of Shop Products | 5962 |
Quality Control for the Technician | 386E02 |
Boring Mills | 5636A |
Planers | 6118 |
Broaching | 6091 |
Shapers, Slotters, and Keyseaters | 2222 |
Nontraditional Machining Technologies | 386029 |
Hardening and Tempering | 3195 |
Tool Grinding | 386017 |
Tool Dressing | 3194 |
Gear Calculations | 2243 |
Gear Making | 5532A-B |
Manufacturing Processes, Part 1 | 186075 |
Manufacturing Processes, Part 2 | 186076 |
Manufacturing Processes, Part 3 | 186077 |
Manufacturing Processes, Part 4 | 186078 |
CNC Technology and Programming | 066903 |
Estimated Curriculum Duration: 773 hours.
Number of Exams: 87.

Optional: Tool and Die Maker Skills
Mechanics of Materials ......................................................5282A-C
Heat Treatment ................................................................3541A-D
Dies and Die Making ......................................................5101A-B
Dies and Die Making, Part 3 ............................................386048
Forging Dies ......................................................................3199
Making Forging Dies .......................................................3197
Toolmaking .................................................................2540A-C
Toolmaking, Part 4 ........................................................386047
Gage Making ......................................................................5098
Jigs and Fixtures ............................................................5099
Jig and Fixture Making ......................................................5100
Jig and Fixture Making, Part 2 .........................................386049

Estimated Duration: 200 hours.
Number of Exams: 20.

Tool and Die Maker/Tool and Die Maker Apprentice

The Tool and Die Maker Apprentice curriculum provides apprentices with the study materials that enable them to perform the tasks associated with this trade. The program has been designed to meet the subject requirements set forth in the standards established by the Bureau of Apprenticeship and Training (BAT). When combined with on-the-job training, the program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

Upon completion of this program, students will be able to:

- Read working drawings.
- Identify different types of cutting tools.
- Explain the function of forming dies.
- Select the proper machine tool for a job.
- Explain how to recognize steel alloys.
- Explain the use of a fixture.
- Explain the function of forging dies.
- Describe a layout procedure.
- Discuss the hardening and tempering of steels.
- Explain the various uses of a jig.
- Discuss the use of drill bushings.
- Explain how to lay out a casting.
- Describe various press operations.

Base Curriculum

Course Title | Course Number
---|---

Pre-Technical and Basic Industrial Skills

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186023</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
</tr>
<tr>
<td>Fluid Measurement</td>
<td>186025</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
<tr>
<td>Material Handling Safety</td>
<td>186006</td>
</tr>
<tr>
<td>Jobs, Companies, and the Economy: Basic Concepts for Employees</td>
<td>186034</td>
</tr>
<tr>
<td>Manufacturing Processes, Part 1</td>
<td>186075</td>
</tr>
<tr>
<td>Introduction to Print Reading</td>
<td>186080</td>
</tr>
<tr>
<td>Print Reading Symbols and Abbreviations</td>
<td>186081</td>
</tr>
<tr>
<td>Dimensioning and Tolerancing</td>
<td>186082</td>
</tr>
<tr>
<td>Reading Shop Prints, Part 1</td>
<td>386043</td>
</tr>
<tr>
<td>Reading Shop Prints, Part 2</td>
<td>386044</td>
</tr>
<tr>
<td>Hand and Power Tools</td>
<td>Block X24</td>
</tr>
<tr>
<td>Common Hand Tools, Part 1</td>
<td>186052</td>
</tr>
<tr>
<td>Common Hand Tools, Part 2</td>
<td>186053</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 1</td>
<td>186068</td>
</tr>
<tr>
<td>Electric Drilling and Grinding Tools</td>
<td>186054</td>
</tr>
<tr>
<td>Power Cutting Tools</td>
<td>186055</td>
</tr>
<tr>
<td>Pneumatic Hand Tools</td>
<td>186056</td>
</tr>
<tr>
<td>Plumbing and Pipefitting Tools</td>
<td>286042</td>
</tr>
<tr>
<td>Electricians’ Tools</td>
<td>006026</td>
</tr>
<tr>
<td>Tool Grinding and Sharpening</td>
<td>186057</td>
</tr>
<tr>
<td>Woodworking Hand Tools</td>
<td>186058</td>
</tr>
<tr>
<td>Routers, Power Planers, and Sanders</td>
<td>186059</td>
</tr>
<tr>
<td>Jacks, Hoists, and Pullers</td>
<td>186060</td>
</tr>
<tr>
<td>Bench Work, Part 3</td>
<td>5004C</td>
</tr>
<tr>
<td>Fasteners</td>
<td>286095</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 2</td>
<td>186069</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 3</td>
<td>186072</td>
</tr>
<tr>
<td>Basic Machining Skills</td>
<td>Block X08</td>
</tr>
<tr>
<td>Practical Shop Math, Part 1</td>
<td>X0801</td>
</tr>
<tr>
<td>Practical Shop Math, Part 2</td>
<td>X0802</td>
</tr>
<tr>
<td>Practical Shop Measurement</td>
<td>X0803</td>
</tr>
<tr>
<td>Safe Shop Practices</td>
<td>X0804</td>
</tr>
<tr>
<td>Properties and Classifications of Metals</td>
<td>X0805</td>
</tr>
<tr>
<td>Using Shop Drawings, Process, and Routing Sheets, Part 1</td>
<td>X0806</td>
</tr>
<tr>
<td>Using Shop Drawings, Process, and Routing Sheets, Part 2</td>
<td>X0807</td>
</tr>
<tr>
<td>Layout</td>
<td>X0808</td>
</tr>
<tr>
<td>Metal Cutting and Machine Tooling, Part 1</td>
<td>X0809</td>
</tr>
<tr>
<td>Metal Cutting and Machine Tooling, Part 2</td>
<td>X0810</td>
</tr>
<tr>
<td>Metal Cutting Machinery, Part 1</td>
<td>X0811</td>
</tr>
</tbody>
</table>
Tool and Die Making

- Fundamentals of Metal Cutting .............................................. 386030
- Drilling .............................................................................. 3521A-B
- Metal Processing .............................................................. X0601
- Ferrous Metals .................................................................... X0602
- Nonferrous Metals ............................................................ X0603
- Identification of Metals ...................................................... X0604
- Lubrication, Part 1 ............................................................. 286091
- Lubrication, Part 2 ............................................................. 286092
- Applied Geometry ............................................................ X0211
- Practical Trigonometry ........................................................ X0212
- Layout ................................................................................ 3501
- Milling Machine Fundamentals .......................................... 386031
- Milling Machine Cutting Tools ........................................... 386032
- Milling Machine Practice and Operation, Part 1 .................. 386033
- Milling Machine Practice and Operation, Part 2 ................. 386034
- Milling Machine Indexing and Spiral Work ......................... 386035
- Lathes, Part 1 ................................................................. 386036
- Lathes, Part 2 ..................................................................... 386037
- Lathes, Part 3 ..................................................................... 386038
- Lathes, Part 4 ..................................................................... 386039
- Lathes, Part 5 ..................................................................... 386040
- Fundamentals of Grinding .................................................. 386016
- Cylindrical Grinding, Part 1 ................................................. 386010
- Cylindrical Grinding, Part 2 ................................................. 386011
- Surface Grinding, Part 1 ..................................................... 386012
- Surface Grinding, Part 2 ..................................................... 386013
- Nontraditional Machining Technologies ......................... 386029
- Hardening and Tempering .................................................. 3195
- Tool Grinding ..................................................................... 386017
- Geometric Dimensioning and Tolerancing ......................... 386E01
- Quality Concepts: Tools and Applications ........................ 186036
- Quality Control for the Technician ...................................... 386E02
- CNC Technology and Programming ................................. 066903
- CNC Turning ................................................................. 386041
- CNC Milling ...................................................................... 386042
- Toolholding Systems ......................................................... 386028
- Machine Sketching ........................................................... 5807
- Metallurgy of Iron ............................................................ 5110
- Metallurgy of Nonferrous Metals ...................................... 5337
- Metallurgy of Steel .......................................................... 5111
- Metallography .................................................................. 5338A-B
- Heat Treatment .................................................................. 3541A-D
- Toolmaking ........................................................................ 2540A-C
- Toolmaking, Part 4 ............................................................ 386047
- Gage Making ...................................................................... 5098
- Jigs and Fixtures .............................................................. 5099
- Jig and Fixture Making ....................................................... 5100
- Jig and Fixture Making, Part 2 ........................................... 386049
- Dies and Die Making ......................................................... 5101A-B
- Dies and Die Making, Part 3 .............................................. 386048
- Making Forging Dies ........................................................ 3197
- Forging Dies ...................................................................... 3199
- Manufacturing Processes, Part 1 ...................................... 186075
- Manufacturing Processes, Part 2 ...................................... 186076
- Manufacturing Processes, Part 3 ...................................... 186077
- Manufacturing Processes, Part 4 ...................................... 186078

Estimated Curriculum Duration: 972 hours
Number of Exams: 110.

Optional Drawings:

- Drafting Kit ....................................................................... 1200M
- Elementary Mechanical Drawing (includes 8 plates) .......... 5434

Estimated Duration: 130 hours.

Plastics Process Technician

The Plastics Process Technician Apprentice curricula provides apprentices with the study materials that enable them to perform the tasks associated with this trade. This program has been designed to meet the subject requirements set forth in the standards established by the Bureau of Apprenticeship and Training (BAT). When combined with on-the-job training, these programs provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

Upon completion of this program, students will be able to:

- Discuss and explain the processes in making plastic parts.
- Be able to use applied mathematics.
- Be familiar with basic electrical concepts, especially as applied to the industrial environment.
- Understand the concepts and principles of hydraulic and pneumatic components and circuits.
- Read and understand blueprints.
- Explain the principles of Statistical Process Control.
- Explain the concepts of industrial robotics theory and operation.
- Explain and understand the principles of injection mold construction and operation.
- Understand the testing procedures used in determining the physical properties of materials.
- Understand common safety practices.
- Understand the concepts of heat and heat transfer.
- Explain and understand the use of common instrumentation to measure temperature and pressure.

Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Technical Foundation Skills</td>
<td></td>
</tr>
<tr>
<td>Jobs, Companies, and the Economy: Basic Concepts for Employees</td>
<td>186034</td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
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<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
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<td>186001</td>
</tr>
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<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
<tr>
<td>Material Handling Safety</td>
<td>186006</td>
</tr>
</tbody>
</table>
Introduction to Print Reading.................................................................186080
Print Reading Symbols and Abbreviations ........................................186081
Dimensioning and Tolerancing...........................................................186082
Print Reading Applications.................................................................186083
Electrical Drawings and Circuits .......................................................186044
Electronic Drawings ..........................................................................186045
Hydraulic and Pneumatic Drawings ..................................................186046
Piping: Drawings, Materials, and Parts .............................................186047
Sketching ............................................................................................186050
Preventive Maintenance ....................................................................286085
Preventive Maintenance Techniques .................................................286086

Chemistry and Plastics Concepts
Elements of Chemistry .......................................................................5011
Basic Organic Chemistry ....................................................................5017A-B
Industrial Plastics: Materials, Properties and Manufacturing ..........686E1

Electrical Maintenance
Working Safely with Electricity ............................................................4400
DC Principles .......................................................................................Block A21
Alternating Current .............................................................................086006
Alternating Current Circuits ...............................................................086008
Inductors in AC Circuits ......................................................................086009
Capacitors in AC Circuits ......................................................................086010
Transformers .......................................................................................086011
Alternators ...........................................................................................086012
Electrical Energy Distribution .............................................................086013
Rectification and Basic Electronic Devices .......................................086014
Experiments with Basic AC Theory – Lab Manual .........................086087
AC Principles .......................................................................................Block A22
Basic Test Equipment ..........................................................................086025
Troubleshooting with Volt-Ohm-Milliamp Meters (VOMs) ..............086026
Using Basic Oscilloscopes ...................................................................086027
Experiments in Electrical Measurements – Lab Manual .................086089
Electrical Safety for the Trades ............................................................186005

Mechanical Maintenance
Bench Work ..........................................................................................5004A-C
Mechanical Testing of Materials ..........................................................2608A-B
Materials Handling................................................................................2512
Quality Concepts: Tools and Applications .........................................186036
Introduction to ISO 9000: ISO for the Technician ..............................186037
Quality Control for the Technician .......................................................386E02
Quality Control of Manufactured Products ...........................................2590
Heat, Part 1 .........................................................................................086001
Heat, Part 2 .........................................................................................086002
Heat Transfer ........................................................................................2545
Precision Measuring Instruments, Part 1 ............................................186068
Precision Measuring Instruments, Part 2 ............................................186069
Precision Measuring Instruments, Part 3 ............................................186072
Pneumatic Instrumentation for the Technician .....................................286M01
Control Technology for Technicians ....................................................286M04
Distributed Control Systems, Part 1 ....................................................086084
Distributed Control Systems, Part 2 ....................................................086085
Distributed Control Systems, Part 3 ....................................................086086

Principles of Automatic Process Control Instruments .......................6309A-B
Temperature Measuring and Control Instruments ..........................6309A-B
Process Pressure Measuring and Control Instruments ......................6309A-B
Pneumatics, Part 1 .............................................................................286098
Pneumatics, Part 2 .............................................................................286099
Pneumatics, Part 3 .............................................................................286100
Air Compressors, Part 1 .......................................................................286096
Air Compressors, Part 2 .......................................................................286097
Hydraulic Power Basics .....................................................................286060
Hydraulic Components: Actuators, Pumps, and Motors .................286061
Hydraulic Components: Conductors, Conditioners, and Fluids ..........286062
Hydraulic Power System Control .......................................................286063
Interpreting Hydraulic System Schematics .......................................286064
Hydraulic Power System Troubleshooting .........................................286065
Industrial Robotics: Technology, Programming, and Applications ........066902
Predictive Maintenance ....................................................................286072
Predictive Maintenance: Vibration Analysis .....................................286088
Predictive Maintenance: Advanced Topics .......................................286089

Estimated Curriculum Duration: 892 hours
(excluding optional lab experiments).
Number of Exams: 122.

Optional Laboratory Experiment:
Measurements Trainer ......................................................................XK-100

Welder/Welder Apprentice

The Welder Apprentice curriculum provides apprentices with the study materials that enable them to perform the tasks associated with this trade. The program has been designed to meet the subject requirements set forth in the standards established by the Bureau of Apprenticeship and Training (BAT). Since welding skills can only be perfected through practice, trainees should have access to both gas and arc welding equipment. When combined with on-the-job training, the program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

Upon completion of this program, students will be able to:

- Describe the electrode color system.
- Select the proper tip for gas welding.
- Read basic welding prints.
- Explain the start up procedure for arc welding.
- Describe the various uses of Gas Tungsten Arc Welding.
- Discuss the use of Gas Metal Arc Welding.
- Select the proper shielding gases for welding.
- Describe the procedures for the inspection of welds.
- Discuss the procedures for nondestructive testing of welds.
- Select the proper filler metal for a particular job.
## Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Technical and Basic Industrial Skills</strong></td>
<td></td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186023</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
</tr>
<tr>
<td>Fluid Measurement</td>
<td>186025</td>
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<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
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<td>Material Handling Safety</td>
<td>186006</td>
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<tr>
<td>Working Safely with Electricity</td>
<td>4400</td>
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<tr>
<td>Jobs, Companies, and the Economy: Basic Concepts for Employees</td>
<td>186034</td>
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<td>Quality Concepts: Tools and Applications</td>
<td>186036</td>
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<td>Reading Prints and Schematics</td>
<td>Block X25</td>
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<tr>
<td>Introduction to Print Reading</td>
<td>186080</td>
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<td>Print Reading Symbols and Abbreviations</td>
<td>186081</td>
</tr>
<tr>
<td>Dimensioning and Tolerancing and Symbols</td>
<td>186082</td>
</tr>
<tr>
<td>Print Reading Applications</td>
<td>186083</td>
</tr>
<tr>
<td>Building Drawings</td>
<td>186043</td>
</tr>
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<td>Electrical Drawings and Circuits</td>
<td>186044</td>
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<tr>
<td>Electronic Drawings</td>
<td>186045</td>
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<td>Hydraulic and Pneumatic Drawings</td>
<td>186046</td>
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<td>Piping: Drawings, Materials, and Parts</td>
<td>186047</td>
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<td>Welding Symbols</td>
<td>186048</td>
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<td>Sketching</td>
<td>186050</td>
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<td>Reading Shop Prints, Part 1</td>
<td>386043</td>
</tr>
<tr>
<td>Reading Shop Prints, Part 2</td>
<td>386044</td>
</tr>
<tr>
<td>Hand and Power Tools</td>
<td>Block X24</td>
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<tr>
<td>Common Hand Tools, Part 1</td>
<td>186052</td>
</tr>
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<td>Precision Measuring Instruments, Part 1</td>
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<td>186054</td>
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<tr>
<td>Power Cutting Tools</td>
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<td>286042</td>
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<td>Routers, Power Planers, and Sanders</td>
<td>186059</td>
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<tr>
<td>Jacks, Hoists, and Pullers</td>
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<td>Bench Work, Part 3</td>
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<td>Fundamentals of Welding, Part 2</td>
<td>286066</td>
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<tr>
<td>Safe Handling of Pressurized Gasses and Welding</td>
<td>186004</td>
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<tr>
<td>Gas Welding Equipment</td>
<td>6272A-B</td>
</tr>
<tr>
<td>Gas Welding Techniques</td>
<td>6276A-C</td>
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<tr>
<td>Common Thermal Cutting Processes</td>
<td>286028</td>
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<td>DC Principles</td>
<td>Block A21</td>
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<td>Nature of Electricity</td>
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<td>Circuit Analysis and Ohm’s Law</td>
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<tr>
<td>Capacitors and Inductors</td>
<td>086003</td>
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<tr>
<td>Magnetism and Electromagnetism</td>
<td>086004</td>
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<tr>
<td>Conductors, Insulators, and Batteries</td>
<td>086005</td>
</tr>
<tr>
<td>DC Motors and Generator Theory</td>
<td>086006</td>
</tr>
<tr>
<td>AC Principles</td>
<td>Block A22</td>
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<tr>
<td>Alternating Current</td>
<td>086007</td>
</tr>
<tr>
<td>Alternating Current Circuits</td>
<td>086008</td>
</tr>
<tr>
<td>Inductors in AC Circuits</td>
<td>086009</td>
</tr>
<tr>
<td>Capacitors in AC Circuits</td>
<td>086010</td>
</tr>
<tr>
<td>Transformers</td>
<td>086011</td>
</tr>
<tr>
<td>Alternators</td>
<td>086012</td>
</tr>
<tr>
<td>Electrical Energy Distribution</td>
<td>086013</td>
</tr>
<tr>
<td>Rectification and Basic Electronic Devices</td>
<td>086014</td>
</tr>
<tr>
<td>Basic Test Equipment</td>
<td>086025</td>
</tr>
<tr>
<td>Troubleshooting with Volt-Ohm-Milliamp Meters (VOMs)</td>
<td>086026</td>
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<td>Electrical Safety for the Trades</td>
<td>186005</td>
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<tr>
<td>Arc Welding Equipment, Part 1</td>
<td>286032</td>
</tr>
<tr>
<td>Arc Welding Equipment, Part 2</td>
<td>286033</td>
</tr>
<tr>
<td>Arc Welding Equipment, Part 3</td>
<td>286053</td>
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<td>Shielded Metal Arc Welding Techniques, Part 1</td>
<td>286030</td>
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<tr>
<td>Shielded Metal Arc Welding Techniques, Part 2</td>
<td>286031</td>
</tr>
<tr>
<td>Gas Metal Arc Welding Fundamentals (GMAW or Mig)</td>
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</tr>
<tr>
<td>Gas Tungsten Arc Welding Fundamentals (GTAW or Tig)</td>
<td>286035</td>
</tr>
<tr>
<td>Practical Metallurgy for Welders</td>
<td>6152A-B</td>
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<tr>
<td>Arc Welding of Low Carbon Steel</td>
<td>5249A-B</td>
</tr>
<tr>
<td>Arc Welding of Alloy Steels and Iron</td>
<td>5250</td>
</tr>
<tr>
<td>Arc Welding of Nonferrous Metals and Overlaying</td>
<td>5251</td>
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<tr>
<td>Fabrication of Pipe by Welding</td>
<td>6278A-B</td>
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<td>Inspection and Testing of Welds</td>
<td>5160</td>
</tr>
</tbody>
</table>

Estimated Curriculum Duration: 645 hours (excluding videos).
Number of Exams: 92
Pattern Maker Apprentice

The Pattern Maker Apprentice curricula provides apprentices with the study materials required to enable them to perform the tasks associated with this trade. It is appropriate for trainees who need a complete understanding of the metal cutting process and the equipment used to cut metal.

The program has been designed to meet the subject requirements set forth in the standards established by the Bureau of Apprenticeship and Training (BAT). When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

Upon completion of this program, students will be able to:

- Read a shop drawing.
- Select the proper metal alloy.
- Learn to use the hand and power tools commonly found in a machine shop.
- Draw the design and cut the various patterns, coreboxes, and shapes used in metal working.
- Select the proper speeds and feeds for cutting metal.
- Describe the setup and operation of standard machine tools such as the lathe, milling machine, and drill press.
- Discuss the setup and operation of numerically controlled machine tools.

### Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Technical and Basic Industrial Skills</strong></td>
<td></td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
<tr>
<td>Material Handling Safety</td>
<td>186006</td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
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<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
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<tr>
<td>Applied Geometry</td>
<td>X0211</td>
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<tr>
<td>Practical Trigonometry</td>
<td>X0212</td>
</tr>
<tr>
<td>Introduction to Print Reading</td>
<td>186080</td>
</tr>
<tr>
<td>Print Reading Symbols and Abbreviations</td>
<td>186081</td>
</tr>
<tr>
<td>Dimensioning and Tolerancing</td>
<td>186082</td>
</tr>
<tr>
<td>Reading Shop Prints, Part 1</td>
<td>386043</td>
</tr>
<tr>
<td>Reading Shop Prints, Part 2</td>
<td>386044</td>
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<tr>
<td>Geometric Dimensioning and Tolerancing</td>
<td>386E01</td>
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<tr>
<td>Jobs, Companies, and the Economy: Basic Concepts for Employees</td>
<td>186034</td>
</tr>
<tr>
<td>Quality Concepts: Tools and Applications</td>
<td>186036</td>
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</tbody>
</table>

### Wood and Metal Working Principles and Tools

| Layout .................................................................. | 3501          |
| Hand and Power Tools ....................................... | Block X24     |
| Common Hand Tools, Part 1                          | 186052        |
| Common Hand Tools, Part 2                          | 186053        |
| Precision Measuring Instruments, Part 1            | 186068        |
| Electric Drilling and Grinding Tools               | 186054        |
| Power Cutting Tools                                 | 186055        |
| Pneumatic Hand Tools                                | 186056        |
| Plumbing and Pipefitting Tools                     | 286042        |
| Electricians' Tools                                | 006026        |
| Tool Grinding and Sharpening                       | 186057        |
| Woodworking Hand Tools                             | 186058        |
| Routers, Power Planers, and Sanders                | 186059        |
| Jacks, Hoists, and Pullers                         | 186060        |
| Metal Processing                                   | X0601         |
| Ferrous Metals                                     | X0602         |
| Nonferrous Metals                                  | X0603         |
| Identification of Metals                           | X0604         |
| Nonmetallic Materials                              | X0605         |
| Plastics, Elastomers, and Composite Materials      | X0606         |
| Wood Products                                      | X0607         |
| Paints and Adhesives                               | X0608         |
| Precision Measuring Instruments, Part 2            | 186069        |
| Precision Measuring Instruments, Part 3            | 186072        |
| Bench Work                                         | 5004A-C       |
| Fasteners                                         | 286095        |
| Pattern Making                                     | 6427A-F       |
| Drafting Kit                                       | 1200M         |
| Geometrical Drawing (includes 5 plates)            | 5544A-B       |
| Elements of Projection Drawing (includes 5 plates) | 5649          |

### Machine Shop Equipment Operation

| Fundamentals of Metal Cutting                      | 386030        |
| Machine Shop Safety                                | 186007        |
| Drilling                                           | 3521A-B       |
| Lathes, Part 1                                     | 386036        |
| Lathes, Part 2                                     | 386037        |
| Lathes, Part 3                                     | 386038        |
| Lathes, Part 4                                     | 386039        |
| Lathes, Part 5                                     | 386040        |
| Milling Machine Fundamentals                      | 386031        |
| Milling Machine Cutting Tools                      | 386032        |
| Milling Machine Practice and Operation, Part 1     | 386033        |
| Milling Machine Practice and Operation, Part 2     | 386034        |
| Surface Grinding, Part 1                           | 386012        |
| Surface Grinding, Part 2                           | 386013        |
| Cylindrical Grinding, Part 1                       | 386010        |
| Cylindrical Grinding, Part 2                       | 386011        |

Estimated Curriculum Duration: 736 hours.
Number of Exams: 95.
Basic Metal Cutting Specialist

This topical program provides entry-level trainees with the courseware that prepares them for career opportunities in Machine Technology. When combined with on-the-job training, the program will give trainees a comprehensive foundation in the basic skills and knowledge they will need to perform as a Machinist Helper. Additionally, the courses support skills development for the millwright or general plant maintenance trades.

Upon completion of this program, students will be able to:

• Work with basic mathematics.
• Determine the proper hand tools for a particular job.
• Select the proper material for a workpiece.
• Select and use the proper measuring instrument for a particular measurement.
• Read a basic drawing used for a particular job.
• Discuss the use of bearings, pumps, and the transmission of power.
• Describe the proper safety precautions to be followed in the work area.
• Discuss the use of drills and drill presses.

Base Program

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
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<td>Material Handling Safety</td>
<td>186006</td>
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<td>Working Safely with Electricity</td>
<td>4400</td>
</tr>
<tr>
<td>Fundamentals of Metal Cutting</td>
<td>386030</td>
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<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
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<td>Bulk Measurement</td>
<td>186022</td>
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<tr>
<td>Temperature Measurement</td>
<td>186023</td>
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<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
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<td>Manufacturing Processes, Part 1</td>
<td>186075</td>
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<tr>
<td>Introduction to Print Reading</td>
<td>186080</td>
</tr>
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<td>Print Reading Symbols and Abbreviations</td>
<td>186081</td>
</tr>
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<td>Dimensioning and Tolerancing</td>
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<td>386041</td>
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<td>186054</td>
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<td>186055</td>
</tr>
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<td>186057</td>
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<td>186058</td>
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<td>186059</td>
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<td>Jacks, Hoists, and Pullers</td>
<td>186060</td>
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<td>186072</td>
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<td>Metal Processing</td>
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<td>X0602</td>
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<td>Fasteners</td>
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<td>Introduction to Pumps and Compressors</td>
<td>X0610</td>
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<td>286101</td>
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<td>Materials Handling</td>
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Estimated Program Duration: 375 hours.
Number of Exams: 54.

Operator of Milling Machines, Lathes, Grinding Machines, and NC/CNC Equipment

This topical program provides trainees with the courseware that enables them to improve their skills and broaden their knowledge of milling machine, lathe, grinding machine, and NC/CNC equipment operations. The training is appropriate for experienced operators, and employees learning to operate machine tools. Trainees should enter the program with the knowledge of those topics covered in the Basic Metal Cutting Specialist program.

Upon completion of this program, students will be able to:

• Select the proper type of milling machine, grinder, and the proper measuring instruments.
• Determine the setup for a particular job and select the proper cutting or grinding tools.
• Compute the proper cutting speeds and feeds.
• Identify the components of and how numerical control/computerized numerical control (NC/CNC) systems work.
• Describe the procedure for troubleshooting an NC/CNC job.
• Explain the procedure for first piece machining.
• Describe internal and external turning operations.
• Explain the automatic threading operations.
• Describe the procedure for cutting a taper.
### Base Program

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision Measuring Instruments, Part 1</td>
<td>186068</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 2</td>
<td>186069</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 3</td>
<td>186072</td>
</tr>
<tr>
<td>Machine Shop Safety</td>
<td>186007</td>
</tr>
<tr>
<td>Milling Machine Fundamentals</td>
<td>386031</td>
</tr>
<tr>
<td>Milling Machine Cutting Tools</td>
<td>386032</td>
</tr>
<tr>
<td>Milling Machine Practice and Operation, Part 1</td>
<td>386033</td>
</tr>
<tr>
<td>Milling Machine Practice and Operation, Part 2</td>
<td>386034</td>
</tr>
<tr>
<td>Milling Machine Indexing and Spiral Work</td>
<td>386035</td>
</tr>
<tr>
<td>Toolholding Systems</td>
<td>386028</td>
</tr>
<tr>
<td>CNC Technology and Programming</td>
<td>066903</td>
</tr>
<tr>
<td>CNC Turning</td>
<td>386041</td>
</tr>
<tr>
<td>Nontraditional Machining Technologies</td>
<td>386029</td>
</tr>
<tr>
<td>Quality Control for the Technician</td>
<td>386E02</td>
</tr>
<tr>
<td>Geometric Dimensioning and Tolerancing</td>
<td>386E01</td>
</tr>
<tr>
<td>Lubrication, Part 1</td>
<td>286091</td>
</tr>
<tr>
<td>Lubrication, Part 2</td>
<td>286092</td>
</tr>
<tr>
<td>Lathes, Part 1</td>
<td>386036</td>
</tr>
<tr>
<td>Lathes, Part 2</td>
<td>386037</td>
</tr>
<tr>
<td>Lathes, Part 3</td>
<td>386038</td>
</tr>
<tr>
<td>Lathes, Part 4</td>
<td>386039</td>
</tr>
<tr>
<td>Lathes, Part 5</td>
<td>386040</td>
</tr>
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<td>Turret Lathes</td>
<td>3525A</td>
</tr>
<tr>
<td>Turret Lathe Tools and Setups</td>
<td>2213</td>
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<tr>
<td>Automatic Screw Machines</td>
<td>3530A-B</td>
</tr>
<tr>
<td>Fundamentals of Grinding</td>
<td>386016</td>
</tr>
<tr>
<td>Surface Grinding, Part 1</td>
<td>386012</td>
</tr>
<tr>
<td>Surface Grinding, Part 2</td>
<td>386013</td>
</tr>
<tr>
<td>Cylindrical Grinding, Part 1</td>
<td>386010</td>
</tr>
<tr>
<td>Cylindrical Grinding, Part 2</td>
<td>386011</td>
</tr>
<tr>
<td>Tool Grinding</td>
<td>386017</td>
</tr>
<tr>
<td>Boring Mills</td>
<td>5636A</td>
</tr>
<tr>
<td>Planers</td>
<td>6118</td>
</tr>
<tr>
<td>Broaching</td>
<td>6091</td>
</tr>
<tr>
<td>Shapers, Slotters, and Keyseaters</td>
<td>2222</td>
</tr>
</tbody>
</table>

Estimated Program Duration: 450 hours.
Number of Exams: 46.

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### Industrial Maintenance Welder

The Industrial Maintenance Welder topical program is designed for individuals who require welding skills as part of their plant maintenance work. The training will benefit maintenance mechanics and skilled trades people who need to learn welding theory. Since welding requires manipulative skills that can be acquired only through practice, the trainee should have access to oxyacetylene and shielded metal arc (stick electrode) welding equipment.

This program provides both theory and working instruction in the equipment and techniques of gas and arc welding, and the cutting of iron, steel, pipe, and nonferrous metals. It includes the needed instruction in basic mathematics, print reading, safety, metallurgy, electricity, and weld inspection.

Upon completion of this program, students will be able to:

- Select the proper tip for gas welding.
- Read basic welding prints.
- Explain the start up procedure for arc welding.
- Describe the various uses of Gas Tungsten Arc Welding.
- Discuss the use of Gas Metal Arc Welding.
- Select the proper shielding gases for welding.
- Describe the procedures for the inspection of welds.
- Discuss the procedures for nondestructive testing of welds.

### Base Program

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186023</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
</tr>
<tr>
<td>Fluid Measurement</td>
<td>186025</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
<tr>
<td>Introduction to Print Reading</td>
<td>186080</td>
</tr>
<tr>
<td>Print Reading Symbols and Abbreviations</td>
<td>186081</td>
</tr>
<tr>
<td>Dimensioning and Tolerancing</td>
<td>186082</td>
</tr>
<tr>
<td>Print Reading Applications</td>
<td>186083</td>
</tr>
<tr>
<td>Reading Shop Prints, Part 1</td>
<td>386043</td>
</tr>
<tr>
<td>Reading Shop Prints, Part 2</td>
<td>386044</td>
</tr>
<tr>
<td>Quality Control for the Technician</td>
<td>386E02</td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
<tr>
<td>Safe Handling of Pressurized Gasses and Welding</td>
<td>186004</td>
</tr>
<tr>
<td>Material Handling Safety</td>
<td>186006</td>
</tr>
<tr>
<td>Working Safely with Electricity</td>
<td>3400</td>
</tr>
<tr>
<td>Fundamentals of Welding, Part 1</td>
<td>286025</td>
</tr>
<tr>
<td>Fundamentals of Welding, Part 2</td>
<td>286066</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 1</td>
<td>186068</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 2</td>
<td>186069</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 3</td>
<td>186072</td>
</tr>
<tr>
<td>Bench Work</td>
<td>5004A-C</td>
</tr>
<tr>
<td>Gas Welding Equipment</td>
<td>6272A-B</td>
</tr>
<tr>
<td>Practical Metallurgy for Welders</td>
<td>6152A-B</td>
</tr>
<tr>
<td>Gas Welding Techniques</td>
<td>6276A-C</td>
</tr>
<tr>
<td>Common Thermal Cutting Processes</td>
<td>286028</td>
</tr>
</tbody>
</table>
Nature of Electricity ......................................................086001
Circuit Analysis and Ohm's Law ......................................086002
Alternating Current ......................................................086005
Alternating Current Circuits ...........................................086008
Arc Welding Equipment, Part 1 ......................................286032
Arc Welding Equipment, Part 2 ......................................286033
Arc Welding Equipment, Part 3 ......................................286053
Shielded Metal Arc Welding Techniques, Part 1 ..............286030
Shielded Metal Arc Welding Techniques, Part 2 ..............286031
Gas Metal Arc Welding Fundamentals (GMAW or Mig) ..286059
Arc Welding of Low Carbon Steel ..................................5249A-B
Arc Welding of Alloy Steels and Iron ...............................5250

Estimated Program Duration: 495 hours.
Number of Exams: 60.

Industrial Distributor: Knowledge and Skills Training

This topical program provides people employed in the Industrial Distribution industry with the technical knowledge needed to understand the tools, machinery and equipment used by your customers in their machine shop. It is recommended that students learn the business knowledge provided in the Distribution Industry: Core Knowledge and Skills program described in Resource 2, Foundation Skills, before starting the industrial and machine technology training. Supplemental video-based courses are suggested to reinforce the independent study units.

Upon completion of this program, students will be able to:

• Learn the types and the use of the common hand and power tools, and both metal and wood shop materials.
• Describe the operation of shop equipment such as the lathe, grinder, and milling machines.
• Identify the components of and how numerical control/computerized numerical control (NC/CNC) systems work.

Base Program

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jobs, Companies, and the Economy:</td>
<td></td>
</tr>
<tr>
<td>Basic Concepts for Employees</td>
<td>186034</td>
</tr>
<tr>
<td>Hand and Power Tools</td>
<td></td>
</tr>
<tr>
<td>Common Hand Tools, Part 1</td>
<td>186052</td>
</tr>
<tr>
<td>Common Hand Tools, Part 2</td>
<td>186053</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 1</td>
<td>186068</td>
</tr>
<tr>
<td>Electric Drilling and Grinding Tools</td>
<td>186054</td>
</tr>
<tr>
<td>Power Cutting Tools</td>
<td>186055</td>
</tr>
<tr>
<td>Pneumatic Hand Tools</td>
<td>186056</td>
</tr>
<tr>
<td>Plumbing and Pipefitting Tools</td>
<td>286042</td>
</tr>
<tr>
<td>Electricians' Tools</td>
<td>060026</td>
</tr>
<tr>
<td>Tool Grinding and Sharpening</td>
<td>186057</td>
</tr>
</tbody>
</table>

Woodworking Hand Tools ........................................................................186058
Routers, Power Planers, and Sanders ..................................................186059
Jacks, Hoists, and Pullers .....................................................................186060
Industrial Materials and Components .................................................Block X06
Metal Processing .....................................................................................X0601
Ferrous Metals .......................................................................................X0602
Nonferrous Metals ..................................................................................X0603
Identification of Metals ........................................................................X0604
Nonmetallic Materials ............................................................................X0605
Plastics, Elastomers, and Composite Materials ....................................X0606
Wood Products .........................................................................................X0607
Paints and Adhesives .............................................................................X0608
Fasteners ...................................................................................................X0609
Introduction to Pumps and Compressors ..............................................X0610
Introduction to Bearings and Seals ......................................................X0611
Introduction to Power Transmission .....................................................X0612
Precision Measuring Instruments, Part 2 ..............................................186069
Precision Measuring Instruments, Part 3 ..............................................186072
Safe Shop Practices ................................................................................X0804
Properties and Classifications of Metals ...............................................X0805
Metal Cutting and Machine Tooling .......................................................X0809
Metal Cutting and Machine Tooling, Part 2 .........................................X0810
Metal Cutting Machinery, Part 1 ..........................................................X0811
Metal Cutting Machinery, Part 2 ..........................................................X0812
Fundamentals of Grinding .....................................................................X0813
CNC Machine Tool Features and Applications .......................................X0814
Manufacturing Processes, Part 1 .........................................................186075
Manufacturing Processes, Part 2 ..........................................................186076
Manufacturing Processes, Part 3 ..........................................................186077
Fundamentals of Metal Cutting ...............................................................386030
Fundamentals of Grinding .....................................................................386016
Lathes, Part 1 .........................................................................................386036
Lathes, Part 2 .........................................................................................386037
Lathes, Part 3 .........................................................................................386038
Lathes, Part 4 .........................................................................................386039
Lathes, Part 5 .........................................................................................386040
Milling Machine Fundamentals ...............................................................386031
Milling Machine Cutting Tools ................................................................386032
Milling Machine Practice and Operation, Part 1 .....................................386033
Milling Machine Practice and Operation, Part 2 .....................................386034
Cylindrical Grinding, Part 1 ..................................................................386010
Cylindrical Grinding, Part 2 ..................................................................386011
Surface Grinding, Part 1 .........................................................................386012
Surface Grinding, Part 2 .........................................................................386013
Fundamentals of Welding, Part 1 ...........................................................286025
Fundamentals of Welding, Part 2 ...........................................................286066
CNC Technology and Programming ..........................................................066903
CNC Turning ...........................................................................................386041
CNC Milling ............................................................................................386042
Nontraditional Machining Technologies ...............................................386029
Toolholding Systems ..............................................................................386028

Estimated Program Duration: 458 hours.
Number of Exams: 49.
066903
CNC Technology and Programming

Duration: 45 hours (includes 3 tests)
Course Prerequisite: Basic Machining Skills (Block X08)

What Students Learn:
- Numerical Control Basics; The History of Numerical Control; The Computer; Input Media; How Numerical Control Operates; Machine Tools.
- CNC System Programming; Programming Data; Simple Programming; Angular and Contour Programming; Miscellaneous Numerical Control Functions.
- Types of CNC Equipment; Machining Centers; Chucking and Turning Centers; Electrical Discharge Machining; Numerical Control and the Future.

186068
Precision Measuring Instruments, Part 1

Duration: 10 hours (includes 1 test)

What Students Learn:
- Purpose and Language of Measurement; Scale Instruments and Accessories; Vernier Caliper; Micrometers, Gages, and Protractors.

Special Notes:
- This updated course replaces course 3500A.
- The entire course consists of study units 186068, 186069, and 186072.

186069
Precision Measuring Instruments, Part 2

Duration: 10 hours (includes 1 test)

What Students Learn:
- Indicators; Shop Gages; Gage Blocks; Fundamentals of Trigonometry; Sine Bar and Sine Plate.

Special Notes:
- This updated course replaces course 3500B.
- The entire course consists of study units 186068, 186069, and 186072.

186072
Precision Measuring Instruments, Part 3

Duration: 10 hours (includes 1 test)

What Students Learn:
- Setup and operation of optical alignment systems including laser and alignment telescopes
- Use digital readout gages that apply either absolute or incremental measuring systems
- Explain the use of optical comparators and toolmaker's microscopes
- Recognize applications that call for in-process and post-process gaging, including video inspection and CNC tool presetters
- Uses of modern non destructive testing (NDT) technologies including magnetic particle inspection and ultrasonic testing

Special Notes:
- This updated course replaces courses 3500C and 186070.
- The entire course consists of study units 186068, 186069, and 186072.

186075
Manufacturing Processes, Part 1

Duration: 10 hours (includes 1 test)

What Students Learn:
- Relate historical trends in manufacturing to modern ones
- Describe the development and importance of modern quality systems
- Explain how available material types shape manufacturing processes
- Describe early factory systems and their impact on modern systems
- Classify modern manufacturing systems by type and abilities

This course replaces 2520A

186076
Manufacturing Processes, Part 2

Duration: 10 hours (includes 1 test)

What Students Learn:
- Explain the relationship between atomic structure and material properties
- Classify materials used in manufacturing based on physical and mechanical properties
- Identify benefits and drawbacks of specific materials for a given application
- Interpret the classifications of various metallic materials
- Compare properties of various metallic materials
- Identify properties of and applications for various nonmetallic materials

This course replaces 2520B
Manufacturing Processes, Part 3

Duration: 10 hours (includes 1 test)

What Students Learn:
- Describe common methods and applications for casting metals and plastics
- Describe and contrast various forming processes including forging, drawing, and others
- Differentiate between the benefits and costs of casting and forming processes
- Explain how the various conventional metal-removal technologies are used in manufacturing
- Identify the benefits of and range of applications for robotics and CNC systems in manufacturing
- Describe the benefits and costs of non-contact metal removal and shaping processes

This course replaces 2520C

Manufacturing Processes, Part 4

Duration: 10 hours (includes 1 test)

What Students Learn:
- Relate the factors of production to how a given manufacturing organization is structured
- List the types of manufacturing production systems
- Suggest modifications of equipment layout to improve productivity
- Evaluating automation strategies and problems
- Benefits of quality management methods
- Describe their role in JIT, Lean, and e Manufacturing systems

This course replaces 2520D

Sheet Metal Work

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Basic Machining Skills (Block X08)

What Students Learn:
Sheet Metal Fundamentals; Sheet Metal Types and Applications; Construction Techniques; Soldering and Painting; Publications.

Manufacturing Processes

Duration: 40 hours (includes 4 tests)

What Students Learn:
Part 1 (2520A). Cutting Tools; Efficient Machining; Workpiece Holding Devices; Machine Tool; Machine Tool Controls.
Part 2 (2520B). Powder Metallurgy; Casting Process; Plastics and Rubber; Hot-Working of Metals; Cold-Working of Metals.
Part 3 (2520C). Heat Treatment; Welding Techniques; Magnetoforming; Electrical and Chemical Machining; Ultrasonics; Surface Protection.
Part 4 (2520D). Metrology Caliper; Micrometer; Gage Blocks; Optical Flat; Sine Plate; Automatic Assembly.

Special Note:
- This course has been replaced by study units 186075 through 186078.
2521A-E

**Statistical Quality Control**

**Duration:** 75 hours (includes 5 tests)

**Course Prerequisites:**
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Logarithms (5254)

**What Students Learn:**

Part 1 (2521A), Introduction to Statistical Quality Control and Statistical Process Control; Fundamental Statistical Concepts; Why the Control Chart Works; Examples of Processes in Control and out of Control.

Part 2 (2521B), X and R Control Charts – Objectives, Recording Measurements, Plotting, Drawing Conclusions; Rational Subgrouping – Analyzing Process Capability; Adapting the Control Charts to Isolate and Analyze Sources of Variation.

Part 3 (2521C), Fundamentals of the Theory of Probability; Hypergeometric, Binomial, and Poisson Distributions; Normal Distribution and the Central Limit Theorem; The Control Chart for Fraction Rejected – P Chart and NP Chart; The Control Chart for Nonconformities – C Chart and U Chart; Pareto Analysis; Cause and Effect Analysis; Special Process Control Procedures.

Part 4 (2521D), Cumulative Sum Control Charts; Aspects of Specifications and Tolerances; Fundamental Concepts in Acceptance Sampling; The Dodge-Romig System for Lot-by-Lot Acceptance Sampling by Attributes.

Part 5 (2521E), An Acceptable Quality Level System for Lot-by-Lot Acceptance Sampling by Attributes; Acceptance Inspection for Continuous Production; Acceptance Sampling by Variables; Aspects of Life Testing and Reliability; Economic Aspects of Quality Decisions.

2540A-C

**Toolmaking**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisite:**
Basic Machining Skills (Block X08)

**What Students Learn:**

Part 1 (2540A), General Toolroom Work; Materials and Equipment; Procedure and Measurements; Limitations of Toolmaking; Examples of Toolmaking and Toolmaking Operations.

Part 2 (2540B), Cutting Tools; Hand Taps; Machine Taps; Taper Taps; Hobs; Dies for Thread Cutting; Die Holders; Reamers; Theory of Cutting Tools.

Part 3 (2540C), Countershares; Hollow Mills; Milling Cutters; Screw-Machine, Turret-Lathe, and Broaching Tools.

**Special Note:**
- A new addition to this course, Toolmaking, Part 4 (386047) focuses on modern toolmaking practices.

2590

**Quality Control of Manufactured Products**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Engineering Orientation, Parts 1-2 (062002 - 062003)

**What Students Learn:**
Basic Concepts of Quality Control; Quantity Costs and Their Control; Quality Policies and the Marketplace; Measurement; Inspection Function; Control Function; Vendor Relations; Role of Statistical Methods; Manufacturing Planning for Quality; Quality Improvement.

286025

**Fundamentals of Welding, Part 1**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Introduction to Welding; Definitions of Weld, Braze, and Braze Weld; Oxyfuel Gas Welding (OFW); Arc Welding (AW); Resistance Welding (RW); Solid-State Welding (SSW); The Brazing Welding Process; Soldering Process; Other Welding Processes.

**Special Notes:**
- This updated course replaces course 6151.
- The entire course consists of study units 286025 and 286066.

286028

**Common Thermal Cutting Processes**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Fundamentals of Welding, Parts 1-2 (286025, 286066)

**What Students Learn:**
Introduces the Process of using Heat to Cut Metal and other Materials; Describes the Common Thermal Cutting Processes used in Industry and the capabilities of each; The Tables to use when Estimating Requirements for specific Cutting Operations; Describe the types of Equipment used for Oxyfuel Gas Cutting; Identify the appropriate Procedures used in Oxygen Cutting Processes.

**Special Note:**
- This new course replaces courses 6275A-B.
286030

**Shielded Metal Arc Welding Techniques, Part 1**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Practical Measurements (Block X22)
- Fundamentals of Welding, Parts 1-2 (286025, 286066)
- Arc Welding Equipment, Parts 1-3 (286032-286033, 286053)

**What Students Learn:**
- Equipment and Materials; Weld Metal Testing; Welding Applications of Covered Mild-Steel Electrodes; Basic Arc Welding Operations; Single V-Groove Butt Welds.

**Special Notes:**
- This updated course replaces course 3536A.
- The entire course consists of study units 286030-286031.

286031

**Shielded Metal Arc Welding Techniques, Part 2**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Practical Measurements (Block X22)
- Fundamentals of Welding, Parts 1-2 (286025, 286066)
- Arc Welding Equipment, Parts 1-3 (286032-286033, 286053)

**What Students Learn:**
- The Vertical Position; The Horizontal Position; The Overhead Position; Fillet Welds: Welding Heavy Metal Plates; Sheet Metal Welding.

**Special Notes:**
- This updated course replaces course 3536B.
- The entire course consists of study units 286032, 286033, and 286053.

286032

**Arc Welding Equipment, Part 1**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Fundamentals of Welding, Parts 1-2 (286025, 286066)
- Electricity (4210A-C)

**What Students Learn:**
- Terminology and Processes; Power Sources for Arc Welding; Arc Welding Machines; Transformer Types of Welding Power Source.

**Special Notes:**
- This updated course replaces course 6274A.
- The entire course consists of study units 286030-286031.

286033

**Arc Welding Equipment, Part 2**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Fundamentals of Welding, Parts 1-2 (286025, 286066)
- Electricity (4210A-C)

**What Students Learn:**
- Sources of DC Welding Power; Sources of AC Welding Power; Supplemental Arc Welding Equipment: Meters, Indicators, Cables, Electrode Holders; Face Shields, Helmets, Goggles, Protective Clothing, Screens.

**Special Notes:**
- This new course replaces course 6161.
- The entire course consists of study units 286032, 286033, and 286053.

286035

**Gas Tungsten Arc Welding Fundamentals (GTAW or Tig)**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Fundamentals of Welding, Parts 1-2 (286025, 286066)
- Safety in Welding and Cutting (6154)

**What Students Learn:**
- Applications and Advantages of Gas Tungsten Arc Welding; Identify the Variables involved in the GTAW process; Explain the uses for Equipment and Supplies required for GTAW Applications; Identify the different types of Tungsten Electrodes; How to select, prepare and use Tungsten Electrodes; List the requirements for preparing Workpieces prior to welding; Introduction to GTAW Welding Techniques and Practices.

**Special Notes:**
- This updated course replaces course 6274B.
- The entire course consists of study units 286032, 286033, and 286053.

286053

**Arc Welding Equipment, Part 3**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Fundamentals of Welding, Parts 1-2 (286025, 286066)
- Electricity (4210A-C)

**What Students Learn:**
- Requirements for Mechanized, Semiautomatic, and Automatic Welding; Submerged Arc Welding; Robotic and Adaptive Control; Electroslag Welding; Tubular Filler Metals; Gas Tungsten Arc Welding; Gas Metal Arc Welding; Spot Welding Equipment; Electron Beam, Plasma Arc, Flux Cored Arc, and Laser Beam Welding, Equipment and Processes.

**Special Notes:**
- This updated course replaces course 6274C.
- The entire course consists of study units 286032, 286033, and 286053.
**286059**

**Gas Metal Arc Welding Fundamentals (GMAW or Mig)**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Fundamentals of Welding, Parts 1-2 (286025, 286066)
Safety in Welding and Cutting (6154)

**What Students Learn:**
Applications and Advantages of Gas Metal Arc Welding; Identify the Variables involved in the GMAW process; Explain the uses for Equipment and Supplies required for GMAW Applications; The use of components such as GMAW Welding Guns and Shielding Gas; How to select Welding Gun Positions for particular applications; List the requirements for preparing Workpieces prior to welding; Introduction to GMAW Welding Techniques and Practices; Using Tables to select appropriate Operating Data for a particular Welding application.

**Special Note:**
- This new course replaces course 6162.

**3197**

**Making Forging Dies**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Dies and Die Making (5101A-B)

**What Students Learn:**
Kinds of Steel Used in Making Forging Dies; Annealing, Hardening, and Tempering Treatment of Die Blocks; Machine Tools Used in Working with Die Sinkers; Using Hand Tools in the Diemaking Practice; Laying Out and Machining Die Blocks; Handwork on Die Impressions; Making Breakdowns and Trimming Dies.

**3199**

**Forging Dies**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Dies and Die Making (5101A-B)

**What Students Learn:**
Construction and Use of Drop-Forging Dies; Nature and Construction of Press-Forging Dies; Bending Dies.

**3501**

**Layout**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Marking Devices: Punches, Scribers, Dividers, Calipers, Gages, Beam Trammels, Combination Sets, Bevel Protractors, Keyseat Clamps; Scribing Problems; Use of Bench Plates, Surface Plates, Parallels, V Blocks, and Arbors; How to Draw Horizontal, Vertical, and Inclined Lines; How to Draw a Circle or Circular Arc; Layout Problems: Location of Holes in a Plate; Location of Boundaries of Flat Surfaces; Marking of Lines on Curved Surfaces; Locating the Center of a Circle in an Opening; Subdividing a Circle into a Number of Equal Parts; Determining Required Length of Stock for Forming a Bent Part; Laying Out of Keyways, Templates, Castings, Cams, and Sprockets. **Special Note:**
- Covers subject at an advanced, in-depth level.
3521A-B

Drilling

Duration: 20 hours (includes 2 tests)

What Students Learn:
Part 1 (3521A). Drilling Process; Upright Drill Press; Multiple-Spindle Drill Press; Drilling Tools; Reconditioning of Drills.
Part 2 (3521B). Work-Holding Devices; Tool-Holding Devices; Drill Press Setup; Cutting Fluids; Related Tools and Practices; Care of Equipment.

Special Note:
• Covers subject at an advanced, in-depth level.
• This course will be replaced by new courses (386050 and 386051) currently in development.

3525A

Turret Lathes

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Basic Machining Skills (Block X08)

What Students Learn:
Turret Lathe Design; Ram-Type Turret Lathes; Saddle-Type Turret Lathes; Electronically Controlled Turret Lathes; Turret-Lathe Basic Maintenance; Work-Holding and Work-Feeding Devices.

3530A-B

Automatic Screw Machines

Duration: 20 hours (includes 2 tests)

Course Prerequisites:
Basic Machining Skills (Block X08)
Turret Lathes (3525A)
Turret Lathe Tools and Setups (2213)

What Students Learn:
Part 1 (3530A). Types of Automatic Screw Machines; Single-Spindle Chucking Lathe; Multiple-Spindle Chucking Lathe; Bar-Type Lathes.
Part 2 (3530B). Tools and Setups; Single-Spindle Chucking Lathe; Multiple-Spindle Chucking Lathe; Single-Spindle Bar Machine; Swiss-Type Automatic Lathe; Single-Spindle Bar Lathe; Multiple-Spindle Bar Lathe.

3541A-D

Heat Treatment

Duration: 40 hours (includes 4 tests)

Course Prerequisites:
Practical Measurements (Block X22)
Elements of Chemistry (5011)

What Students Learn:
Part 1 (3541A). Steel Ingots; Hot Working of Steel; Effects of Hot Working on Microstructure; Cold Working of Steel; Heat-Treating Equipment; Cooling Mediums and Devices; Temperature Measurement and Control; Miscellaneous Equipment; Metric System Conversion Information.
Part 3 (3541C). Composition of Alloy Steels; Heat Treatment of Alloy Steels; Properties of Low-Alloy Steels; Special Steels; Case Hardening; Furnace Atmospheres.
**386010**

**Cylindrical Grinding, Part 1**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Basic Machining Skills (Block X08)

**What Students Learn:**
Types of Cylindrical Grinding Machines; Major Units of Center-Type Grinders; Grinding Machine Controls; Grinding Wheels; Coolants.

**Special Notes:**
- This updated course replaces course 3560A.
- The entire course consists of study units 386010-386011.

**386011**

**Cylindrical Grinding, Part 2**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Basic Machining Skills (Block X08)

**What Students Learn:**
General Safety Information; Machine Setup Procedure; Production Grinding; Roll Grinding; Grinding Applications; Troubleshooting in Cylindrical Grinding.

**Special Notes:**
- This updated course replaces course 3560B.
- The entire course consists of study units 386010-386011.

**386012**

**Surface Grinding, Part 1**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Fundamentals of Grinding (386016)

**What Students Learn:**
Introduction to Surface Grinding; Types of Surface-Grinding Machines; Components of Surface-Grinding Machines.

**Special Notes:**
- This updated course replaces course 5024A.
- The entire course consists of study units 386012-386013.

**386013**

**Surface Grinding, Part 2**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Fundamentals of Grinding (386016)

**What Students Learn:**
Preparing the Abrasive Wheel for Surface Grinding; Surface Grinder Operations; Surface Finish and Measurement.

**Special Notes:**
- This updated course replaces course 5024B.
- The entire course consists of study units 386012-386013.

**386016**

**Fundamentals of Grinding**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Basic Machining Skills (Block X08)

**What Students Learn:**
Forms of Abrasives; Classification of Abrasives; Abrasive Grinding Processes and Machines; Standard Wheel Marking System; Abrasive Types; Grain Size; Wheel Grade, Wheel Structure, Wheel Bonds; Diamond and Cubic Boron Nitride Wheels; Wheel Grinding Machines; Wheel Shapes; Grinding Wheel Testing and Maintenance; Grinding Fluids or Coolants Coated Abrasives; Applications and Characteristics of Coated Abrasives; Factors Affecting Stock Removal and Finish; Safe Practices for Grinding.

**Special Notes:**
- Covers subject at an advanced, in-depth level.
- This updated course replaces course 5023.

**386017**

**Tool Grinding**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Fundamentals of Grinding (386016)

**What Students Learn:**
Wheel Selection and Shapes; Oilstones; Honing Cutting Tools; Grinding Single-Point Tools; Angle Calculations; Universal Grinder; Drill Grinding; Testing Drill Points; Grinding Milling Cutters; Clearance Grinding; Tooth Rest; Grinding Side, Shank Angular, Inserted-Blade, and Helical Cutters; Grinding Circular Saws, Formed Cutters, Gear Cutters, Hobs, Reamers, Taps, Radial, and Tangential Chasers; Grinding Carbide Tools; Grinding Internal and Slab Broaches.

**Special Note:**
- This updated course replaces course 5349.

**386028**

**Toolholding Systems**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Fundamentals of Metal Cutting (386030)

**What Students Learn:**
- Understand the fundamental characteristics of toolholders required for various machine tools.
- Understand and describe how the toolholder affects the quality of the machining operation.
- Interpret national standards for tool and toolholder identification systems.
- Understand the differences in toolholder tapers and the proper applications for each type of taper.
- Understand and describe the effects of toolholder concentricity and imbalance.
### Machine Technologies

#### 386029

**Nontraditional Machining Technologies**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:** Fundamentals of Metal Cutting (386030)

**What Students Learn:**
- Explain how electrical discharge machining (EDM) works.
- Describe the difference between wire and ram EDM.
- Explain how laser light is produced and how lasers are used in industrial settings.
- Explain why a plasma cutting torch is so much hotter than other types of cutting torches.
- Describe the difference between chemical and electro-chemical machining.
- Explain how water can be made to cut steel.
- Describe the common manufacturing methods of rapid prototyping.

#### 386030

**Fundamentals of Metal Cutting**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Introduction to Metal Cutting; Fundamentals, Feed, Speed, Depth of Cut; Requirements for Cutting Tool Materials; Tool Materials; Carbon Tool Steels, High-Speed Steels, Carbides, Cast Alloys, Ceramics, Boron Nitride, Diamond, Abrasives; Principles of Single-Point Cutting; The Turning Tool, Tool Wear, Modern Turning Tools, and Practices; Other Single-Point Tools; Milling Cutters; Drills; Tapping, Threading, and Reaming Tools; Miscellaneous Multiple-Point Cutting Tools; Cutting Fluids.

**Special Notes:**
- Covers subject at an advanced, in-depth level.
- This new course replaces courses 5021A and 386015.

#### 386032

**Milling Machine Cutting Tools**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:** Milling Machine Fundamentals (386031)

**What Students Learn:**
- Milling Cutter Materials; Milling Cutter Design; Milling Cutters; Carbide Inserts; Milling Techniques; Care and Reconditioning of Cutters.

**Special Note:**
- This new course replaces courses 3522C and 386008.

#### 386033

**Milling Machine Practice and Operation, Part 1**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:** Milling Machine Fundamentals (386031)

**What Students Learn:**
- Kinds of Work Done on the Milling Machine; Cutting Speeds and Feeds; Preparation of Stock; Setting Machine; Setting and Holding Work on Table, in Vise, on Faceplate, in Fixtures and Chucks, and between Centers; Taking Cuts; Milling-Machine Troubles.

**Special Note:**
- This new course replaces courses 2217 and 386009.

#### 386034

**Milling Machine Practice and Operation, Part 2**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:** Milling Machine Fundamentals (386031)

**What Students Learn:**
- Kinds of Work Done on the Milling Machine; Cutting Speeds and Feeds; Preparation of Stock; Setting Machine; Setting and Holding Work on Table, in Vise, on Faceplate, in Fixtures and Chucks, and between Centers; Taking Cuts; Milling-Machine Troubles.

**Special Note:**
- This new course replaces courses 2217 and 386009.
**386035**

**Milling Machine Indexing and Spiral Work**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Milling Machines Fundamentals (386031)
Milling Machine Practice and Operation, Parts 1-2 (386033-386034)

**What Students Learn:**
- Indexing: Direct Indexing; Indirect Indexing; Compound Indexing;
- Differential Indexing; Linear Indexing; Spiral Work; Generation of Helix;
- Calculation of Spiral-Head Change Gears; Cutting Helixes; Milling Cams;
- Tables; Simple and Differential Indexing; Compound Indexing;
- Bevel-Gear Dividing Head; Angular Indexing; Power Drive for Helical Milling;
- The Use of CNC in Modern Indexing and Spiral Work.

**Special Note:**
- This new course replaces courses 2218 and 386014.

**386036**

**Lathes, Part 1**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Types of Lathes; Principal Parts of a Lathe; Speed Controls; Feed Controls for Tools; Basic Work-Holding Devices.

**Special Note:**
- This new course replaces courses 3520A and 386001.

**386037**

**Lathes, Part 2**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Auxiliary Work-Holding Devices; Preparation for Machining; External Machining.

**Special Note:**
- This new course replaces courses 3520B and 386002.

**386038**

**Lathes, Part 3**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Internal Machining; Special Lathe Operations; Tailstock Operations; Offset Turning

**Special Note:**
- This new course replaces courses 3520C and 386003.

**386039**

**Lathes, Part 4**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Types of Tapers; Taper Turning.

**Special Note:**
- This new course replaces courses 3520D and 386004.

**386040**

**Lathes, Part 5**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Threading; Thread Standards and Chasing Setup; Thread Chasing and Standard Threads. Specialty Threads.

**Special Note:**
- This new course replaces courses 3520E and 386005.

**386041**

**CNC Turning**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
- CNC Technology and Programming (066903)

**What Students Learn:**
- Apply of canned cycles, subroutines, and loops in real-world programming applications
- Modify and adapt basic programs and commands to develop advanced turning programs
- Use special codes to automate complete jobs, including programming for maximum production efficiency
- Affect of some CNC operations on cutting speeds and feed rates
- Correct common problems such as unacceptable part size and out-of-tolerance feature locations
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Duration:</th>
<th>Course Prerequisite:</th>
<th>What Students Learn:</th>
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</thead>
<tbody>
<tr>
<td>386042</td>
<td>CNC Milling</td>
<td>10 hours (includes 1 test)</td>
<td>CNC Technology and Programming (066903)</td>
<td>• Apply of canned cycles, subroutines, and loops in real-world programming applications</td>
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<td>• Modify and adapt basic programs and commands to develop advanced milling programs</td>
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<td>• Use special codes to automate complete jobs, including programming for maximum production efficiency</td>
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<td>• Affect of some CNC operations on cutting speeds and feed rates</td>
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<td>• Correct common problems such as unacceptable part size and out-of-tolerance feature locations</td>
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<tr>
<td>386043</td>
<td>Reading Shop Prints, Part 1</td>
<td>10 hours (includes 1 test)</td>
<td></td>
<td>• Interpret working drawings</td>
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<td>• Evaluate various systems of dimensions and tolerances</td>
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<td>• Recognize symbols, notes, and specifications called out on detail and assembly prints</td>
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<td>• Identify material requirements as specified on a print</td>
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<td>• Evaluate a print to determine the proper procedure to make a simple part</td>
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<td>• This study unit takes the place of study unit 6720A.</td>
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<tr>
<td>386044</td>
<td>Reading Shop Prints, Part 2</td>
<td>10 hours (includes 1 test)</td>
<td>Reading Shop Prints, Part 1 (386043)</td>
<td>• Interpret more complex working drawings</td>
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<td>• Define and use cam, gear, and thread terminology</td>
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<td>• Interpret cam, gear, and thread specifications on shop prints</td>
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<td>• Work with various sectioning techniques</td>
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<td>• Read and interpret a bill of materials</td>
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<td>• Evaluate more complex prints to determine the best order of machining</td>
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<td><strong>Special Note:</strong></td>
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<td>• This study unit takes the place of study unit 6720B.</td>
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<td>386047</td>
<td>Toolmaking, Part 4</td>
<td>10 hours (includes 1 test)</td>
<td>Toolmaking, Parts 1-3 (2540A-C)</td>
<td>• Select modern tool materials to suit a particular application</td>
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<td>• Explain how various tool coatings improve tool performance</td>
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<td>• Identify and select standard tool inserts and tool holders for a specific application</td>
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<td>• Explain the benefits of using inserted tools for drilling, milling, and turning operations</td>
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<td>• Describe the benefits of and proper use of roll-forming and thread-forming taps</td>
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<td>• Troubleshoot tool life and wear problems, and suggest corrective actions</td>
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<td>• Describe instances in which modern machining processes such as WEDM and EDM are superior</td>
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<td>386048</td>
<td>Dies and Diemaking, Part 3</td>
<td>10 hours (includes 1 test)</td>
<td>Dies and Diemaking, Parts 1-2 (5101A-B)</td>
<td>• Explain modern-day improvements in presses and related equipment</td>
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<td>• Recognize the proper use of modern tool materials and coatings</td>
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<td>• Make informed choices about when to use a particular die material</td>
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<td>• Explain how to build a die in a way that works well with the chosen tooling material</td>
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<td>• Identify commercially available components and how they can be used in modern die designs</td>
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<td>• Describe how modern machining practices are considered when designing and building dies</td>
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<td>• Understand modern requirements of high-speed light-gauge stamping processes</td>
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<td>386049</td>
<td>Jig and Fixture Making, Part 2</td>
<td>10 hours (includes 1 test)</td>
<td>Jig and Fixture Making (5100)</td>
<td>• Explain the required characteristics of jigs and fixtures used in modern automated assembly and CNC machining</td>
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<td>• Describe a range of up-to-date machining practices used in building jigs and fixtures</td>
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<td>• List and describe the uses of commercially available components that can be incorporated into jig and fixture designs</td>
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<td>• Understand how to design and build jigs and fixtures to compensate for normal product variations such as flash, parting lines, burrs, and casting irregularities</td>
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</tbody>
</table>
386E01

Geometric Dimensioning and Tolerancing

Duration: 20 hours (includes 4 tests)

Course Prerequisites:
Basic Industrial Math (Block X21)
Reading Shop Prints (386043 and 386044)

What Students Learn:
Lesson 1 - Introduction to GD&T Systems, Datum and Feature Control Frames
• Defining Tolerance Control Systems; Reasons for Using Geometrics; GD&T Symbols; Datum; Interpreting Feature Control Frames; Scanning Prints.

Lesson 2 - Geometric Tolerance Zones: Controlling Form, Profile and Orientation.
• Entities Found in the Tolerance Zone; Form and Profile Controls: Straightness, Flatness, Roundness, Cylindricity, Lines and Surfaces; Orientation Controls: Parallelism, Angularity, and Perpendicularity.

Lesson 3 - Material Modifiers, Location & Runout Characteristics and the GD&T System:
• Least and Maximum Material Conditions; Runout; Inspecting Geometric Position; Finding Earned Tolerance; System Notes; “The 13 Characteristics”.

Lesson 4 - Practical Application of GD&T Skills for Manufacturing
• Single Axis Feature Inspection and Rework; Inspecting and Reworking Two Axis Features; Computing Geometric Tolerances for Designs; Complex Tolerances.

Special Note:
• This course consists of a textbook and supplemental study guides. We recommend the course be purchased in its entirety. However, if needed due to targeted training, study guides (Parts 1 and 2) can be purchased separately, with or without the textbook. Note that the textbook is required for the Part 1 study guide. Call Customer Service for pricing and ordering information.

386E02

Quality Control for the Technician

Duration: 70 hours (includes 7 tests)

Course Prerequisite:
Basic Industrial Math (Block X21)

What Students Learn:
Part 1 (386026). Lesson 1 - Total Quality Management for Technicians:
• Quality Systems, Communication, and Motivation; Total Quality Management (TQM) Tools, Responsibilities and Systems; Quality Costs: Identifying, Controlling, Minimizing, Reporting and Analysis; Planning and Conducting Audits; Inspection Systems and Planning.

Lesson 2 - Blueprint and GD&T System Interpretation for Inspection:
• Using Engineering Prints for Inspection; Working with Geometric Dimensioning and Tolerancing Systems; Graphical Inspection Analysis Procedures and Advantages.

Part 2 (386027). Lesson 3 - Common Inspection Tools:
• Measurement Tools, Accuracy and Errors; Spring Calipers; Gage Blocks; Indicators; Micrometers and Vernier Instruments; Hole, Attribute, and Radius Gages; Tapered Parallels; Measuring Threads; Calibration Techniques.

5001

Plastic Adhesives and Coatings

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Practical Measurements (Block X22)

What Students Learn:
Fundamentals of Adhesives Technology; Functions of Adhesives; Resins for Adhesives; Making Adhesive Joints; Applying Adhesives; Curing Adhesive Joints; Plastic Adherents; Plastic Coatings; Plastic Tape.

5002

Plastics: Films, Sheets, Foams, and Laminates

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Practical Measurements (Block X22)

What Students Learn:
Films and Sheets; Mechanical and Physical Properties; Color Characteristics; Methods of Producing Films and Sheets; Resins Used; Production Methods and Applications for each Resin; Foams; Resin Materials Used; Properties; Foaming Methods - Mechanical, Physical, Chemical; Blowing Agents; Batch Mixing Techniques; Continuous Metering and Mixing; Foam Application, by Spray; Laminates: Resins and Base Materials Used in Laminates; Grades of Laminates; High-Pressure and Low-Pressure Laminating Processes; Applications of Laminates.
5004A-C
Bench Work
Duration: 30 hours (includes 3 tests)

What Students Learn:
Part 1 (5004A). Introduction to Bench Work; Wrenches, Hammers, Pliers, and Screwdrivers; Punches, Twist Drills, Reamers, and Broaches; Saws, Chisels, and Snips; Finishing and Grinding Tools; Files, Scrapers, and Abrasives.
Part 2 (5004B). Threaded Fasteners; Bolts, Screws, and Studs; Thread Systems; Hole Preparation for Threaded Fasteners; Mechanical Fasteners; Rivets, Keys, and Pins; Threading with Hand Tools; Taps; Tap Drills; Tap Wrenches; Removal of Broken Taps; Repairing Damaged Threads.
Part 3 (5004C). Fitting Practice; Tolerance, Allowance, Clearance, and Fit; Babbitting; Hack Saw; Band Saw Machine; Clamping Work for Sawing; Soldering; Soft Solder; Soldering Copper; Sweat Soldering; Brazing; Hand Solderers and Fluxes; Torch Brazing; Induction Brazing; Furnace Brazing.

5041
Numerical Control for Machining
Duration: 10 hours (includes 1 test)

Course Prerequisite:
Basic Machining Skills (Block X08)

What Students Learn:
Introduction to Numerical Control (NC) and its Applications in Machining Operations; Advantages and Disadvantages of NC; Basics of NC - The Coordinate System; Types of Control Systems; Input Data Requirements; Components of NC Systems; The Machine Tool, Control System, Tooling, and Personnel; Steps in Performing an NC Job; Role of the Machine Operator.

Special Note:
• Covers subject at an advanced, in-depth level.

5042
Numerical Control Milling and Drilling
Duration: 10 hours (includes 1 test)

Course Prerequisites:
Numerical Control for Machining (5041)
Drilling (3521A-B)
Milling Machine Practice and Operation (386033-386034)

What Students Learn:
NC Milling and Drilling Machines; Typical Milling and Drilling Job; Setting up an NC Job; Tape Proving; First-Piece Machining and Production; Troubleshooting; The Operator's Role in the Manufacturing System.

Special Note:
• Covers subject at an advanced, in-depth level.

5043
Numerical Control Turning
Duration: 10 hours (includes 1 test)

Course Prerequisites:
Numerical Control for Machining (5041)
Lathes, Parts 1-5 (386036-386040)

What Students Learn:
NC Turning Machines; A Typical NC Turning Job; Setting Up an NC Job; Tape Proving; First-Piece Machining and Production; Troubleshooting; The Operator's Role in the Manufacturing System.

Special Note:
• Covers subject at an advanced, in-depth level.

5098
Gage Making
Duration: 10 hours (includes 1 test)

Course Prerequisite:
Basic Machining Skills (Block X08)

What Students Learn:
Classification, Accuracy, and Tolerances; Materials for Gages; Proportions of Gages; Grinding and Lapping Gages; Making Thread Gages; Making End-Measuring Gages; Making Caliper Gages; Limit Gages; Flat-Surface Gages; Angular Gages; Making Straightedges; Making Taper Gages; Contour Gages; Pin Gages; Cylindrical Square; Indicator Gages; Ball Gages; Gaging Teeth of Spur Gears; Gaging Compound Angles; Sine-Bar Angles for Lathe Tools, Templates, and Template Making.

5099
Jigs and Fixtures
Duration: 10 hours (includes 1 test)

Course Prerequisite:
Basic Machining Skills (Block X08)

What Students Learn:
Types of Jigs; Examples of Jigs; Jig Parts and Accessories; Bushings; Jig Covers and Clamps; Miscellaneous Details of Jigs; Fixtures; Common Vise Fixture; Special Vise Fixture; Bolted Fixture; Combination Jig and Fixture; Triunion Fixture; Roller Fixture; Broaching Fixture.
5100

**Jig and Fixture Making**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Basic Machining Skills (Block X08)

**What Students Learn:**
Processes in Jig and Fixture Making; Planning; Machining; Locating and Producing Holes; Locating Centers by Buttons; Locating by Calculation; Locating Buttons by Rings and Disks; Micrometer Measurements with Rings; Locating Holes; Examples of Jig Making; Making Jig Bushings; Master Plates; Continuous Dialing; Setting Up Indexing Jigs; Making Jigs on Drilling Machines; Checking Jigs; Making Plate Jigs; Making Fixtures.

**Special Note:**
• A new addition to this course, Jig and Fixture Making, Part 2 (386049) focuses on modern jig and fixture making practices.

5160

**Inspection and Testing of Welds**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Inspection of Equipment; Tests of Welders; Inspection of Preparation for Welding; Inspection of Structural Work, Tank Work; Tacking, Seam Spacing, Pipe Work, Welding in Progress; Visual Inspection of Completed Welds; Gauging of Fillers; Nondestructive Tests; Tests with Air, Water, and Oil; Magnetic and Sonic Tests; Radiography in Examining Welds; Polariscope Tests; Destructive Tests; Tests of Spot Welds; Code Requirements for Fusion Welding; Welding Symbols; Protection of Welders.

5101A-B

**Dies and Die Making**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisite:**
Basic Machining Skills (Block X08)

**What Students Learn:**
- Part 1 (5101A). Dies for Sheet-Metal Work; Cutting Dies; Punch Presses; Speeds of Punch Presses; Attaching Dies to Presses; Examples of Die Work; Machine Tool Equipment for Die Making; Making Cutting Dies; Selecting Materials for Dies; Preparation of Die Blanks; Layout of Die; Making Templates; Machining of Die Blank; Making Stripper and Punch Plate; Forms of Cutting Dies; Shear of Dies; Making Progressive Cutting Dies; Making Subpress Cutting Dies.
- Part 2 (5101B). Making Shaping Dies; Drawing Dies; Size of Blanks; Deep Cylindrical and Non-Cylindrical Cups; Redrawing Dies; Making Dies for Curling, Wiring, Seaming, Coining, Extruding, and Embossing; Making Combination Dies; Cutting, Drawing, and Embossing Combination Dies; Combination Forming and Swaging Dies; Combination Blanking, Piercing, and Swaging Dies; Progressive Combination Dies; Hardening and Tempering Dies; Prevention of Cracks; Die Setting Estimating Capacity of Press; Lubrication of Dies; Mechanical Feeds for Punch Presses.

**Special Note:**
• A new addition to this course, Dies and Die Making, Part 3 (386048) focuses on modern die making practices.

5249A-B

**Arc Welding of Low Carbon Steel**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
Electricity (4210A-C) Fundamentals of Welding, Parts 1-2 (286025, 286066) Arc Welding Equipment, Parts 1-3 (286032-286033, 286053)

**What Students Learn:**
- Part 1 (5249A). Welding Techniques; Joint Designs and Preparation; Steel Manufacture; Rimmed, Capped, Killed, and Semikilled Steels; Cast Steels; Specifications for Low Carbon Steel Electrodes; Electrode Classification; Electrode Groups; Chemical Composition of Electrodes; Electrode Coverings; Storage and Rebaking of Electrodes; Welding Current; Use of Low Hydrogen Electrodes; Electrode Tests; Welding Test Plates; Tension and Impact Tests; Fillet Weld Test; Establishment of Welding Procedures; Developing Welding Procedures; Identification of Welding Process, Base Metal, Filler Metal, and Supplementary Materials; Welding Position Qualifications; Arc Welding Single V-Groove Butt Joints, V-Groove with Backing Strip, Double V-Groove Butt Joints, and Fillet Welds; Application of Submerged Arc Welding; Classification of Submerged Arc Electrodes and Filler Metal; Submerged Arc Welding Fluxes; Submerged Arc Welding versus Metal Arc Welding; Selection of Submerged Arc Electrodes and Fluxes; Submerged Arc Welding Procedure; Electroslag Welding.
- Part 2 (5249B). Gas Tungsten Arc (Tig) Welding; Application of Tig Welding; Filler Metals for Tig Welding; Tig Welding of Pipe; Techniques for Root Bead Welding; Gas Backup for Root Bead Welding; Volume of Backup Gas; Root Welding of Pipe; Pipe Welding involving Two Welding Procedures; Tig Spot Welding; Basic Features of Gas Metal Arc (Mig) Welding; Mig Shielding Gases; Mig Filler Metal; Drop and Short Circuiting Metal Transfer in Mig Welding; Current Effect on Mig Welding; Pulsed Spray Arc Welding; Electrodes for Mig Welding; Mig Welding Procedures; Linde Equipment; Hobart and Airco Operating Data; Flux Cored Welding; Flux Cored Welding Electrodes; Operating Data on Flux Cored Welding Electrodes.
5250

Arc Welding of Alloy Steels and Iron

Duration: 10 hours (includes 1 test)
Course Prerequisites:
Electricity (4210A-C)
Fundamentals of Welding, Parts 1-2 (286025, 286066)
Arc Welding Equipment, Parts 1-3 (286032-286033, 286053)

What Students Learn:
Alloy Steels; Alloy Steel Electrodes; Arc Welding of Stainless Steel; Heat Treatment of Welded Stainless Steel; Arc Welding of Manganese Steel, Silicon Steel, and High-Carbon Steels; Welding Band and Circular Saws; Arc Welding of Cast Iron; Welding Wrought Iron; Electric Welding in Ship Construction; Repairing Wobblers and Coupling Boxes; Welding of Rail Joints; Building Up Rail Ends; Welding Firebox Sheets, Locomotive Frames, Tanks, and Boilers; Pipe Welding; Welding of Structural Shapes; Carbon Arc Cutting.

5251

Arc Welding of Nonferrous Metals and Overlaying

Duration: 10 hours (includes 1 test)
Course Prerequisites:
Electricity (4210A-C)
Fundamentals of Welding, Parts 1-2 (286025, 286066)
Arc Welding Equipment, Parts 1-3 (286032-286033, 286053)

What Students Learn:
Metals considered: Aluminum, Copper, Nickel, Magnesium, and Their Various Alloys; Metallic and Carbon Electrodes; Welding Clad Metals; Welding Galvanized Sheets; Overlaying; Soft Facing; Hard Facing; Electric Arc Cutting.

5636A

Boring Mills

Duration: 10 hours (includes 1 test)

What Students Learn:
Fundamentals of Boring Mills; Basic Functions; Vertical Boring Mills; Horizontal Boring Mills; Attachments and Accessories; Special Boring Mills; Boring Mill Motions; Boring Operations.

5961

Nondestructive Testing of Castings

Duration: 10 hours (includes 1 test)

What Students Learn:
Introduction to Nondestructive Testing; Pressure Testing; Magnetic Particle Testing; Liquid Penetrant Testing; Radiographic Testing; Ultrasonic Testing.

5962

Inspection of Shop Products

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)

What Students Learn:
Specifications for Inspection; Tolerances, and Allowances; Standards; First-Piece Inspection; Automatic Machine-Product Inspection; Patrol Inspection; Batch Inspection; Final Inspection; Screw Inspection; Measuring Threads; Three-Wire Methods; Thread Gages; Comparators; Measuring Spur Gears; Gaging Odd Teeth; Recurring Inspection; Ultrasonic Equipment; Dynamic Balances; Inspection of Machined Castings; Spectrographic Testing.

5532A-B

Gear Making

Duration: 20 hours (includes 2 tests)
Course Prerequisites:
Practical Measurements (Block X22)
Plane Trigonometry (2309A-B)
Millling Machine Practice and Operation (386033 and 386034)
Millling Machine Indexing and Spiral Work (386035)
Gear Calculations (2243)

What Students Learn:
Part 1 (5532A). Processes; Cutters; Tooth Dimensions; Milling Spur Gear; Helical Gears; Bevel Gears; Worm Gears; Internal Gears; Planning; Generating; Herringbone Gears.
Part 2 (5532B). Hobbing; Spiral Bevels; Hypoids; Gear Finishing; Rack Shaving; Rotary Shaving; Curve Shaving; Burnishing; Lapping; Grinding; Gear Inspection; Gear Materials; Heat Treatment; Flame Hardening.

6091

Broaching

Duration: 10 hours (includes 1 test)

What Students Learn:
Broaching Principle; Broaching Tools; Internal Broaching; Pull and Push Broaches; Chip Breakers; Burnishers; Manual and Automatic Broach Pullers; Surface Broaches; Broaching Machines; Broaching Press; Broaching Fixtures; Broaching Practice; Cutting Speeds; Cutting Oils; Chip Disposal; Dislodging a Stuck Broach.
6152A-B

**Practical Metallurgy for Welders**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:** Fundamentals of Welding, Parts 1-2 (286025, 286066)

**What Students Learn:**

**Part 1 (6152A).** Identifying Metals; Mechanical Properties of Metals; Physical Properties of Metals; Chemical Properties of Metals.

**Part 2 (6152B).** Filler-Metal Specifications; Iron and Steel Rods for Gas Welding; Understanding Metals; Heat Transfer; Thermal Stresses and Distortion; Preventing Distortion; Grain Structure of Metals; Metal Solidification and Strength; Cast Iron; Stainless Steel; Aluminum Alloys; Copper Alloys; Other Metals.

**Special Note:**

- This course will be replaced by a new version (286104 and 286105) currently in development.

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6154

**Safety in Welding and Cutting**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:** Fundamentals of Welding, Parts 1-2 (286025, 286066)

**What Students Learn:**

Importance of Safe Work Habits; Organizations That Make Rules for Welding Safety; Safe Practices for Handling and Using Compressed Gases, Liquefied Gases, Acetylene, and Cryogenic Gases; Electric Arc Welding Safety; Fire Prevention; Welding Hazardous Containers; Eye and Body Protection; Harmful Fumes, Vapors, and Dusts.

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6275A-B

**Gas Cutting**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:** Fundamentals of Welding, Parts 1-2 (286025, 286066)

**What Students Learn:**

**Part 1 (6275A).** The Equipment and its Fields of Use for Both Manual and Machine Oxygen Cutting; How to Start a Cut at the Edge of a Plate and at the Center of a Plate; Circular Cuts; Bevel Cuts; Rivet Cutting; Surface Removal of Metal by Flame Machining; Flame Gouging; Flame Scarfing; Flame Drilling.

**Part 2 (6275B).** The Equipment Used for Shape Cutting and for Cutting Heavy Section; Pantograph and Pipe Cutting Machines; Oxygen Lances; Tracing Devices; Iron Powder Cutting; Flux Injection Cutting; Stack Cutting, Underwater Cutting; Using Solid Welding Electrodes; Hollow Electrodes – both Steel and Ceramic – and Carbon Electrodes for Arc Cutting; Carbon Arc, Arc Oxygen, Arc Air, and Gas Shielded Metal Arc Cutting.

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6276A-C

**Gas Welding Techniques**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:** Fundamentals of Welding, Parts 1-2 (286025, 286066)

**Gas Welding Equipment (6272A-B)**

**What Students Learn:**

**Part 1 (6276A).** Instructions for Practice Welds; Joint Preparation; Corner Joints, Butt Joints, Lap and Tee Joints, and Fillet Welds; Tests to Make on Practice Welds; Welding with Single and Two or More Weld Layers; Progress Tests and Supplementary Heating; Welding Production Data; Application to Estimating and Calculation of Costs.

**Part 2 (6276B).** Weight and Schedule Systems of Classifying Pipe; Positions in Which Pipe is Welded, the Joint Preparation, and the Techniques to Use; Changes in Direction with Commercial Fittings, by Bending, and with Fabricated Fittings; Stress Relieving Tests and Tables of Weld Requirements; Advantages and Disadvantages of Braze Welding; Filler Metals; Fluxes; Joint Preparations; Braze Welding Techniques; Groove Preparations; Fluxes; Heat Treatment; Joint Preparation; Estimating Requirements; Welding Cast Iron with Cast-Iron Welding Rods and Braze Welding Cast Iron; Malleable Iron Welding.

**Part 3 (6276C).** Welding Procedures for Medium Carbon, High Carbon, and Stainless Steels; Preheating and Supplementary Heating; Welding Rods, Fluxes, and Joint Designs for Copper and Copper Alloys; Using Oxycrylene and Oxhydrogen for Welding Aluminum and Aluminum Alloys; Welding Rods, Fluxes, Joint Designs, and Techniques; Welding Procedures, Joint Designs, Fluxes, Welding Rods, and Techniques of Welding Magnesium and Magnesium Alloys, Nickel and Nickel Alloys, and Lead; Weld Sequence; Jigs and Fixtures; Joint Design; Drum Heading; Pre-deforming to Control Distortion.
**6278A-B**

*Fabrication of Pipe by Welding*

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
- Fundamentals of Welding, Parts 1-2 (286025, 286066)

**What Students Learn:**
- Part 1 (6278A). Uses of Welded Piping; Reliability; Effects of Pipe Threads; Determining Wall Thickness; Making Pipe by Piercing, Extrusion, Cupping and Drawing, and Welding; Compositions and Designations of Steel, Copper, Wrought Iron, Aluminum, Nickel, and Lead Pipe; Fabricated and Standard Fittings; Alignment of Pipes, Flanges, and Connections.

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**6569A-B**

*Transfer Devices for Machine Tools*

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisite:**
- Practical Measurements (Block X22)

**What Students Learn:**
- Part 2 (6569B). Devices Used for Linear Transfer; Chain Transfer Devices; Linkages; Trolleys; Bar Systems; Walking Beams; Compound Motion Transfer Devices.

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**6427A-F**

*Pattern Making*

**Duration:** 60 hours (includes 6 tests)

**Course Prerequisites:**
- Practical Measurements (Block X22)
- Elements of Print Reading (6719A-B)
- Reading Shop Prints (386043 and 386044)

**What Students Learn:**
- Part 2 (6427B). Jointing and Turning, Joints Used, Ways in Which They are Made, and How Patterns and Pieces of Patterns are Turned to Size; Advantages and Ways of Making Build-Up Patterns, Uses and Ways of Making Solid-Wood Patterns, and Examples of Cored Patterns.
- Part 3 (6427C). Detailed Examples of Rectangular, Partial, Tapered, and Cylindrical Core Boxes; How to Make Match Boards, and Complete Details of the Patterns Needed for a Grate; Complete Rules and Tables that Help the Patternmaker Determine the Lengths of Chords and the Weights of Castings; Shell-Molding Patterns and Complete Details of Making Patterns of Gypsum Cement and Plastic.
- Part 4 (6427D). Metals Used, Steps Necessary to Develop a Metal Pattern, and Examples of Metal Patterns; Using Pattern Plates, Fixtures, and Frames to Mount Regular- and Irregular-Shaped Patterns on Molding Machines.
- Part 5 (6427E). Patterns and Core Boxes for Castings Having Circular Sections Using Pulleys and Flywheels as Examples; Patterns for Racks, Bevel Gears, Worm and Worm Gears, Fillets, and Tooth Blocks; Sweeps, Patterns, and Core Boxes for a Transmission Case; How to Determine Curves and Thicknesses for Developing Patterns for Propellers, and the Patterns and Core Boxes for Complicated Pump Cylinders; Engine Frame as Example of a Casting Needing Many Patterns and Core Boxes.
- Part 6 (6427F). Patterns for Straight, Return-Bend and Branch Pipes, Stopping-off, Cored Holes in Flanges, and Slotted Holes in Flanges; Molding Procedures and Patterns for Large and Small Valves; Pattern Marking, Color Code, Records, and Storage.

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**6712A-B**

*Sheet Metal Hand Processes*

**Duration:** 20 hours (includes 2 tests)

**What Students Learn:**
- Part 1 (6712A). Metal Stock and Properties; Gages; Rules and Tapes; Screwdrivers; Hammers and Mallets; Pliers; Clamps and Vises; Wrenches; Squares; Hand Snips; Hand Hacksaws; Cold Chisels; Files, Punches.
- Part 2 (6712B). Hand and Breast Drills; Notchers, Seamers, and Crimpers; Stakes, Plates, and Dollies; Riveting Tools; Grooving Tools; Soldering Processes; Patterns; Flanging; Single Seams; Double Seams; The Pittsburgh Lock; Grooved Seams; The Plain Dovetailed Seam; Stanching Seams; Wire Edges.

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**6716**

*Sheet Metal Machine Processes*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
- Basic Machining Skills (Block X08)

**What Students Learn:**
- Description of Common Sheet Metal Machines and an Explanation of Their Proper Use; Bar Folders; Hand Brakes; Slip Roll Forming Machines; Squaring Shears; Beading Machines; Crimping Machines; Ring and Circle Shears; Turning Machines; Burring Machines; Bench Drill Presses; Grinding Wheels; Tool Grinding.
Lesson 1 – Introduction to Industrial Plastics: Industrial Plastics: Materials and Properties
Part 1 (686006)
Manufacturing processes. Process control and other key parts of the product development and be introduced to the fundamentals of moldmaking, material selection, Coatings and bonding materials and processes are explained. Students will between and characteristics of casting and thermoforming processes. Molding, machining, finishing, extruding and other manufacturing processes are defined and described in detail. Students learn the differences between and characteristics of casting and thermoforming processes. Coatings and bonding materials and processes are explained. Students will be introduced to the fundamentals of moldmaking, material selection, process control and other key parts of the product development and manufacturing processes.

Part 1 (686006) Industrial Plastics: Materials and Properties
Lesson 1 – Introduction to Industrial Plastics:
• Understand the vocabulary of plastics.
• Explain how and why plastics are used today.
• Understand the basics of polymer chemistry.
• Identify health and safety issues associated with plastic materials and processes.

Lesson 2 – Types, Properties and Components of Plastics:
• Identifying plastics by sight and application.
• Understand typical methods for testing plastics. Explain mechanical, physical, thermal, environmental, optical and electrical properties.
• Understand the various forms of plastics: their benefits and applications.
• Identify the ingredients used in plastic production.

Lesson 3 – Thermoplastics and Their Properties:
• List the types, benefits and uses of various types of thermoplastics.
• Explain thermoplastic properties and their effect on process design and product applications.

Lesson 4 – Thermosetting Plastics and Their Properties:
• List the types, benefits and uses of various types of thermosetting plastics.
• Explain thermosetting plastic properties and their effect on process design and product applications.

Lesson 5 – Manufacturing Processes (Part 1):
• Describe finishing and machining processes.
• Identify commonly used molding techniques.
• Describe how the extrusion process works and why it’s used.
• Explain how laminating processes work.

Lesson 6 – Manufacturing Processes (Part 2):
• Explain the benefits of composite materials and how reinforcing works.
• Understand the materials and methods used in casting plastics.
• Identify the uses for and benefits of thermoforming processes.
• Understand what expanded cellular structures are.

Lesson 7 – Plastic Coatings and Assembly of Plastic Components:
• Identify nine techniques for applying plastic coatings.
• Explain the range of methods used to bond or fabricate plastic assemblies.
• Discuss the effects of radiation processes on plastics.

Lesson 8 – Plastics Industry Today:
• Understand the product development cycle.
• Identify the best plastic for a given application.
• Explain how tooling is designed and made for the plastics industry.

Special Note:
• This is a two part series comprised of a textbook and two study guides. While we recommend that the entire course be studied, either part one or part two can be purchased and studied separately.
### Machine Technologies

**Components:**
- X0601 Metal Processing
- X0602 Ferrous Metals
- X0603 Nonferrous Metals
- X0604 Identification of Metals
- X0621 Progress Examination
- X0605 Nonmetallic Materials
- X0606 Plastics, Elastomers, and Composite Materials
- X0607 Wood Products
- X0608 Paints and Adhesives
- X0610 Introduction to Pumps and Compressors
- X0611 Introduction to Bearings and Seals
- X0612 Introduction to Power Transmission
- X0623 Progress Examination
- X0620 Progress Examination Booklet

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#### X0601 Metal Processing

**Objectives:**
- Identify industrial metals by their names and chemical symbols.
- Define in basic terms the characteristics and properties of metals.
- Explain the various metal-processing methods used in producing industrial metals.
- Explain how metals are extracted from their ores found in the earth and then refined.

#### X0602 Ferrous Metals

**Objectives:**
- Identify the features of a blast furnace.
- Recognize cast irons by their fractures and other properties.
- Describe the major steelmaking processes.
- Discuss the hot-working and cold-working methods used to shape steel.
- Classify the types of steel, according to both processing method and carbon content.
- Relate certain grade numbers to the types of steel they identify.

#### X0603 Nonferrous Metals

**Objectives:**
- Explain how the various metals are extracted from their ores.
- Describe how the addition of certain elements affects the physical properties of the base metals.
- Select the metal alloy most suitable for a given job.
- Recognize whether a copper alloy is a brass or a bronze.

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#### X0604 Identification of Metals

**Objectives:**
- Identify a metal by making a file, test magnetic test, temperature test, chip test, or spark test.
- Find the hardness of a metal by using a Brinell-Rockwell Monotron, a Vickers-Herbert Pendulum, or a scieroscope hardness-testing machine.

#### X0605 Nonmetallic Materials

**Objectives:**
- Tell how temperature and pressure can change the volume of a gas.
- Handle acids and alkalies safely.
- Discuss the uses of industrial chemicals and gases.
- Select solders and lubricants.
- Recognize carbon in its various forms.

#### X0606 Plastics, Elastomers, and Composite Materials

**Objectives:**
- Explain how plastics are formed.
- Filing, drilling, cementing, and welding plastics.
- Have a basic understanding of elastomers, and recognize their uses throughout the shop.
- Cut a piece of glass.
- Describe the uses of insulation.

#### X0607 Wood Products

**Objectives:**
- Explain how wood and lumber are classified or graded.
- Select a wood, by comparing ease of working or forming.
- Describe the methods used in making composition board and plywood.
- Select the best type of wood fastener for a specific use.

#### X0608 Paints and Adhesives

**Objectives:**
- Identify and select the best paint for a particular job.
- Explain what the different types of finishes are and what to use as solvents for them.
- Determine the easiest method of applying paint.
- Describe paint spraying techniques.
- Select the proper type of adhesives to join parts.
**X0609**  
**Fasteners**

**Objectives:**
- Identify the two basic types of fasteners.
- Define the various terms related to national thread form.
- Recognize the many types of screws and their uses.
- Identify the various types of washers.
- Properly install and remove threaded fasteners.
- Install the various types of mechanical fasteners.

**X0610**  
**Introduction to Pumps and Compressors**

**Objectives:**
- Recognize the parts of the three basic types of pumps.
- Understand the working of different types of pumps.
- Select the proper pump for a specific use.
- Explain why air compressors are used in plants.
- Describe the parts of air compressors.
- Select the proper air compressor for a specific use.

**X0611**  
**Introduction to Bearings and Seals**

**Objectives:**
- Identify the two basic types of bearings: plain and antifriction.
- State the advantage of premounted bearings.
- Describe the various rolling elements used in antifriction bearings.
- Properly clean antifriction bearings.
- Select the lip-type seal for a given application.
- Properly install lip-type seals.

**X0612**  
**Introduction to Power Transmission**

**Objectives:**
- Install, inspect, and troubleshoot V-belt drives.
- Understand the construction details of various types of belts and sheaves.
- Identify the components and uses of various chains.
- Select the suitable oil for lubricating chain drives.
- Describe the various types of gears used for transmitting power.
- Properly lubricate open and closed gear drives.

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**Block X08**  
**Basic Machining Skills**

**Duration:**  56 hours (includes 3 tests)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Industrial Safety (Block X23)
- Hand and Power Tools (Block X24)

**What Students Learn:**
This block presents the trainee with a broad overview of the basic industrial skills and knowledge needed by an entry level machinist. Skilled workers, such as electricians, pipefitters, and mechanics, whose duties include the maintenance and repair of machine tools, can benefit through cross training, from taking this course. The course starts with shop math and measurements, and applies these concepts to shop drawings, blueprint reading, layout, and metal cutting. On-the-job tasks, such as working with metal cutting machinery - milling machines, drilling machines, lathes, grinders, and CNC machine tools - are described in detail. Safety procedures relating to job tasks using metal shop machinery are an essential part of this course.

**Components:**
- X0801  Practical Shop Math, Part 1
- X0802  Practical Shop Math, Part 2
- X0803  Practical Shop Measurement
- X0804  Safe Shop Practices
- X0805  Properties and Classifications of Metals
- X0821  Progress Examination
- X0806  Using Shop Drawings, Process, and Routing Sheets, Part 1
- X0807  Using Shop Drawings, Process, and Routing Sheets, Part 2
- X0808  Layout
- X0822  Progress Examination
- X0809  Metal Cutting and Machine Tooling, Part 1
- X0810  Metal Cutting and Machine Tooling, Part 2
- X0811  Metal Cutting Machinery, Part 1
- X0812  Metal Cutting Machinery, Part 2
- X0813  Fundamentals of Grinding
- X0814  CNC Machine Tool Features and Applications
- X0823  Progress Examination
- X0820  Progress Examination Booklet

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**X0801**  
**Practical Shop Math, Part 1**

**Objectives:**
- Learn the basics of shop mathematics as they relate to machine technology.
- Add, subtract, multiply, and divide fractions and decimal values of whole units such as inches, and feet.
- Derive the square root of fractions and decimals.
- Compute a machine drive ratio for a given speed.
- Make calculations using the metric or SI system of measurement.
X0802

**Practical Shop Math, Part 2**

**Objectives:**
- Learn the fundamentals of geometry and trigonometry as they apply to machine shop calculations.
- Compute the areas of rectangles, triangles, circles, parallelograms, and other common shapes.
- Compute the volumes of solid figures such as cubes, cylinders, cones, rectangles, and combinations of these.
- Use the principles of geometry and trigonometry to analyze and solve various kinds of triangles and their parts.
- Plot coordinates of a point using both the rectangular (Cartesian) and the polar systems.
- Present the fundamentals of calculator operations as they apply to shop work.

X0803

**Practical Shop Measurement**

**Objectives:**
- Teach the terminology of linear (length) and angular dimensioning.
- Learn which tools and measuring instruments are commonly used to determine the size and dimensions of a sample workpiece.
- Use a steel rule to measure the length of a part in inches or millimeters.
- Measure the sizes of parts to 1/10,000 inch using a vernier caliper.
- Use a micrometer to measure diameters and thicknesses of workpieces.
- Make angular measurements using various instruments.

X0804

**Safe Shop Practices**

**Objectives:**
- List the proper safety equipment to be worn when performing machine shop tasks.
- State the environmental hazards most commonly encountered in a machine shop.
- Teach the fundamental safety measures for the machine shop environment and for the more popular types of machine tools used across industry.
- State the method used to remove stock from a workpiece mounted in a lathe, milling machine, and drill press.
- Name one method used to protect the worker from harmful fumes when cutting fluids are used.

X0805

**Properties and Classifications of Metals**

**Objectives:**
- Understand the four basic methods of manufacturing iron and steel.
- Discuss the fundamental properties of metals.
- Recognize standard identification of various steels and alloys.
- Know the characteristics and applications of particular steels and alloys.
- Realize the effects and limitations of heat treatment.
- Be familiar with materials testing methods.
- Differentiate between hot-working and cold-working metal processes.

X0806

**Using Shop Drawings, Process, and Routing Sheets, Part 1**

**Objectives:**
- Understand the uses of industrial blueprints.
- Learn how to read shop drawings, process, and routing sheets.
- Recognize surfaces, object lines, and object points on a blueprint.
- Recognize front, top, and right-side views of an object.
- Identify lines on a drawing and explain their use.
- Read and understand sectional views and apply information from them to other views.
- Identify and read auxiliary and double auxiliary lines.
- Understand tolerances and apply them to dimensions, and read different tolerancing systems.
- Introduce the trainee to the language of print reading.

X0807

**Using Shop Drawings, Process, and Routing Sheets, Part 2**

**Objectives:**
- Recognize and read a geometric drawing.
- Understand the system of geometric dimensioning and tolerancing used in industrial shop drawings.
- Understand variations used on geometric drawings.
- Locate and correctly read a drawing block, and apply its information to a drawing.
- Recognize and read a process sheet, and use the information it contains.
- Understand the baseline dimensioning system.
- Understand the Cartesian coordinate system.
- Understand the fixed or floating zero system.
X0808

Layout

Objectives:
• Prepare a work surface and know the types and uses of layout compounds.
• Identify and use common layout tools.
• Identify and use measuring instruments used in layout.
• Identify and use precision layout tools.
• Perform basic layout operations and construct various geometric shapes.

X0809

Metal Cutting and Machine Tooling, Part 1

Objectives:
• Describe metal cutting, how it is accomplished, and whether a cutting tool is performing properly.
• Identify a variety of cutting tools.
• Understand how a cutting tool cuts and separates material by using the three kinds of cutting edges.
• Identify the three major types of chips a cutting tool produces.
• Name the key parts of a twist drill.
• Describe the applications of a counterbore, countersink, and combination countersink/centerdrill.
• State the differences between reamers for machine and hand use.
• Explain the differences between taps used for hand tapping and machine tapping methods.
• Describe the dies used to produce threads by both hand and machine methods.
• Identify the different machine attachments and tooling components needed for tap and die threading on production machinery.

X0810

Metal Cutting and Machine Tooling, Part 2

Objectives:
• Define the major parts of a lathe tool bit.
• Identify the types and applications of turning, boring, and milling tools used in machining operations.
• Describe the different styles of end mills available.
• Identify the different horizontal end mills.
• Explain the difference between the mounting methods used for horizontal and end mill style cutters.
• Understand the differences among the various cutting tool materials used.
• Describe the reasons for using a tool coating on a cutting tool or cutting insert.
• Describe the effects of coolants on the cutting point.
• Identify the major methods of applying cutting fluids.

X0811

Metal Cutting Machinery, Part 1

Objectives:
• Identify the different types and applications of drilling machines used in industry and their important operating parts.
• Describe the major accessories and workholders used on drilling machines.
• Explain the difference between horizontal and vertical milling machines.
• Describe the different types of horizontal and vertical milling machines available.
• Understand numerical control and computerized numerical control of machine tools and differentiate between them.
• Distinguish a machining center from an ordinary milling machine.
• Understand the differences among the four designs of automatic toolchangers.

X0812

Metal Cutting Machinery, Part 2

Objectives:
• Describe basic lathe construction.
• Describe the manual and automated turning machines used by industry.
• Recognize the uses of turning centers for mass-production applications.
• Differentiate between bar and chucking types of automatic screw machines.
• Identify turning machine accessories and workholders.
• State the differences between horizontal and vertical bandsaw configurations.
• Interpret the different tooth styles of bandsaws and the applications for each style.
• Describe conventional and vertical bandsaw cutting operations.
• Explain circular cold sawing, abrasive cutting, and friction sawing techniques.

X0813

Fundamentals of Grinding

Objectives:
• Explain the physical characteristics, setup, and operation of grinding wheels.
• Name the different types of abrasives and bonds.
• Define how structure applies to the grinding process.
• Recognize Standard Marking System symbols to choose the correct grinding wheel.
• Describe the major wheel types by shape and list specific applications for each.
• Describe how to put a grinding wheel into operation and keep it in good working order.
• State the various types of grinding fluids, what they are used for, and the different methods of applying them.
• List uses and nomenclature associated with utility grinders, surface grinders, and cylindrical grinders.
• Demonstrate safe practices when using grinders.
CNC Machine Tool Features and Applications

Objectives:

• Name the common machines adapted to computer numerical control.
• Describe how CNC machines operate and what processes they are capable of performing.
• State advantages of CNC over manual control.
• Name various CNC components and describe what each does.
• Explain the function of a feedback device.
• Understand the Cartesian coordinate system of measurement.
• Define tool length compensation and describe the process of zeroing a CNC machine.
• Demonstrate safe practices when operating CNC machines.
• Describe the job responsibilities of people involved in CNC operations.
Basic Skills for the Building Trades

Carpentry

Heating and Ventilation

Masonry

Plumbing
# RESOURCE 7
## Building Trades
### Subject Index

<table>
<thead>
<tr>
<th>Basic Skills for the Building Trades</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Drawings (186043)</td>
<td>60</td>
</tr>
<tr>
<td>Erecting (2246A-B)</td>
<td></td>
</tr>
<tr>
<td>Fasteners (286095)</td>
<td>267</td>
</tr>
<tr>
<td>National Building Code (4501A-C)</td>
<td>268</td>
</tr>
<tr>
<td>National Electrical Code (5177EM)</td>
<td>269</td>
</tr>
<tr>
<td>National Fuel Gas Code (6593)</td>
<td>272</td>
</tr>
<tr>
<td>National Standard Plumbing Code (286M08)</td>
<td>268</td>
</tr>
<tr>
<td>Reading Construction Prints (6705)</td>
<td>272</td>
</tr>
<tr>
<td>Specification Writing (2175A-B)</td>
<td>266</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Carpentry</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Builders' Hardware (6421A-B)</td>
<td>271</td>
</tr>
<tr>
<td>Carpentry (5602A-F)</td>
<td>270</td>
</tr>
<tr>
<td>Carpentry (986M01)</td>
<td></td>
</tr>
<tr>
<td>Forms and Centering (2756A-B)</td>
<td>267</td>
</tr>
<tr>
<td>Millwork (2179)</td>
<td>266</td>
</tr>
<tr>
<td>Operations Preliminary to Building (2190)</td>
<td>267</td>
</tr>
<tr>
<td>Painting (6227A-C)</td>
<td>271</td>
</tr>
<tr>
<td>Planers (6118)</td>
<td>271</td>
</tr>
<tr>
<td>Plastering (2019)</td>
<td>266</td>
</tr>
<tr>
<td>Reading Architects' Blueprints (1842A-C)</td>
<td>266</td>
</tr>
<tr>
<td>Roofing (3074A-B)</td>
<td>268</td>
</tr>
<tr>
<td>Stair Building (2569)</td>
<td>267</td>
</tr>
<tr>
<td>The Steel Square (1066A-B)</td>
<td>266</td>
</tr>
<tr>
<td>Woodworking Tools (2180)</td>
<td>266</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Masonry</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Unit Construction (2185)</td>
<td>266</td>
</tr>
<tr>
<td>Common Brickwork (6290)</td>
<td></td>
</tr>
<tr>
<td>Concrete Construction (4512A-B)</td>
<td>269</td>
</tr>
<tr>
<td>Limes, Cements, and Mortars (1830)</td>
<td>266</td>
</tr>
<tr>
<td>Production of Concrete (5469A-C)</td>
<td>270</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plumbing</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic and Institutional Water Supply (5390)</td>
<td>270</td>
</tr>
<tr>
<td>Drainage Systems (4502)</td>
<td>268</td>
</tr>
<tr>
<td>Duct and Piping Design for Air Conditioning (2945)</td>
<td>206</td>
</tr>
<tr>
<td>High Pressure Pipefitting (2452)</td>
<td>198</td>
</tr>
<tr>
<td>Industrial Plumbing and Pipefitting (Block D20)</td>
<td>209</td>
</tr>
<tr>
<td>Insulation for Pipefitting (6814)</td>
<td>209</td>
</tr>
<tr>
<td>National Standard Plumbing Code (286M06)</td>
<td>268</td>
</tr>
<tr>
<td>Pipefitting Practice (5581)</td>
<td>206</td>
</tr>
<tr>
<td>Pipes and Fittings (5886)</td>
<td>207</td>
</tr>
<tr>
<td>Pipework (5386)</td>
<td>206</td>
</tr>
<tr>
<td>Plumbing Drawing (6211)</td>
<td>335</td>
</tr>
<tr>
<td>Plumbing Plans, Specifications, and Inspection (4516)</td>
<td>269</td>
</tr>
<tr>
<td>Reading Piping Prints (6732)</td>
<td>209</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heating and Ventilation</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic Combustion Control (2596A-C)</td>
<td>267</td>
</tr>
<tr>
<td>Heat Transmission through Buildings (5207)</td>
<td>270</td>
</tr>
<tr>
<td>Hot Water Heating (4503)</td>
<td>268</td>
</tr>
<tr>
<td>Introduction to Comfort Control (3569)</td>
<td>268</td>
</tr>
<tr>
<td>Radiators, Convectors, and Unit Heaters (6465)</td>
<td>272</td>
</tr>
<tr>
<td>Servicing Gas Appliances (4500B)</td>
<td>268</td>
</tr>
<tr>
<td>Steam Heating Systems (4507)</td>
<td>269</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Air Conditioning and Refrigeration</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Conditioning Systems (6084A-B)</td>
<td>207</td>
</tr>
<tr>
<td>Controls for Air Conditioning (006035)</td>
<td>197</td>
</tr>
<tr>
<td>Lithium Bromide Absorption System (014005)</td>
<td>197</td>
</tr>
<tr>
<td>Modern Refrigeration and Air Conditioning (G14003)</td>
<td>215</td>
</tr>
<tr>
<td>Principles of Heating, Ventilating, and Air Conditioning (6447A-B)</td>
<td>208</td>
</tr>
<tr>
<td>Principles of Refrigeration (5127C)</td>
<td>206</td>
</tr>
<tr>
<td>Refrigeration in Air Conditioning (5383)</td>
<td>206</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tanks, Pumps, and Boilers</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Water Supply (5384)</td>
<td>206</td>
</tr>
<tr>
<td>Condensers (6553)</td>
<td>209</td>
</tr>
<tr>
<td>Hot Water Supply (5385)</td>
<td>206</td>
</tr>
<tr>
<td>Pressure Vessel and Tank Print Reading (6691)</td>
<td>209</td>
</tr>
<tr>
<td>Pumps, Part 1 (286001)</td>
<td>199</td>
</tr>
<tr>
<td>Pumps, Part 2 (286002)</td>
<td>199</td>
</tr>
<tr>
<td>Pumps, Part 3 (286003)</td>
<td>199</td>
</tr>
<tr>
<td>Steam Boiler Operation and Maintenance (6734)</td>
<td>209</td>
</tr>
<tr>
<td>Tanks and Pumps (5389)</td>
<td>206</td>
</tr>
<tr>
<td>Tanks, Pumps, and Boilers (286046)</td>
<td>210</td>
</tr>
</tbody>
</table>

| Sanitary Plumbing Fixtures (4515A-B) | 269 |

---

**Page 254**
Recommended Career/Apprentice Curricula

- Carpenter/Carpenter Apprentice
- Construction Craft Laborer Apprentice
- Plumber/Plumber Apprentice
- Facilities Maintenance Mechanic/Technician

Recommended Topical Programs

- Basic Skills for the Building Trades
- HVAC Maintenance Specialist
  - Sheet Metal Mechanic
  - Painter
- Plumbing Distributor: Knowledge and Skills Training
- Electrician: Residential and Commercial Building Trades
  (refer to Resource 4, Electrical and Electronics)
Carpenter/ Carpenter Apprentice

The Carpenter Apprentice curriculum provides apprentices with the study materials that enable them to perform this trade. This program has been designed to meet the subject requirements set forth in the standards established by the Bureau of Apprenticeship and Training (BAT). When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

Upon completion of this program, students will be able to:

• Select proper protective clothing, eye protection, and equipment for a particular task.
• Work with basic mathematics, algebra, geometry, and trigonometry.
• Apply basic concepts for reading drawings used in the fields of construction and maintenance.
• Identify and select the proper hand or power tool for a particular task.
• Demonstrate safe practices when using common hand and power tools.
• Classify various woods according to their characteristics and properties.
• Explain the methods for performing framing tasks and other rough carpentry jobs.
• Describe the tasks involved in roof building and stair building.
• Select wood for millwork, specify moldings, and types of joints for cabinet work.
• Discuss the general concepts of the National Building Code.

### Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Technical and Basic Industrial Skills</strong></td>
<td></td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186023</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
</tr>
<tr>
<td>Fluid Measurement</td>
<td>186025</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
</tbody>
</table>

### Carpentry

- Fire Safety ................................................................. 186003
- Material Handling Safety ............................................. 186006
- Working Safely with Electricity ................................. 4400
- Jobs, Companies, and the Economy: Basic Concepts for Employees ................................................. 186034
- Quality Concepts: Tools and Applications .................. 186036
- Hand and Power Tools .................................................. Block X24
- Common Hand Tools, Part 1 .......................................... 186052
- Common Hand Tools, Part 2 .......................................... 186053
- Precision Measuring Instruments, Part 1 ...................... 186068
- Electric Drilling and Grinding Tools ......................... 186054
- Power Cutting Tools ................................................... 186055
- Pneumatic Hand Tools .................................................. 186056
- Plumbing and Pipefitting Tools ................................. 286042
- Electricians’ Tools ..................................................... 006026
- Tool Grinding and Sharpening ....................................... 186057
- Woodworking Hand Tools .............................................. 186058
- Routers, Power Planers, and Sanders ......................... 186059
- Jacks, Hoists, and Pulleys .......................................... 186060
- Preventive Maintenance ............................................... 286085
- Preventive Maintenance Techniques ............................. 286086
- Reading Prints and Schematics ................................. Block X25
- Introduction to Print Reading ..................................... 186080
- Print Reading Symbols and Abbreviations ..................... 186081
- Dimensioning and Tolerancing ................................... 186082
- Print Reading Applications ........................................ 186083
- Building Drawings ...................................................... 186043
- Electrical Drawings and Circuits ............................... 186044
- Electronic Drawings ................................................... 186045
- Hydraulic and Pneumatic Drawings ......................... 186046
- Piping: Drawings, Materials, and Parts ..................... 186047
- Welding Symbols .......................................................... 186048
- Sheet Metal Basics ...................................................... 186049
- Sketching ....................................................................... 186050
- Carpentry ........................................................................ 2180
- Reading Architects’ Blueprints (includes 5 blueprints) ... 1842A-C
- Nonmetallic Materials ................................................. X0605
- Plastics, Elastomers, and Composite Materials ............ X0606
- Wood Products ............................................................. X0607
- Paints and Adhesives .................................................... X0608
- Properties of Materials ............................................... 686005
- Principles of Mechanics, Part 1 .................................. 286007
- Principles of Mechanics, Part 2 .................................. 286008
- Specification Writing (includes 13 drawings) ............... 2175A-B
- Woodworking Tools ..................................................... 2180
- Carpentry ........................................................................ 986M01
- Applied Geometry ....................................................... X0211
- Practical Trigonometry ................................................ X0212
- The Steel Square .......................................................... 1066A-B
- Operations Preliminary to Building ......................... 2190
- Concrete Construction ................................................ 4512A-B
- Roofing .......................................................................... 3074A-B
- Stair Building .............................................................. 2569
- Plastering ........................................................................ 2019
Construction Craft Laborer Apprentice

The Construction Craft Laborer Apprentice curriculum provides apprentices with the study materials that enable them to perform this trade. This program has been designed to meet most of the subject requirements set forth in the new standards established by the Bureau of Apprenticeship and Training (BAT). This Education Direct curricula primarily covers the general skills needed by construction craft laborers: use of tools, equipment, and materials; site/project preparation and maintenance; and safety. Introductory courses in the library that cover building and highway construction are included. This curricula doesn't cover the subject of environmental remediation. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

Upon completion of this program, students will be able to:
- Select proper protective clothing, eye protection, and equipment for a particular task.
- Work with basic mathematics, algebra, geometry, and trigonometry.
- Apply basic concepts for reading drawings used in the fields of construction and maintenance.
- Identify and select the proper hand or power tool for a particular task.
- Demonstrate safe practices when using common hand and power tools.
- Prepare and construct roads paved with concrete and asphalt.
- Construct using structural steel, reinforced concrete, and wood.
- Learn the principles of construction for the following structures: foundations, steel and concrete building frames, roof trusses, plate girders, flat slabs, retaining walls, masonry arches, rigid frames, and steel bridges.

Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Technical and Basic Industrial Skills</td>
<td></td>
</tr>
<tr>
<td>Basic Industrial Math...............................</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186023</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
</tr>
<tr>
<td>Fluid Measurement</td>
<td>186025</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
<tr>
<td>Working Safely with Electricity</td>
<td>186004</td>
</tr>
<tr>
<td>Material Handling Safety</td>
<td>186006</td>
</tr>
<tr>
<td>Jobs, Companies, and the Economy: Basic Concepts for Employees</td>
<td>186034</td>
</tr>
<tr>
<td>Quality Concepts: Tools and Applications</td>
<td>186035</td>
</tr>
<tr>
<td>Hand and Power Tools</td>
<td>Block X24</td>
</tr>
<tr>
<td>Common Hand Tools, Part 1</td>
<td>186052</td>
</tr>
<tr>
<td>Common Hand Tools, Part 2</td>
<td>186053</td>
</tr>
<tr>
<td>Precision Measuring Instruments, Part 1</td>
<td>186068</td>
</tr>
<tr>
<td>Electric Drilling and Grinding Tools</td>
<td>186054</td>
</tr>
<tr>
<td>Power Cutting Tools</td>
<td>186055</td>
</tr>
<tr>
<td>Pneumatic Hand Tools</td>
<td>186056</td>
</tr>
<tr>
<td>Plumbing and Pipefitting Tools</td>
<td>286042</td>
</tr>
<tr>
<td>Electricians’ Tools</td>
<td>006026</td>
</tr>
<tr>
<td>Tool Grinding and Sharpening</td>
<td>186057</td>
</tr>
<tr>
<td>Woodworking Hand Tools</td>
<td>186058</td>
</tr>
<tr>
<td>Routers, Power Planers, and Sanders</td>
<td>186059</td>
</tr>
<tr>
<td>Jacks, Hoists, and Pullers</td>
<td>186060</td>
</tr>
<tr>
<td>Preventive Maintenance</td>
<td>286085</td>
</tr>
<tr>
<td>Preventive Maintenance Techniques</td>
<td>286086</td>
</tr>
<tr>
<td>Reading Prints and Schematics</td>
<td>Block X25</td>
</tr>
<tr>
<td>Introduction to Print Reading</td>
<td>186080</td>
</tr>
<tr>
<td>Print Reading Symbols and Abbreviations</td>
<td>186081</td>
</tr>
<tr>
<td>Dimensioning and Tolerancing</td>
<td>186082</td>
</tr>
<tr>
<td>Print Reading Applications</td>
<td>186083</td>
</tr>
<tr>
<td>Building Drawings</td>
<td>186043</td>
</tr>
<tr>
<td>Electrical Drawings and Circuits</td>
<td>186044</td>
</tr>
<tr>
<td>Electronic Drawings</td>
<td>186045</td>
</tr>
<tr>
<td>Hydraulic and Pneumatic Drawings</td>
<td>186046</td>
</tr>
<tr>
<td>Piping: Drawings, Materials, and Parts</td>
<td>186047</td>
</tr>
<tr>
<td>Welding Symbols</td>
<td>186048</td>
</tr>
<tr>
<td>Sheet Metal Basics</td>
<td>186049</td>
</tr>
<tr>
<td>Sketching</td>
<td>186050</td>
</tr>
<tr>
<td>Reading Architects’ Blueprints (includes 5 blueprints)</td>
<td>1842A-C</td>
</tr>
<tr>
<td>Building and Craft Laborer Knowledge</td>
<td></td>
</tr>
<tr>
<td>Metal Processing</td>
<td>X0601</td>
</tr>
<tr>
<td>Ferrous Metals</td>
<td>X0602</td>
</tr>
<tr>
<td>Nonferrous Metals</td>
<td>X0603</td>
</tr>
<tr>
<td>Identification of Metals</td>
<td>X0604</td>
</tr>
<tr>
<td>Nonmetallic Materials</td>
<td>X0605</td>
</tr>
<tr>
<td>Plastics, Elastomers, and Composite Materials</td>
<td>X0606</td>
</tr>
<tr>
<td>Wood Products</td>
<td>X0607</td>
</tr>
<tr>
<td>Paints and Adhesives</td>
<td>X0608</td>
</tr>
<tr>
<td>Properties of Materials</td>
<td>686005</td>
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<td>Builders’ Hardware</td>
<td>6421A-B</td>
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<td>Low Cost Road Surfaces</td>
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Estimated Curriculum Duration: 615 hours.
Number of Exams: 74.
Plumber/Plumber Apprentice

The Plumber Apprentice curricula provide apprentices with the study materials that enable them to perform the tasks associated with this trade. This program has been designed to meet the subject requirements set forth in the standards established by the Bureau of Apprenticeship and Training (BAT). When combined with on-the-job training, these programs provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

Upon completion of this program, students will be able to:

- Select proper protective clothing, eye protection, and equipment for a particular task.
- Demonstrate safe practices when using common hand and power tools.
- Apply basic concepts for reading drawings used in the fields of construction and maintenance.
- Discuss the methods used to join and assemble different kinds of pipe joints.
- Describe the procedures for laying out, supporting, and testing piping systems.
- Describe basic maintenance for tanks, pumps, and plumbing fixtures.
- Explain the proper techniques for gas and arc welding and cutting.
- Discuss the fundamentals of refrigeration and identify refrigeration tools and materials.
- Identify and describe the components of different types of refrigeration, heating, and air conditioning systems.

Base Curriculum

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Building Trades
Gas Welding Equipment ..................................................6272A-B
Gas Welding Techniques .............................................6276A-C
Common Thermal Cutting Processes .........................286028
Nature of Electricity .........................................................086001
Circuit Analysis and Ohm’s Law .....................................086002
Conductors, Insulators, and Batteries .........................086005
Alternating Current .........................................................086007
Alternating Current Circuits .........................................086008
Arc Welding Equipment, Part 1 .................................286032
Arc Welding Equipment, Part 2 .................................286033
Arc Welding Equipment, Part 3 .................................286053
Shielded Metal Arc Welding Techniques, Part 1 .......286030
Shielded Metal Arc Welding Techniques, Part 2 .......286031
Gas Metal Arc Welding Fundamentals .......................286059
Principles of Heating, Ventilating, and Air Conditioning 6447A-B
Air Conditioning Systems ...........................................6084A-B
Radiators, Convectors, and Unit Heaters .....................6465
National Fuel Gas Code ..................................................6593
National Standard Plumbing Code (Codebook and Textbook Course) ........................................286M06

Estimated Curriculum Duration: 786 hours.
Number of Exams: 101.

Facilities Maintenance Mechanic/Technician

The Facilities Maintenance Mechanic/Technician curriculum provides trainees with the courseware materials that enable them to perform multi-craft tasks within a typical industrial plant or service location. This print-based curriculum has been developed to meet the subject requirements of either an apprenticeship or an organization’s skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

The Facilities Maintenance Mechanic/Technician curriculum provides comprehensive training in pre-technical foundation skills, blueprint reading, building trade crafts, troubleshooting, mechanical maintenance, electrical and electrical motor maintenance, and welding equipment/ techniques. This curriculum is appropriate for entry level and experienced workers alike. Specific plants and service facilities may have unique skill and training needs derived from their operations and equipment. To fit some of these needs, supplemental course outlines have been assembled for the basic electronics, steam boiler and generator maintenance, and refrigeration and air conditioning trades.

Upon completion of this program, students will be able to:

- Perform multi-craft tasks associated with in-plant or facilities maintenance.
- Use common hand and power tools applicable to all trades.
- Read and interpret the standard prints, drawings, and schematics used in the building, electrical, electronic, mechanical, and metalworking trades.
- Identify the tools, equipment, and skills used in industrial plumbing, piping, fitting, and HVAC.
- Handle preventive maintenance and equipment downtime situations and procedures.
- Explain and apply the principles of fluid power and hydraulic systems and the associated equipment operations and maintenance skills.
- Install and test electrical wires, circuits, and equipment using the correct equipment, materials, and procedures for safe operation.
- Learn the concepts of welding fundamentals, gas and arc welding practices, and the proper use of equipment.

### Base Curriculum

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<th>Course Number</th>
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<td>Dimensioning and Tolerancing .................................186082</td>
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<td>Print Reading Applications .......................................186083</td>
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<td>Building Drawings ...................................................186043</td>
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<td>Electronic Drawings ................................................186045</td>
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<td>Sketching ............................................................186050</td>
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Transformers......................................................................................4040
Fractional Horsepower Motors..........................................................4033
Motor Control Fundamentals
   (for Programmable Logic Controllers)........................................006010
Industrial Motor Control
   (for Programmable Logic Controllers), Part 1.............................006011
   (for Programmable Logic Controllers), Part 2 .....................006012
Predictive Maintenance .................................................................286087
Predictive Maintenance: Vibration Analysis .................................286088
Predictive Maintenance: Advanced Topics .....................................286089

Estimated Duration: 105 hours.
Number of Exams: 12.

**Optional: Basic Electronics**

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<th>Component Testers</th>
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<td>Digital Test Equipment</td>
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<td>Analog Electronic Components</td>
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<td>Basic Semiconductor Components: Diodes</td>
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<td>086021</td>
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<td>Electronic Sensors</td>
<td>086022</td>
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<td>Special Rectifiers: Electron Tubes</td>
<td>086023</td>
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<td>Optoelectronic and Fiber Optic Components</td>
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<td>How to Solder and Desolder</td>
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Troubleshooting Industrial Electrical, Electronic,
and Computer Systems ...............................................................Block B26
| Industrial Electronic Troubleshooting | 086064 |
| Electronic Troubleshooting of Industrial Motor Controllers | 086065 |
| Troubleshooting Sensing Devices and Systems | 086066 |
| Troubleshooting Industrial Control Systems and Output Devices | 086067 |
| Troubleshooting Industrial Computer Systems and Software | 086068 |
| Industrial Computer Networks | 086069 |

Estimated Duration: 93 hours.
Number of Exams: 16.

**Optional: Welding**

Fundamentals of Welding, Part 1 ...............................................286025
Fundamentals of Welding, Part 2 ...............................................286066
Gas Welding Equipment ..............................................................6272A-B
Gas Welding Techniques ..............................................................6276A-C
Arc Welding Equipment, Part 1 ..................................................286032
Arc Welding Equipment, Part 2 ..................................................286033
Arc Welding Equipment, Part 3 ..................................................286053
Shielded Metal Arc Welding Techniques, Part 1 .......................286030

Estimated Duration: 140 hours.
Number of Exams: 14.

**Optional: Steam Boiler and Generator Maintenance**

Steam ............................................................................................2620
Steam Boiler Operation and Maintenance ....................................6734
Types of Steam Generators .........................................................6632
Steam Generator Accessories .......................................................2585
Power Plant Steam Flow Paths, Part 1 .......................................786021
Power Plant Steam Flow Paths, Part 2 .......................................786022
Power Plant Steam Flow Paths, Part 3 .......................................786023
Power Plant Instrumentation Systems .........................................786025
Power Plant Auxiliary Equipment .............................................786024
Power Plant Boilers and Related Equipment ............................786026
Conveyor Systems ......................................................................786027

Estimated Duration: 40 hours.
Number of Exams: 4.

**Optional: Refrigerator and Air Conditioning Systems**

Modern Refrigeration and Air Conditioning ..............................G14003

Estimated Duration: 152 hours.
Number of Exams: 19.
Basic Skills for the Building Trades

This topical program provides entry-level trainees with the courseware that prepares them for career opportunities in Industrial Maintenance and Construction. When combined with on-the-job training, the program will give trainees a comprehensive foundation in the basic skills and knowledge they will need to perform in these trade areas. The Basic Skills for Building Trades program can support qualifying employees as a Maintenance Helper.

Upon completion of this program, students will be able to:

- Select proper protective clothing, eye protection, and equipment for a particular task.
- Demonstrate safe practices when using common hand and power tools.
- Perform basic arithmetic functions.
- Distinguish between the various physical principles such as energy, force, and power.
- Identify and select the proper hand and power tools for a specific task.
- Understand basic concepts for reading drawings used in the fields of maintenance and construction.
- Discuss troubleshooting techniques, how to handle downtime, and maintenance procedures.
- Read and interpret architect’s drawings and construction specifications.

Base Program

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<th>Course Title</th>
<th>Course Number</th>
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<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
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<td>Working Safely with Chemicals</td>
<td>186002</td>
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<td>Plumbing and Pipefitting Tools</td>
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<td>186082</td>
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<td>186083</td>
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<td>Reading Electrical Schematic Diagrams</td>
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Estimated Program Duration: 360 hours.
Number of Exams: 48.
HVAC Maintenance Specialist

The HVAC Maintenance Specialist topical program is designed for mechanics, contractors, and facilities maintenance workers who install, service, and repair heating, ventilating, and air conditioning systems. The program provides training in mathematics, print reading, pipe fitting, air conditioning systems, controls for air conditioning, electric circuits, and motors.

Upon completion of this program, students will be able to:
- Discuss the fundamentals of refrigeration and identify refrigeration tools and materials.
- Describe the installation and servicing of the components for different types of refrigeration and air conditioning systems.
- Explain basic ventilation requirements, and air distribution and cleaning techniques.
- Identify and describe the servicing of refrigerant controls and air conditioning controls, circuits, and instruments.
- Understand heat transmission and measurement.
- Describe the procedures for laying out, supporting, and testing piping systems.

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<table>
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<tr>
<th>Course Title</th>
<th>Course Number</th>
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</tr>
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<td>186002</td>
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<td>186003</td>
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<td>186013</td>
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<td>186022</td>
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<tr>
<td>Pipes and Fittings</td>
<td>5886</td>
</tr>
<tr>
<td>Pipefitting Practice</td>
<td>5581</td>
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<tr>
<td>Insulation for Pipefitting</td>
<td>6814</td>
</tr>
<tr>
<td>Tanks and Pumps</td>
<td>5389</td>
</tr>
<tr>
<td>Heat Transmission through Buildings</td>
<td>5207</td>
</tr>
<tr>
<td>Electric Heating</td>
<td>006034</td>
</tr>
<tr>
<td>Steam Heating Systems</td>
<td>4507</td>
</tr>
<tr>
<td>Radiators, Convectors, and Unit Heaters</td>
<td>6465</td>
</tr>
<tr>
<td>Cold Water Supply</td>
<td>5384</td>
</tr>
<tr>
<td>Hot Water Supply</td>
<td>5385</td>
</tr>
<tr>
<td>Servicing Gas Appliances</td>
<td>4500B</td>
</tr>
<tr>
<td>Nature of Electricity</td>
<td>086001</td>
</tr>
<tr>
<td>Circuit Analysis and Ohm’s Law</td>
<td>086002</td>
</tr>
<tr>
<td>Conductors, Insulators, and Batteries</td>
<td>086005</td>
</tr>
<tr>
<td>Alternating Current</td>
<td>086007</td>
</tr>
<tr>
<td>Alternating Current Circuits</td>
<td>086008</td>
</tr>
<tr>
<td>Fractional Horsepower Motors</td>
<td>4033</td>
</tr>
<tr>
<td>Repairing Fractional Horsepower Motors</td>
<td>4034</td>
</tr>
<tr>
<td>Estimated Program Duration: 512 hours.</td>
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<tr>
<td>Number of Exams: 64.</td>
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</tr>
</tbody>
</table>

Sheet Metal Mechanic

This topical program provides trainees with the mathematics, measurements, machining, and drafting skills needed to perform the trade of Sheet Metal Mechanic.

Upon completion of this program, students will be able to:
- Read a shop drawing.
- Calculate basic shop mathematics problems used in the workplace.
- Describe sheet metal forming.
- Work with metal cutting tools and machinery such as drills, lathes, saws, milling machines, grinding wheels, and CNC machines.

Base Program

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Machining Skills</td>
<td>Block X08</td>
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<tr>
<td>Practical Shop Math, Part 1</td>
<td>X0801</td>
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<tr>
<td>Practical Shop Math, Part 2</td>
<td>X0802</td>
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<tr>
<td>Practical Shop Measurement</td>
<td>X0803</td>
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<tr>
<td>Safe Shop Practices</td>
<td>X0804</td>
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<tr>
<td>Properties and Classifications of Metals</td>
<td>X0805</td>
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<tr>
<td>Using Shop Drawings, Process, and Routing Sheets, Part 1</td>
<td>X0806</td>
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<tr>
<td>Using Shop Drawings, Process, and Routing Sheets, Part 2</td>
<td>X0807</td>
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<tr>
<td>Layout</td>
<td>X0808</td>
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<tr>
<td>Metal Cutting and Machine Tooling, Part 1</td>
<td>X0809</td>
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<tr>
<td>Metal Cutting and Machine Tooling, Part 2</td>
<td>X0810</td>
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<tr>
<td>Metal Cutting Machinry, Part 1</td>
<td>X0811</td>
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<tr>
<td>Metal Cutting Machinry, Part 2</td>
<td>X0812</td>
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<tr>
<td>Fundamentals of Grinding</td>
<td>X0813</td>
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<tr>
<td>CNC Machine Tool Features and Applications</td>
<td>X0814</td>
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<tr>
<td>Machine Shop Safety</td>
<td>186007</td>
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<tr>
<td>Applied Geometry</td>
<td>X0211</td>
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<tr>
<td>Practical Trigonometry</td>
<td>X0212</td>
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<tr>
<td>Sheet Metal Hand Processes</td>
<td>6712A-B</td>
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<tr>
<td>Metric System</td>
<td>186011</td>
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<tr>
<td>Sheet Metal Machine Processes</td>
<td>6716</td>
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<tr>
<td>Drafting Kit</td>
<td>1200M</td>
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<tr>
<td>Elementary Mechanical Drawing (includes 8 plates)</td>
<td>5434</td>
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<tr>
<td>Sheet Metal Drafting (includes 4 plates)</td>
<td>5551A-B</td>
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<tr>
<td>Practical Projection (includes 7 plates)</td>
<td>1949A-C</td>
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<tr>
<td>Estimated Program Duration: 468 hours.</td>
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<tr>
<td>Number of Exams: 15.</td>
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</tbody>
</table>
Painter

This program provides trainees with the related study materials required to prepare them to perform those tasks associated with the trade of Painter. When combined with on-the-job training, the painting program will give trainees a comprehensive understanding of the skills and knowledge they will need to perform in this trade area.

Upon completion of this program, students will be able to:

- Discuss physical changes, solutions, acids, bases, and other fundamentals of chemistry.
- Describe the properties and characteristics of different materials to be painted.
- Classify and select the tools and materials required for particular painting tasks.
- Discuss the importance of the proper use of colors and color schemes.
- Identify the various materials used as floor, wall, and ceiling coverings.

### Base Program

#### Course Title | Course Number
--- | ---
**Pre-Technical Skills**
 Trades Safety: Getting Started | 186001
 Working Safely with Chemicals | 186002
 Fire Safety | 186003
 Material Handling Safety | 186006
 Basic Industrial Math | Block X21
 Addition and Subtraction | 186008
 Multiplication and Division | 186009
 Fractions, Percents, Proportions, and Angles | 186010
 Metric System | 186011
 Formulas | 186012
 Introduction to Algebra | 186013
 Problem Solving and Troubleshooting | 186073
 Hand and Power Tools | Block X24
 Common Hand Tools, Part 1 | 186052
 Common Hand Tools, Part 2 | 186053
 Precision Measuring Instruments, Part 1 | 186068
 Electric Drilling and Grinding Tools | 186054
 Power Cutting Tools | 186055
 Pneumatic Hand Tools | 186056
 Plumbing and Pipefitting Tools | 286042
 Electricians’ Tools | 006026
 Tool Grinding and Sharpening | 186057
 Woodworking Hand Tools | 186058
 Routers, Power Planers, and Sanders | 186059
 Jacks, Hoists, and Pullers | 186060

#### Painting Skills and Trade Concepts

Engineering Materials | 2536A-C
Elements of Chemistry | 5011
Painting | 6227A-C
Plastering | 2019

Estimated Program Duration: 205 hours.
Number of Exams: 31.

Plumbing Distributor: Knowledge and Skills Training

This topical program provides people employed in the Plumbing Distribution industry with the technical knowledge needed to understand the tools, machinery and equipment used by your customers. It is recommended that students learn the business knowledge provided in the Distribution Industry: Core Knowledge and Skills program described in Resource 2, Foundation Skills, before starting the plumbing and building trades training.

Upon completion of this program, students will be able to:

- Learn the types and the use of the common hand and power tools, metals and measuring instruments used by plumbers and pipefitters.
- Learn the basic maintenance techniques for tanks, pumps and plumbing fixtures.
- Describe the procedures for laying out, supporting and testing piping systems.
- Identify the equipment and techniques used in gas and arc welding and cutting.

### Base Program

#### Course Title | Course Number
--- | ---
 Quality Concepts: Tools and Applications | 186036
 Common Hand Tools, Part 1 | 186052
 Common Hand Tools, Part 2 | 186053
 Precision Measuring Instruments, Part 1 | 186068
 Electric Drilling and Grinding Tools | 186054
 Pneumatic Hand Tools | 186056
 Fundamentals of Metal Cutting | 386030
 Preventive Maintenance | 286085
 Preventive Maintenance Techniques | 286086
 Hydraulic and Pneumatic Drawings | 186046
 Piping: Drawings, Materials, and Parts | 186047
 Welding Symbols | 186048
 Reading Piping Prints | 6732
 Industrial Plumbing and Pipefitting | Block D20
 The Trades of Plumbing and Pipefitting | 286040
 Pipes, Fittings, and Valves | 286041
 Plumbing and Pipefitting Tools | 286042
 Joining and Assembling Pipes | 286043
 Supporting, Installing, and Testing Pipes | 286044
 Plumbing Fixtures and Appliances | 286045
 Tanks, Pumps, and Boilers | 286046
 Insulation for Piping and Ducting | 286047
 Fasteners | 286095
 Insulation for Pipefitting | 6814
 Domestic and Institutional Water Supply | 5390
 Cold Water Supply | 5384
 Sanitary Plumbing Fixtures | 4515A-B
 Safety in Welding and Curting | 6154
 Fundamentals of Welding, Part 1 | 286025
Estimated Program Duration: 374 hours.
Number of Exams: 47.
### Building Trades

#### 1066A-B

**The Steel Square**

**Duration:** 20 hours (includes 2 tests)

**What Students Learn:**
- **Part 1 (1066A):** Description of the Square; Theory and Application; Polygons, Circles, and Ellipses; The Gable Roof; The Hip Roof.
- **Part 2 (1066B):** The Equal-Pitch Intersecting Roof; The Unequal Pitch Intersecting Roof; Framing Tables; Miscellaneous Applications.

#### 1830

**Limes, Cements, and Mortars**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Importance of Mortars; Limes and Cements; Aggregates; Properties, Proportions, and Kinds of Mortar; Preparation; Workmanship.

#### 1842A-C

**Reading Architects’ Blueprints**

**Duration:** 30 hours (includes 3 tests)

**What Students Learn:**
This text explains the use of drawings in representing buildings and the relation between drawings, blueprints, and specifications.
- **Part 1 (1842A):** Blueprints; Drawings and Specifications; Scale Detail; Use of the Scale; Indications of Materials; Parts of Buildings; Steel Framing Plans; Drawings for Reinforced Concrete; Frame Buildings; Doors and Windows.
- **Part 2 (1842B):** Interior Woodwork; Stairs; Plumbing; Heating; Drawing for a Residence.
- **Part 3 (1842C):** Plans, Elevations, and Details; Drawings of an Apartment Building.

**Special Notes:**
- 1842A: Includes 3 blueprints.
- 1842B: Includes 1 blueprint.
- 1842C: Includes 1 blueprint.

#### 2019

**Plastering**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Composition, Use, and Characteristics of Plaster; Plaster Bases; Furring and Lathing; Preparations for Plastering; Application; Plaster Problems; Stucco.

#### 2175A-B

**Specification Writing**

**Duration:** 60 hours (includes 2 tests)

**What Students Learn:**
- **Part 1 (2175A):** Specifications and Other Contract Documents; Knowledge Required for Writing Specifications; Specification Language; Outline Specifications; Preliminary Writing Procedures; Specifying Materials.
- **Part 2 (2175B):** Instruction to Bidders; General Conditions; Modifications and Supplementary General Conditions; Forms of Proposal; Excavating and Grading; Concrete; Masonry; Miscellaneous Ironwork; Rough Carpentry; Finish Carpentry; Roofing and Sheet Metal Work; Metal Windows; Glass and Glazing; Caulking; Plastering; Structural Glass; Marble and Ceramic Tile; Vinyl Tile; Painting; Finishing Hardware.

**Special Note:**
- Includes 13 drawings.

#### 2179

**Millwork**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Scope and Materials; Glued Construction; Doors; Windows; Cabinetwork; High-Pressure Laminates.

#### 2180

**Woodworking Tools**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Layout Tools; Hand Woodworking Tools; Power Woodworking Tools.

#### 2185

**Building Unit Construction**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Masonry Units and Mortars; Architectural and Structural Terra-Cotta; Glass Block and Gypsum Block; Concrete Masonry Units.
### 2190

**Operations Preliminary to Building**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
The Earth's Materials; Examination of Soils; Soil Examination by Seismic Analysis; Soil Density and Compaction; Treatment of Soils; Bearing Capacity of Foundation Beds; Tests for Bearing Capacity; Surveying and Clearing the Site; Staking Out Excavations Without a Transit; Use of the Level and Transit; Staking Out Excavations with a Transit.

### 2246A-B

**Erecting**

**Duration:** 20 hours (includes 2 tests)

**What Students Learn:**
Part 1 (2246A). Erecting Tools and Appliances; Foundations; Floors; Floor Pits; Hoists and Trucks; Block and Tackle; Chain and Screw Geared Blocks; Pneumatic and Electric Hoists; Cranes and Tractors; Derrick, Ropes, and Chains; Splicing of Ropes; Safe Loads for Chain Slings; Fitting of Parts; Press Fits; Shrink Fits; Inspection of Work; Limits of Accuracy Required in Finished Work; Study of Defects Disclosed by Inspection.
Part 2 (2246B). Erection of Large Wheels; Erection of Lathes and Planters; Erection of Steam Engines; Shop Erection of Steam Turbine; Field Erection of Turbines; Erection of Surface Condensers; Erection of Jet Condensers.

### 2569

**Stair Building**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Practical Measurements (Block X22)

**What Students Learn:**
Definitions and Classification of Stairs; Rules to Determine the Number of Treads and Risers; Methods to Lay Out Stringers and How to Support Them; Principles of Construction for Different Kinds of Steps; Layout and Construction of Cylinders and Curved Stringers; Discussion of Circular and Elliptic Stairs.

### 2596A-C

**Automatic Combustion Control**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
Practical Measurements (Block X22)
Types of Steam Generators (6632)

**What Students Learn:**
Part 1 (2596A). Preliminary Considerations; Types of Combustion Control; Steam Applications; Hot Water Applications; Feedwater and Draft Controls; Cashco Combustion Controller.

### 2756A-B

**Forms and Centering**

**Duration:** 20 hours (includes 2 tests)

**What Students Learn:**
Part 1 (2756A). Relation of Form Construction to Rate of Pouring; Economy, Safety, and Appearance; Form Materials; Erection Materials; Forms for Buildings; Forms for Footings; Forms for Walls; Ties and Separators; Wooden Panel Forms; Forms for Columns; Forms for Flat Slab Floors; Supports for Dropped Panels; Forms for Beam and Girder Floors.
Part 2 (2756B). Forms for Stairways, Towers, Openings, Sills, Copings, and Cornices; Panel Makeup; Lumber Schedules; Time Schedules; Forms for Retaining Walls and Dams; Forms for Circular Bins and Tanks; Continuously Sliding Forms; Forms for Channels, Culverts, and Sewers; Forms for Bridge Construction; Forms for Road and Street Construction.

### 286095

**Fasteners**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Identify the types and properties of fastener material.
- Describe the components of threaded fastener systems including bolts, nuts, screws and washers.
- Discuss the anchoring systems used in industry.
- Identify rivets and riveting tools.
- Describe other non-threaded fasteners including keys, pins and retaining rings.
- Display fastener installation techniques including tensioning, torquing and lubrication.
- Discuss how to troubleshoot fastener failure.

**Special Note:**
- This updated course replaces 2542.
286M06


Duration: 30 hours (includes 5 tests)

What Students Learn:
- Explain how the National Standard Plumbing Code (NSPC) is administered.
- List the basic principles upon which plumbing codes are based.
- Understand terms that are necessary to comprehend the plumbing code.
- Determine the correct use of materials, fittings, joints, and fixtures.
- Determine if water and sanitary piping systems and their vents conform to the code.
- Use tables to determine the size of different parts of plumbing systems.
- Utilize the special information found in the appendices of the plumbing code.

Administration of the NSPC; Basic Principles of the NSPC; Definitions; General Regulations; Materials; Joints and Connections; Traps; Cleanouts, and Backwater Valves; Interceptors; Plumbing Fixtures; Fixture Fittings and Plumbing Appliances; Hangers and Supports; Indirect Waste Piping and Special Wastes; Water Supply and Distribution; Sanitary Drainage Systems; Vents and Venting; Storm Water Drainage; Special Requirements for Health Care Facilities; Tests and Maintenance; Regulations governing individual Sewage Disposal Systems for Homes and other establishments where public sewage systems are not available; Potable Water Supply Systems; Mobile Home and Travel Trailer Park Plumbing Standards.

Special Note:
- The 2006 NSPC course package consists of: the revised National Standard Plumbing Code textbook; a study guide based on the 2006 code; and Plumber course supplement.

3074A-B

Roofing

Duration: 20 hours (includes 2 tests)

What Students Learn:
Part 1 (3074A). Built-Up Roofing; Failure of Built-Up Roofing; Roll and Canvas Roofing; Corrugated Roofing; Standing-Seam, Flat-Seam, and Batten-Seam Roofing.
Part 2 (3074B). Wood Shingle Roofing; Asphalt Shingle Roofing; Slate Roofing; Tile Roofing; Flashings; Roofing Problems.

4500B

Servicing Gas Appliances

Duration: 10 hours (includes 1 test)

What Students Learn:
Types of Gas-Fired Central Heating Systems; Requirements for Efficient Heating; Heating Unit Controls and Their Adjustment; Methods of Flue Gas Analysis; Service Check List for Various Heating Units; Inspection of Gas-Fired Heating Units; Principles of Gas-Fired Air Conditioning Units; Classification of Systems; Cooling and Heating Cycles of Vacuum-Type Absorption Units; Control Systems and Their Adjustment; Service Checklist for Various Cooling Units; Tables for Operational Service Work.

4501A-C

National Building Code

Duration: 45 hours (includes 3 tests)

What Students Learn:
Part 1 (4501A). Administration; Definitions; Occupancy Requirements; Means of Egress; Restrictions to Buildings and Structures; Environmental Requirements.
Part 2 (4501B). Requirements for Types of Construction; Fire Protection Requirements; Structural Design Requirements of Buildings and Structures; Chimneys, Fireplaces, and Venting Systems; Heat-Producing Appliances; Heating, Ventilating, and Air Conditioning; Blower and Exhaust Systems; Safeguards During Construction.
Part 3 (4501C). Elevators and Mechanical Equipment; Gas Piping; Electrical Wiring Systems; Signs and Outdoor Display Structures; Requirements for Existing Buildings.

4502

Drainage Systems

Duration: 10 hours (includes 1 test)

What Students Learn:
Sanitary Drainage; Storm Drainage; Mechanical Drainage; Piping for Drainage; Vent Piping; Traps; Testing the Drainage System; Sewage Disposal.

4503

Hot Water Heating

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Practical Measurements (Block X22)

What Students Learn:
Fundamental Principles and Definition of Terms; Types of System Piping; System Piping Layouts; System Design Procedure; System Pressurization and Tank Location; Air Control in Hydronic Systems; Design Example; Pressure-Drop Calculations for Large Systems; Factors in Pump Selection; Zone Control.
4507
Steam Heating Systems
Duration: 10 hours (includes 1 test)
What Students Learn:
Types of Steam Heating Systems; Piping and Equipment Design of Piping Systems; District Steam Heating; Control of Steam Heating Systems; Control Systems and Accessories.

4512A-B
Concrete Construction
Duration: 20 hours (includes 2 tests)
What Students Learn:
Part 1 (4512A). Materials; Proportions of Ingredients; Forms of Concrete; Mixing and Conveying Concrete; Placing and Finishing Concrete; Curing.
Part 2 (4512B). Concreting in Hot and Cold Weather; Concrete Floors; Finishes for Formed Concrete; Special Concretes; Tilt-Up Construction; Prestressed Concrete; Testing Concrete; Concrete Problems.

4515A-B
Sanitary Plumbing Fixtures
Duration: 20 hours (includes 2 tests)
What Students Learn:
Part 1 (4515A). Materials and Manufacture; Water Closets; Urinals; Lavatories.
Part 2 (4515B). Bathtubs and Showers; Sinks; Institutional Fixtures; Fixture Problems.

4516
Plumbing Plans, Specifications, and Inspection
Duration: 10 hours (includes 1 test)
Course Prerequisite:
Industrial Plumbing and Pipefitting (Block D20)
What Students Learn:
General Requirements; National Plumbing Code; Plumbing Plans and Specifications for a Residence; Administration of Plumbing Inspection; Plumbing Inspection.

5177EM
National Electrical Code (2008 Code and Textbook Course)
Duration: 60 hours (includes 5 tests)
Course Prerequisites:
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)
AC Principles (Block A22)
What Students Learn:
• This course provides students with the ability to understand what the National Electrical Code (NEC) requires, how to read the Code and to apply the rules.
• The purpose of this Code is the practical safeguarding of persons and property from hazards arising from the use of electricity. The Code is one of the electrical standards accepted by OSHA.
• Definitions and Explanation of Code; History of the Code and the NFPA; Code Changes; Understanding the terms and theories; Layout of the NEC; Understanding a Code Section; How to use and find information in the NEC.
• Understanding the Scope and Attitude of the Code; NEC NFPA 70; Article 90 Purpose, Scope, Enforcement, Explanation, and Safety Summary.
• Wiring Design and Protection; Wiring Methods and Materials; Use and Identification of Grounded Conductors; Branch circuits, feeders, service calculations, overcurrent protection, grounding and bonding; Equipment for General Use; Special Occupancies; Special Equipment; Special Conditions; Communication Systems; Construction Specifications; Tables; Diagrams and Examples.
Special Notes:
• The 2008 NEC course package consists of: the 2008 National Electrical Code text book; a study guide; course supplement, Understanding the NEC; and a NEC graded project, which is optional for course study.
• The project calls for the student to design a residential wiring plan. The project guide is shipped with all course orders. Being graded, it is considered as the sixth test in the course. If the company program coordinator and/or the student determine that the project is not essential to the training program, be sure to notify the Customer Service department to adjust the student record with an excused or omit grade for stock number 006017.
• Course number 5177, National Electrical Code, is also available. This course consists of a copy of the 2008 NEC and a supplemental study guide. Course duration is 18 training hours and the study guide contains 1 mastery test. Contact your Training Consultant or the Customer Service department for ordering information.
**5207**

**Heat Transmission through Buildings**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:** Formulas (186012)

**What Students Learn:**
Composition and Form of Barrier; Design Temperatures; Infiltration of Sun Heat; Computing Heat Transmission for a Laboratory and a Residence.

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**5390**

**Domestic and Institutional Water Supply**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Provision of Water; Ground Water Supply; Surface Water Supply and Reservoirs; Clarification of Water; Other Treatments of Water.

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**5469A-C**

**Production of Concrete**

**Duration:** 30 hours (includes 3 tests)

**What Students Learn:**

**Part 1 (5469A).** Factors Affecting the Quality of Concrete; Manufacture and Use of Portland Cement; Air-Entraining Cement; Shipping, Handling, and Storing Cement; Aggregates for Concrete; Admixtures in Concrete; Sampling Cement; Test for Fineness; Test for Normal Consistency; Test for Soundness; Test for Compressive Strength; Test for Air Content in Mortar.

**Part 2 (5469B).** Properties of Aggregates for Concrete; Processing and Storing Aggregates; Tests for Aggregates; Sieve Analyses; Water-Cement Ratio; Design of Concrete Mixes; Slump Tests for Consistency of Concrete; Use of Kelly Ball and Vebe Machine; Design of Mixes with Lightweight Aggregates; Design of Mixes for No-Plump Concrete.

**Part 3 (5469C).** Measurement of Ingredients for Concrete; Mixing Concrete; Tests for Concrete; Transporting and Handling Mixed Concrete; Compacting Fresh Concrete; Use of Vibrators; Construction Joints; Finishing Concrete; Curing Concrete; Concreting in Hot or Cold Weather.

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**5602A-F**

**Carpentry**

**Duration:** 60 hours (includes 6 tests)

**What Students Learn:**

**Part 1 (5602A).** Growth and Manufacture of Wood; Classification of Hardwoods and Softwoods; Grading of Softwoods and Hardwoods; Qualities of Wood; Use of Joist Table.

**Part 2 (5602B).** Framing Methods; Joints in Wood Frame; Floors, Walls, and Roof Construction; Fastening the Wood Frame; Forms for Concrete; Protection Against Fire Control of Decay and Termites.

**Part 3 (5602C).** Roof Decks; Roof Framing Systems; Materials of Construction; Joists, Beams, and Rafters; Roof Trusses; Timber Arches; Miscellaneous Framing Systems; Erection.

**Part 4 (5602D).** General Requirements of Exterior Finish; Exterior Finish of Walls; Cornices; Windows; Masonry, Brick Veneer, and Stucco.

**Part 5 (5602E).** Thermal Insulation; Condensation Control; Sound Insulation and Acoustical Treatment.

**Part 6 (5602F).** Kinds of Wood and Types of Flooring; Strip Flooring; Plank, Block, and Parquet Flooring; Installation of Wood Flooring; Flooring Problems; Installation of Interior Finish.

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**986M01**

**Carpentry**

**Duration:** 90 hours (includes 18 tests)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)

**What Students Learn:**

**Part 1 (986M01A).** General Carpentry, Part 1:
Lesson 1: Understanding Construction Drawings
Interpret Pictorial and Orthographic Drawings; Interpret Schedules and Specifications on Building Drawings; Use an Architect’s Scale; Understand Common Abbreviations and Symbols on Building Drawings; Elevations, Plot and Foundation Plans; Sections and Detail Drawings of Framing, Footings, and Other Features.

Lesson 2: Building Codes and Building Layout
Reason for Zoning and Building Codes; Lay Out Level Points for a Structure Using a Water Level; Using a Transit; Laser Levels; Locating and Laying Out Foundations.

Lesson 3: Lumber, Building Materials, and Fasteners
Uses for Hardwoods and Softwoods; Moisture Content and Lumber Defects; Sizing and Grading Lumber; Engineered Wood Panels and Structural Members; Fasteners and Adhesives.

Lesson 4: Carpentry Practical Exercise
Practical Problems and Examination Related to Interpreting a Set of Working Drawings.

**Part 2 (986M01B).** General Carpentry, Part 2:
Lesson 5: Hand and Power Tools
Layout and Measurement Tools; Hand and Power Drills; Cutting, Dismantling, and Fastening, Tools; Power Tool Safety; Routers and Sanders; Pneumatic Tools; Table and Radial-Arm Saws; Miter Saws.

Lesson 6: Foundations and Concrete Work
Components of Concrete; How Concrete Cures; Building Forms for Footings, Slabs, Sidewalks, and Driveways; Concrete Wall Forms; Properly Pouring Concrete in Wall and Other Forms.

Lesson 7: Carpentry Practical Exercise
Practical Problems and Examination Related to Woodworking Tools and Concrete Work.
Building Trades

Part 3 (986M01C). Framing and Roofing:
Lesson 8: Floor Framing
Wall and Floor Framing Techniques and Styles; Girders and Beams; Framing a Floor Opening; Installing Bridging; Subfloors.
Lesson 9: Wall and Stair Framing
Sizing Interior and Exterior Wall Framing Members; Framing Interior and Exterior Walls; Sheathing Exterior Walls; Light Steel Framing Systems; Scaffolds, Jacks, and Brackets; Stair Layout and Construction.
Lesson 10: Roof Styles, Framing, and Finishing
Roof Designs; Roof Framing Members; Laying Out a Gable, Hip, Shed, and Intersecting Roof; Roof Sheathing; Cornices; Estimating and Applying Roof-Finishing Materials.
Lesson 11: Carpentry Practical Exercise
Practical Problems and Examination Related to Framing and Roofing.
Part 4 (986M01D). Exterior Work:
Lesson 12: Windows, Doors, and Insulation
Window Components, Selection, and Installation; Exterior Door Components and Installation; Insulation Rating, Selection, and Installation; Vapor Barriers; Ventilation in Insulated Structures.
Lesson 13: Siding, Porches, and Decks
Siding for Residential Construction; Estimate and Install Wood and Vinyl Siding; Installing Decks, Porches, Fences, and Rail Systems.
Lesson 14: Carpentry Practical Exercise
Practical Problems and Examination Related to Exterior Finish Work.

Part 5 (986M01E). Interior Finish Work:
Lesson 15: Drywall Techniques
Types and Sizes of Drywall Panels; Applications for Various Types; Estimating Material Requirements; Fasteners and Compound; Cutting and Installing Drywall; Taping and Finishing Joints; Sanding.
Lesson 16: Interior Finish
Interior Doors and Frames; Hanging Doors and Installing Locksets; Interior Trim Installation Including Molding, Casings, and Baseboards; Stair Finishing; Building Codes Related to Finished Staircases.
Lesson 17: Finish Floors and Ceilings
Suspended Ceiling Options; Material Estimate and Layout for Suspended Ceilings; Hardwood Flooring Selection and Installation; Strip, Plank, and Parquet Flooring Installation; Estimating Floor Materials; Installing Underlayment.
Lesson 18: Carpentry Practical Exercise
Practical Problems and Examination Related to Drywall and Interior Finishing Materials and Techniques.

Special Note:
- This course consists of three textbooks and five supplemental study guides. If targeted training needs dictate that only a portion of this course be studied, study guides (Parts 2 through 5) can be purchased with or without the textbook. The Part 1 study guide can only be purchased with a textbook. Call Customer Support or your Training Consultant for pricing and stock numbers if you wish to order study guides with or without textbooks.
- This updated course replaces Carpentry (5602A-F).

6118

Planers

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Shapers, Slotters, and Keyseaters (2222)

What Students Learn:
Planer Cutting Action; Bed and Table Construction; Drive and Lubrication Systems; Column, Crossrail, and Toolhead Construction; Counterbalancing and Power Swiveling System; Automatic Feed and Rapid-Power Traverse Systems; Elevating and Clamping Mechanisms; Pendant Stations; Cutters; Feeds and Speeds; Work-Setting Equipment; Planer Practice.

6227A-C

Painting

Duration: 30 hours (includes 3 tests)

What Students Learn:
Part 1 (6227A). Materials for Painting and Wood Finishing; Fire Retardant and Special Purpose Paints; Tools; Spray Painting Equipment; Ladders and Scaffolds.
Part 2 (6227B). Preparation for Painting; Masonry, Concrete, and Other Cementitious Surfaces; Structural Steel and Miscellaneous Metals; Exterior Woodwork; Interior Plaster; Interior Woodwork; Wood Finishing; Special Painting Problems; Estimating.
Part 3 (6227C). Pigment Colors; Effects of Color; Color Schemes.

6290

Common Brickwork

Duration: 10 hours (includes 1 test)

What Students Learn:
Characteristics of Brick and Mortar; Tools and Scaffolding; Essentials of Good Construction; Masonry Walls; Chimneys and Fireplaces; Anchors, Flashings, and Expansion Joints.

6421A-B

Builders’ Hardware

Duration: 20 hours (includes 2 tests)

What Students Learn:
Part 1 (6421A). Rough Hardware; Hinges; Locks; Other Door Hardware.
Part 2 (6421B). Window and Transom Hardware; Cabinet Hardware; Miscellaneous Hardware; Selecting and Specifying Hardware.
6465  
**Radiators, Convectors, and Unit Heaters**  
**Duration:** 10 hours (includes 1 test)  
**What Students Learn:**  
Types of Heat-Transmitting Units; Radiators; Convectors; Unit Heaters and Heating, Ventilating, and Cooling Units; Heating Capacity Ratings; Panels for Radiant Heating; Supplementary Radiation.

6593  
**National Fuel Gas Code**  
**Duration:** 15 hours (includes 1 test)  
**What Students Learn:**  

6705  
**Reading Construction Prints**  
**Duration:** 10 hours (includes 1 test)  
**Course Prerequisite:** Practical Measurements (Block X22)  
**What Students Learn:**  
Types and Uses of Drawings and Prints; Dimensions and Scales; Symbols and Common Conventions; Sectional Views; Boiler Components Nomenclature; Examples of Print Reading; Hanger Rods and Penthouse Framing; Large Piping and Headers; Loose Tubing; Superheaters; Wall Tubes; Flues and Ducts; Field Material Shop Orders.
Electric Power Generating Stations

Electrical Power Distribution

Power Transmission, Lines, and Systems

Voltage Regulation
### Utility Industry

**Subject Index**

<table>
<thead>
<tr>
<th>Electric Power Generating Stations</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion Turbines, Part 1 (786013)</td>
<td>293</td>
</tr>
<tr>
<td>Combustion Turbines, Part 2 (786014)</td>
<td>293</td>
</tr>
<tr>
<td>Combustion Turbines, Part 3 (786015)</td>
<td>293</td>
</tr>
<tr>
<td>Conveyor Systems (786027)</td>
<td>295</td>
</tr>
<tr>
<td>Data, Voice, and Video Cabling (086E16)</td>
<td>284</td>
</tr>
<tr>
<td>Distributed Control Systems, Part 1 (086084)</td>
<td>284</td>
</tr>
<tr>
<td>Distributed Control Systems, Part 2 (086085)</td>
<td>284</td>
</tr>
<tr>
<td>Distributed Control Systems, Part 3 (086086)</td>
<td>284</td>
</tr>
<tr>
<td>Electric Power Generating Stations (6589A-B)</td>
<td>288</td>
</tr>
<tr>
<td>Electric Power Substations (6590A-B)</td>
<td>289</td>
</tr>
<tr>
<td>Flue Gas Analysis (6810)</td>
<td>289</td>
</tr>
<tr>
<td>Fuels (5340)</td>
<td>287</td>
</tr>
<tr>
<td>Fundamentals of Power Plant Operation, Part 2 (786006)</td>
<td>292</td>
</tr>
<tr>
<td>Fundamentals of Power Plant Operation, Part 3 (786007)</td>
<td>292</td>
</tr>
<tr>
<td>I-C Engine Fuels and Combustion (2526)</td>
<td>286</td>
</tr>
<tr>
<td>I-C Engine Testing (2527)</td>
<td>286</td>
</tr>
<tr>
<td>Oil and Gas Firing for Steam Generation (2592)</td>
<td>286</td>
</tr>
<tr>
<td>Power Plant Auxiliary Equipment (786024)</td>
<td>294</td>
</tr>
<tr>
<td>Power Plant Boilers and Related Equipment (786026)</td>
<td>295</td>
</tr>
<tr>
<td>Power Plant Economy (2514)</td>
<td>285</td>
</tr>
<tr>
<td>Power Plant Fuel Flow Paths, Part 1 (786018)</td>
<td>293</td>
</tr>
<tr>
<td>Power Plant Fuel Flow Paths, Part 2 (786019)</td>
<td>294</td>
</tr>
<tr>
<td>Power Plant Fuel Flow Paths, Part 3 (786020)</td>
<td>294</td>
</tr>
<tr>
<td>Power Plant Instrumentation Systems (786025)</td>
<td>295</td>
</tr>
<tr>
<td>Power Plant Steam Flow Paths, Part 1 (786021)</td>
<td>294</td>
</tr>
<tr>
<td>Power Plant Steam Flow Paths, Part 2 (786022)</td>
<td>294</td>
</tr>
<tr>
<td>Power Plant Steam Flow Paths, Part 3 (786023)</td>
<td>294</td>
</tr>
<tr>
<td>Power Plant Water Treatment, Part 1 (786008)</td>
<td>292</td>
</tr>
<tr>
<td>Power Plant Water Treatment, Part 2 (786009)</td>
<td>292</td>
</tr>
<tr>
<td>Power Plant Water Treatment, Part 3 (786010)</td>
<td>292</td>
</tr>
<tr>
<td>Pressure Parts for Steam Generators (2588)</td>
<td>286</td>
</tr>
<tr>
<td>Principles and Uses of Nuclear Energy (6683)</td>
<td>289</td>
</tr>
<tr>
<td>Principles of the I-C Engine (2525)</td>
<td>285</td>
</tr>
<tr>
<td>Solid and Pulverized Fuel Burning (6473)</td>
<td>288</td>
</tr>
<tr>
<td>Station Power (786011)</td>
<td>293</td>
</tr>
<tr>
<td>Steam (2620)</td>
<td>287</td>
</tr>
<tr>
<td>Steam Engines and Their Management (2523A-C)</td>
<td>285</td>
</tr>
<tr>
<td>Steam Generator Accessories (2585)</td>
<td>286</td>
</tr>
<tr>
<td>Steam Generator Design (2598A-B)</td>
<td>287</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electrical Power Distribution</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Concepts for Lineworkers (786E03)</td>
<td>290</td>
</tr>
<tr>
<td>Electrical Power Distribution and Transmission for the Technician (786E01)</td>
<td>290</td>
</tr>
<tr>
<td>Fundamentals of Linework (786016)</td>
<td>293</td>
</tr>
<tr>
<td>Hydraulic Turbines (6718A-C)</td>
<td>289</td>
</tr>
<tr>
<td>Lineworker’s Tools (786017)</td>
<td>293</td>
</tr>
<tr>
<td>Local Distribution of Electric Power (006038)</td>
<td>284</td>
</tr>
<tr>
<td>Rigging for Lineworkers (786E04)</td>
<td>291</td>
</tr>
<tr>
<td>Safety for Lineworkers (786E02)</td>
<td>290</td>
</tr>
<tr>
<td>The Lineman’s and Cableman’s Handbook (6070A-I)</td>
<td>288</td>
</tr>
<tr>
<td>Transformation for Lineworkers (786E05)</td>
<td>291</td>
</tr>
<tr>
<td>Underground Distribution for Lineworkers (786E06)</td>
<td>291</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power Transmission, Lines, and Systems</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Power Distribution and Transmission for the Technician (786E01)</td>
<td>290</td>
</tr>
<tr>
<td>Power Line Calculations (6256)</td>
<td>288</td>
</tr>
<tr>
<td>Transmission Lines (4358)</td>
<td>287</td>
</tr>
<tr>
<td>Underground Power Systems (006039)</td>
<td>284</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Voltage Regulation</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Regulation of Distribution Systems (4370)</td>
<td>287</td>
</tr>
<tr>
<td>Voltage Regulators for Generators (4368)</td>
<td>287</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transformers</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design of Transformers (4415)</td>
<td>146</td>
</tr>
<tr>
<td>Distribution and Power Transformers (4042)</td>
<td>145</td>
</tr>
<tr>
<td>Electrical Energy Distribution (086013)</td>
<td>153</td>
</tr>
<tr>
<td>Instrument Transformers (6793)</td>
<td>150</td>
</tr>
<tr>
<td>Transformer Operation (4041)</td>
<td>144</td>
</tr>
<tr>
<td>Transformers (086011)</td>
<td>153</td>
</tr>
<tr>
<td>Transformers (4040)</td>
<td>144</td>
</tr>
</tbody>
</table>
Recommended Career/Apprentice Curricula

- Power Plant Engineer/Operator
- Electrical/Electronics Maintenance Technician or Utilities Engineer/Electrician
- Lineman/High Voltage Electrician
- Meter Reader
This Utilities Industry specific skills curriculum provides trainees with the courseware that enables them to perform the tasks associated with a Power Plant Engineer/Operator. This print-based curriculum has been developed to meet the subject requirements of either an apprenticeship or an organization’s skills development program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

The recommended Power Plant Engineer/Operator curriculum covers the primary skill needs for electric (including coal and fossil fuel plants), hydroelectric, steam, and nuclear power plant operations, and substation operations. The curriculum provides the mathematics background needed to understand the principles and operation of the machinery that generates electricity. Scientific, mechanical technologies, and electrical/electronics courses provide a technical foundation for understanding machinery and equipment operation/maintenance used in utilities. The training covers power plant machinery and equipment including generators, motors, switchgear, protective relaying, and electric power generation, transmission, and distribution.

This curriculum, as modified by custom assembling the appropriate courses, applies to utilities positions such as: Dispatcher, Generating Station Operator, Plant Relayman, and Power Plant General Instrument Mechanic. This training is appropriate for both entry level and experienced utilities employees.

Upon completion of this program, students will be able to:

- Perform calculations using algebra, trigonometry, and geometry.
- Understand the meaning of mathematical formulas as applied to mechanics.
- Understand the principles, components and measuring instruments associated with AC and DC electricity.
- Understand the operation and control of the common motors and generators found in utilities.
- Differentiate between distribution and power transformers by construction and application.
- Discuss the application of protective relays to protect motors, generators, buses and transformers.
- Understand the purpose and operation of the various equipment used in electric power generating stations.
- Describe the functions of the equipment used in power distribution stations.
- Explain the principles of operation of the various types of steam generators.
- Describe the methods used to regulate the voltage of distribution systems.

### Course Title Number

#### Pre-Technical Foundation Skills

- Trades Safety: Getting Started ............................................... 186001
- Working Safely with Chemicals ............................................. 186002
- Fire Safety ............................................................................. 186003
- Material Handling Safety ..................................................... 186006
- Basic Industrial Math.......................................................... Block X21
- Addition and Subtraction ..................................................... 186008
- Multiplication and Division .................................................. 186009
- Fractions, Percents, Proportions, and Angles ...................... 186010
- Metric System ...................................................................... 186011
- Formulas .............................................................................. 186012
- Introduction to Algebra....................................................... 186013
- Linear and Distance Measurement ...................................... 186021
- Bulk Measurement............................................................... 186022
- Temperature Measurement ................................................ 186023
- Energy, Force, and Power ................................................... 186024
- Fluid Measurement .............................................................. 186025
- Problem Solving and Troubleshooting ............................... 186073
- Introduction to Algebra, Geometry, and Trigonometry ...... Block X02
  - Algebra: Monomials and Polynomials .............................. X0201
  - Algebra: Factoring ........................................................... X0202
  - Algebra: Addition and Subtraction of Fractions ............... X0203
  - Algebra: Multiplication and Division of Fractions .......... X0204
  - Algebra: Linear Equations .............................................. X0205
  - Algebra: Simultaneous Linear Equations ....................... X0206
  - Algebra: Determinants ................................................... X0207
  - Algebra: Quadratic Equations ........................................ X0208
  - Algebra: Exponents ....................................................... X0209
  - Algebra: Radicals and Imaginary Numbers .................... X0210
  - Applied Geometry .......................................................... X0211
  - Practical Trigonometry ..................................................... X0212
- Working Safely with Electricity .......................................... 4400
- Quality Concepts: Tools and Applications ......................... 186036
- Preventive Maintenance ..................................................... 286085
- Preventive Maintenance Techniques ................................. 286086
- Predictive Maintenance ..................................................... 286087

#### Scientific Principles

- Heat, Part 1 ........................................................................... 686001
- Heat, Part 2 ........................................................................... 686002
- Steam .................................................................................. 2620
- Elements of Chemistry ....................................................... 5011
- Engineering Chemistry ....................................................... 5012
- Heat Transfer ....................................................................... 2545
### Power Plant Operating Principles

- Fundamentals of Power Plant Operation, Part 1 ............................................786005
- Fundamentals of Power Plant Operation, Part 2 ............................................786006
- Fundamentals of Power Plant Operation, Part 3 ............................................786007
- Power Plant Water Treatment, Part 1 .................................................................786008
- Power Plant Water Treatment, Part 2 .................................................................786009
- Power Plant Water Treatment, Part 3 .................................................................786010
- Power Plant Station Power .................................................................................786011
- Power Plant Fuel Flow Paths, Part 1 .................................................................786018
- Power Plant Fuel Flow Paths, Part 2 .................................................................786019
- Power Plant Fuel Flow Paths, Part 3 .................................................................786020
- Power Plant Steam Flow Paths, Part 1 .................................................................786021
- Power Plant Steam Flow Paths, Part 2 .................................................................786022
- Power Plant Steam Flow Paths, Part 3 .................................................................786023
- Power Plant Auxiliary Equipment ..................................................................786024
- Power Plant Instrumentation Systems .................................................................786025
- Power Plant Boilers and Related Equipment .......................................................786026
- Conveyor Systems .............................................................................................786027
- Combustion Turbines, Part 1 ..............................................................................786031
- Combustion Turbines, Part 2 ..............................................................................786041
- Combustion Turbines, Part 3 ..............................................................................786051

### Mechanical Technologies and Maintenance

- Pumps, Part 1 ........................................................................................................286001
- Pumps, Part 2 ........................................................................................................286002
- Pumps, Part 3 ........................................................................................................286003
- Pneumatics, Part 1 ...............................................................................................286008
- Pneumatics, Part 2 ...............................................................................................286009
- Pneumatics, Part 3 ...............................................................................................286100
- Air Compressors, Part 1 ....................................................................................286006
- Air Compressors, Part 2 ....................................................................................286007
- Bearings and Seals, Part 1 ................................................................................286009
- Bearings and Seals, Part 2 ................................................................................286094
- Lubrication, Part 1 ................................................................................................286901
- Lubrication, Part 2 ................................................................................................286902
- Mechanical Power Transmission Part 1 .............................................................286101
- Mechanical Power Transmission Part 2 .............................................................286102
- Mechanical Power Transmission Part 3 .............................................................286103
- Mechanical Testing of Materials ......................................................................26080A-B
- Engineering Mechanics, Part 1 .........................................................................286036
- Engineering Mechanics, Part 2 .........................................................................286037
- Engineering Mechanics, Part 3 .........................................................................286038
- Engineering Mechanics, Part 4 .........................................................................286039
- Fluid Mechanics, Part 1 ......................................................................................286010
- Fluid Mechanics, Part 2 ......................................................................................286011
- Fluid Mechanics, Part 3 ......................................................................................286012

### Blueprint Reading

- Reading Prints and Schematics ..........................................................................Block X25
- Introduction to Print Reading .............................................................................186080
- Print Reading Symbols and Abbreviations ..........................................................186081
- Dimensioning and Tolerancing .........................................................................186082
- Print Reading Applications ................................................................................186083
- Building Drawings ............................................................................................186043
- Electrical Drawings and Circuits .......................................................................186044
- Electronic Drawings ...........................................................................................186045
- Hydraulic and Pneumatic Drawings ..................................................................186046
- Piping: Drawings, Materials, and Parts ...............................................................186047
- Welding Symbols ................................................................................................186048
- Sheet Metal Basics .............................................................................................186049
- Sketching ............................................................................................................186050
- Reading Shop Prints, Part 1 ................................................................................386043
- Reading Shop Prints, Part 2 ................................................................................386044

### Electrical/Electronics Principles and Equipment

- DC Principles ......................................................................................................Block A21
- Nature of Electricity ............................................................................................086001
- Circuit Analysis and Ohm's Law .........................................................................086002
- Capacitors and Inductors ..................................................................................086003
- Magnetism and Electromagnetism .....................................................................086004
- Conductors, Insulators, and Batteries .................................................................086005
- DC Motors and Generator Theory ......................................................................086006
- Alternating Current .............................................................................................086007
- Alternating Current Circuits ..............................................................................086008
- Inductors in AC Circuits ......................................................................................086009
- Capacitors in AC Circuits ...................................................................................086010
- Transformers ......................................................................................................086011
- Alternators ...........................................................................................................086012
- Electrical Energy Distribution ............................................................................086013
- Rectification and Basic Electronic Devices ..........................................................086014
- Analog Circuit Measurement ..............................................................................Block A23
- Basic Test Equipment ..........................................................................................086025
- Troubleshooting with Volt-Ohm-Millamp Meters (VOMs) ...................................086026
- Using Basic Oscilloscopes ..................................................................................086027
- Electrical Safety for the Trades .........................................................................186005
- Electrical Equipment ..........................................................................................Block A24
- Conductors and Insulators in Industry ...............................................................086070
- Working with Conduit .........................................................................................086071
- Electrical Boxes ...................................................................................................086072
- Industrial Enclosures and Raceways ..................................................................086073
- Connecting Electrical Equipment, Part 1 .........................................................086074
- Connecting Electrical Equipment, Part 2 .........................................................086075
- Industrial Fuses ...................................................................................................086076
- Industrial Circuit Breakers ..................................................................................086077
- Plugs, Receptacles, and Lampholders ..................................................................086078
- Industrial Switches .............................................................................................086079
- Industrial Relay Ladder Logic .............................................................................086080
- Industrial Relays, Contractors, and Solenoids ....................................................086081
- Industrial DC Motors ..........................................................................................086051
- Industrial AC Motors ..........................................................................................086052
- Controlling Industrial Motors ............................................................................086053
- Electrical Grounding ..........................................................................................086054
- Electrical Wiring Practices ..................................................................................086055
- Data, Voice, and Video Cabling ..........................................................................086056
- Component Testers ..............................................................................................086062
- Digital Test Equipment .........................................................................................086063
- Electric Lamps, Part 1 ..........................................................................................006031
- Electric Lamps, Part 2 ..........................................................................................006032
- Electric Heating ....................................................................................................006034

### Electric and Steam Power Generation Plants – Equipment Operation and Maintenance

- Types of Steam Turbines .......................................................................................2505
- Steam Turbine Management and Governing ......................................................2506
- Steam Turbine Calculations ................................................................................2507
- Pressure Vessel and Tank Print Reading .............................................................6691
- Types of Steam Generators ..................................................................................6632
- Steam Generator Design ......................................................................................2598A-B
- Pressure Parts for Steam Generators .................................................................25988
- Steam Generator Settings, Ducts, and Stacks ....................................................2587
- Condensers ...........................................................................................................6553
- Feedwater Treatment and Equipment .................................................................6727
- Fuels ......................................................................................................................5340
- Solid and Pulverized Fuel Burning ......................................................................6473
- Testing Solid and Liquid Boiler Fuels ..................................................................6472
- Oil and Gas Firing for Steam Generation ..............................................................2592
- Automatic Combustion Control .........................................................................2596A-C
- Flue Gas Analysis ..................................................................................................6810
- Steam Boiler Operation and Maintenance ............................................................6734
- Steam Generator Testing .....................................................................................6802
- Principles of the I-C Engine ................................................................................2525
Utility Industry – Operations and Maintenance

Electrical Equipment Applications Used in the Utilities Industry

Transformers ................................................................. 4040
DC Machines ................................................................. 4030A-B
Transformer Operation .............................................. 4041
Distribution and Power Transformers .................. 4042
Instrument Transformers .............................................. 6793
Storage Batteries ............................................................. 4343
Electric Power Measurements .................................. 4019A-B

Transmission and Distribution of Electric Power

Local Distribution of Electrical Power ..................... 006038
Switchgear ................................................................. 086092
Protective Relaying ...................................................... 6538A-B
Telemetering ................................................................. 4048
Voltage Regulators for Generators ...................... 4368
Voltage Regulation of Distribution Systems ........ 4370
Electric Power Generating Stations .................. 6589A-B
Electric Power Substations ......................................... 6590A-B
Transmission Lines ......................................................... 4358
Power Line Calculations .............................................. 6256
Underground Power Systems ................................. 006039
Transformation for Lineworkers .......................... 786E05
Underground Distribution for Lineworkers .......... 786E06
Electric Power Distribution and Transmission for the Technician .................................. 786E01

Estimated Curriculum Duration: 1,655 hours.
Number of Exams: 202.

Optional: Hydro-Electric, Nuclear Power Plant Operations

Hydraulic Turbines ...................................................... 6718A-C
Principles and Uses of Nuclear Energy .................. 6683

Estimated Duration: 40 hours.
Number of Exams: 4.

Electrical/Electronics Maintenance Technician or Utilities Engineer/Electrician

This Utilities Industry specific skills curriculum provides trainees with the courseware that enables them to perform the tasks associated with an Electrical/Electronics Maintenance Engineer or Technician. This print based curriculum has been developed to meet the subject requirements of either an apprenticeship or an organization’s skills development program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

The curriculum starts with the needed mathematics foundation. The training progresses to the electrical and electronics courses needed to give trainees both the theory and a working knowledge of the operation and maintenance of all types of machinery and equipment used in power plants.

This curriculum, as modified by custom assembling the appropriate courses, applies to utilities positions such as: Transformer Mechanic, Transmission Technician, Instrumentation Technician, Electric Control Designer, Electronics and Instrumentation Specialist. This training is appropriate for both entry level and experienced utilities employees.

Upon completion of this program, students will be able to:
- Perform calculations using algebra, geometry, and trigonometry.
- Understand the principles, components, and measuring instruments associated with AC and DC electricity.
- Understand the operation and control of the common motors and generators found in utilities.
- Differentiate between distribution and power transformers by construction and application.
- Discuss the application of protective relays to protect motors, generators, buses, and transformers.
- Describe the methods used to regulate the voltage of distribution systems.
- Work with electrical quantities such as voltage, current, and resistance as they apply to electronic circuits.
- Select the proper type of test equipment for a particular electronic application.
- Discuss the operation of electronic systems such as microprocessors and servo and control systems as used in industry.

Base Curriculum

Course Title Number

Pre-Technical Foundation Skills

Basic Industrial Math .................................................. Block X21
Addition and Subtraction ........................................... 186008
Multiplication and Division ........................................ 186009
Fractions, Percents, Proportions, and Angles ........... 186010
Metric System ......................................................... 186011
Formulas ................................................................. 186012
Introduction to Algebra ............................................ 186013

Practical Measurements ............................................. Block X22
Linear and Distance Measurement ......................... 186021
Bulk Measurement ................................................... 186022
Temperature Measurement ....................................... 186023
Energy, Force, and Power .......................................... 186024
Fluid Measurement .................................................... 186025
Problem Solving and Troubleshooting ..................... 186073
Introduction to Algebra, Geometry, and Trigonometry Block X02
Algebra: Monomials and Polynomials ....................... X0201
Algebra: Factoring .................................................. X0202
Algebra: Addition and Subtraction of Fractions ....... X0203
Algebra: Multiplication and Division of Fractions ...... X0204
Algebra: Linear Equations ........................................ X0205
Algebra: Simultaneous Linear Equations ................ X0206
Algebra: Determinants ............................................ X0207
Algebra: Quadratic Equations ................................ X0208
Algebra: Exponents ............................................... X0209
Algebra: Radicals and Imaginary Numbers ............ X0210
Applied Geometry .................................................... X0211
Practical Trigonometry ............................................. X0212
Trades Safety: Getting Started ............................... 186001
Working Safely with Chemicals ......................... 186002
Fire Safety ............................................................ 186003
Material Handling Safety ................................. 186006
Machine Shop Safety .............................................. 186007
Working Safely with Electricity ........................... 4400
Quality Concepts: Tools and Applications .............. 186036
Preventive Maintenance .......................................... 286085
Preventive Maintenance Techniques ..................... 286086
Predictive Maintenance ............................................ 286087
Electrical Principles and Skills
DC Principles ................................................................. Block A21
Nature of Electricity ..................................................... 086001
Circuit Analysis and Ohm's Law ................................. 086002
Capacitors and Inductors ............................................. 086003
Magnetism and Electromagnetism ................................. 086004
Conductors, Insulators, and Batteries ......................... 086005
DC Motors and Generator Theory ............................... 086006

Optiona Laboratory Experiments:
Electronic Simulation Software .................................. 086800
Experiments with Basic DC Theory – Lab Manual ........ 086087
AC Principles ................................................................. Block A22
Alternating Current ...................................................... 086007
Alternating Current Circuits ......................................... 086008
Inductors in AC Circuits .............................................. 086009
Capacitors in AC Circuits ............................................. 086010
Transformers .................................................................. 086011
Alternators ..................................................................... 086012
Electrical Energy Distribution ...................................... 086013
Rectification and Basic Electronic Devices .................... 086014
Experiments with Basic AC Theory – Lab Manual ........ 086088
Analog Circuit Measurement ......................................... Block A23
Basic Test Equipment .................................................. 086025
Troubleshooting with Volt-Ohm-Milliamp Meters
(VOMs) .................................................................. 086026
Using Basic Oscilloscopes ............................................ 086027
Experiments in Electrical Measurements – Lab Manual 086089
Electrical Safety for the Trades .................................... 186005
Storage Batteries ......................................................... 4343
Electrical Wiring Practices ............................................ 086002
Data, Voice, and Video Cabling .................................... 086016
Electrical Grounding .................................................... 086001
National Electrical Code (NEC Code and Textbook Course) 5177EM

Blueprint Reading
Reading Electrical Schematic Diagrams .......................... 006022
Electrical Blueprint Reading .......................................... 006036

Electrical Motor Maintenance and Operations
Industrial DC Motors ..................................................... 086051
Industrial AC Motors .................................................... 086052
Controlling Industrial Motors ....................................... 086053
Motor Control Fundamentals (for Programmable Logic
Controllers) ............................................................. 006010
Industrial Motor Control (for Programmable Logic
Controllers) Part 1 ..................................................... 006011
Industrial Motor Control (for Programmable Logic
Controllers) Part 2 ..................................................... 006012
AC Motor Repair .......................................................... 6631A-B
Repairing DC Motors and Generators ............................ 4220A-B
Fractional Horsepower Motors .................................... 4033
Repairing Fractional Horsepower Motors ....................... 4034

Transformer Operations
Transformers .................................................................... 4040
Transformer Operation ................................................ 4041
Distribution and Power Transformers ............................ 4042
Instrument Transformers ............................................... 6793

Electric Power Generation, Transmission and
Distribution – Equipment Operation and Maintenance
Safety for Lineworkers .................................................. 786E02

Fundamentals of Linework .............................................. 786016
Lineworker's Tools ........................................................ 786017
Electrical Concepts for Lineworkers ............................... 786E03
Rigging for Lineworkers ............................................... 786E04
Transformation for Lineworkers .................................... 786E05
Underground Distribution for Lineworkers ..................... 786E06
Electric Power Measurements ...................................... 4019A-B
Alternators ...................................................................... 4031
Voltage Regulators for Generators ................................... 4368
Voltage Regulation of Distribution Systems ..................... 4370
Switchgear ........................................................................ 086092
Inductance and Capacitance .......................................... 6617
Protective Relaying ....................................................... 6538A-B
Local Distribution of Electrical Power ........................... 006038
Transmission Lines ....................................................... 4358
Power Line Calculations ............................................... 6256
Electric Power Generating Stations ............................... 6589A-B
Electric Power Substations ............................................ 6590A-B
Electrical Power Distribution and Transmission for the
Technician ................................................................. 786E01

Electronics Skills and Applications for Utilities
Component Testers ......................................................... 086062
Digital Test Equipment .................................................. 086063
Reactive Circuits .......................................................... Block B22
Reactance and Impedance ............................................. 086037
Resonant Circuits .......................................................... 086038
Applications and Troubleshooting
of Resonant Circuits .................................................... 086039
Experiments in Resonant Circuits ................................. 086090
Analog Electronic Components ..................................... Block B23
Basic Semiconductor Components: Diodes .................. 086019
Basic Semiconductor Components: Transistors .......... 086020
Switching Devices ......................................................... 086021
Electronic Sensors ....................................................... 086022
Special Rectifiers: Electron Tubes ................................. 086023
Optoelectronic and Fiber Optic Components .................. 086024
Electronics Hardware ................................................... 086040
Basic Electronic Circuits ............................................... Block B24
Rectifiers and Power Supplies ...................................... 086041
Amplifiers ...................................................................... 086042
Oscillators ................................................................. 086043
Modulation and Detection Circuits ............................... 086044
Switching Circuits ....................................................... 086054
Logic Circuits ............................................................. 086055
Gating and Counting Circuits ....................................... 086056
Pulse and Digital Circuits ............................................. 086057

Electronic Systems ....................................................... Block B25
Electronic Devices and Amplification ............................ 086045
Audio and RF Circuits .................................................. 086046
Oscillators, Feedback, and Waveforms ......................... 086047
Electronic Power Supply Systems ............................... 086048
Industrial Amplification Systems ................................. 086058
Servo and Control Systems .......................................... 086059
Pulse and Logic Circuits .............................................. 086060
Programmable Controllers and Microprocessors .......... 086061
Data, Voice, and Video Cabling .................................... 086016
Troubleshooting Industrial Electrical, Electronic,
and Computer Systems ................................................ Block B26
Industrial Electronic Troubleshooting ............................ 086064
Electronic Troubleshooting
of Industrial Motor Controllers ................................. 086065
Troubleshooting Sensing Devices and Systems .............. 086066
Troubleshooting Industrial Control Systems
and Output Devices ..................................................... 086067
Utility Industry

Basic Industrial Computer Systems Block B10
Industrial Computer Systems Fundamentals B1001
Digital and Analog Systems B1002
Software and Programming B1003
Computer-Aided Control Systems B1004
Interfacing Principles B1005
Introduction to Microprocessors Block B11
Introduction to Computers B1101
Introduction to Microprocessor Applications B1102
Microprocessor Basics, Part 2: Overview of What’s in a Microprocessor B1104
Microprocessor Applications 086E05

Estimated Curriculum Duration: 1,346 hours (excluding optional lab experiments).

Number of Exams: 177.

Optional Laboratory Experiments:
Measurements Trainer XK-100
Digital Trainer XK-200
Microprocessor Trainer 086E02

Recommended Cross Training:
Electro-Mechanical Skills for the Utilities Engineer/Technician
Engineering Mechanics, Part 1 286036
Engineering Mechanics, Part 2 286037
Engineering Mechanics, Part 3 286038
Engineering Mechanics, Part 4 286039
Fluid Mechanics, Part 1 286010
Fluid Mechanics, Part 2 286011
Fluid Mechanics, Part 3 286012
Properties of Materials 686005
Hydraulics Power Basics 286060
Hydraulic Components:
Actuators, Pumps, and Motors 286061

Hydraulic Components:
Conductors, Conditioners, and Fluids 286062
Hydraulic Power System Control 286063
Interpreting Hydraulic System Schematics 286064
Hydraulic Power System Troubleshooting 286065

Pneumatics, Part 1 286098
Pneumatics, Part 2 286099
Pneumatics, Part 3 286100
Fundamental Principles of Rigging Technology 286016
Planning the Rigging Operation 286017
Working with Rigging Tools, Part 1 286018
Working with Rigging Tools, Part 2 286019
Rigging: Lifting Equipment and Applications, Part 1 286020
Rigging: Lifting Equipment and Applications, Part 2 286021

Estimated Duration: 170 hours.
Number of Exams: 17.

Optional: Instrumentation and Control Specialist
Heat, Part 1 686001
Heat, Part 2 686002
Pneumatic Instrumentation for the Technician 286M01
Control Technology for Technicians 286M04

Distributed Control Systems, Part 1 086084
Distributed Control Systems, Part 2 086085
Distributed Control Systems, Part 3 086086
Electronic Process Control 086E17
Principles of Automatic Process Control Instruments 6305A-B
Automatic Process Control Valves 6307
Process Pressure Measuring and Control Instruments 6309A-B
Liquid Level Measuring and Control Instruments 6338A-B
Temperature Measuring and Control Instruments 6306A-B
Fluid Flow Measuring and Control Instruments 6308A-B
Types of Steam Generators 6632
Automatic Combustion Control 2596A-C

Estimated Duration: 310 hours.
Number of Exams: 65.

High Voltage Electrician

This Utilities Industry specific skills curriculum provides trainees with the courseware that enables them to perform the tasks associated with a Lineman/High Voltage Electrician. This print based curriculum has been developed to meet the subject requirements of either an apprenticeship or an organization’s skills development program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

This curriculum starts with the mathematics foundation needed to perform electrical calculations. The training focuses next on AC/DC principles and their applications. Utility lineman specific courses provide instructional skills on the different methods used in the installation, operation, and maintenance of overhead and underground power lines.

This curriculum, as modified by custom assembling the appropriate courses, applies to utilities positions such as: Electrical Lineman, Lineman/Cableman, Power Line Design, and Construction Specialist. This training is appropriate for both entry level and experienced utilities employees.

Upon completion of this program, students will be able to:
- Perform calculations using algebra, geometry, and trigonometry.
- Understand the principles and components associated with AC and DC electricity.
- Explain how to set up overhead poles and power lines.
- Perform the rigging skills and deploy the proper materials used by a lineman.
- Describe how line conductors, distribution transformers, voltage regulators, fuses, and switches work.
- Lay conduit and pull/splice electrical cable.
- Perform efficiency tests on transformers and AC and DC machines.
- Select the proper type of test equipment for a particular electrical/electronic application.
- List the types of devices that are part of an assembled switchgear.
- Describe the functions of the equipment used in power distribution stations.
Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Technical Foundation Skills</strong></td>
<td></td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186023</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
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<tr>
<td>Fluid Measurement</td>
<td>186025</td>
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<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186025</td>
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<tr>
<td>Introduction to Algebra, Geometry, and Trigonometry</td>
<td>Block X02</td>
</tr>
<tr>
<td>Algebra: Monomials and Polynomials</td>
<td>X0201</td>
</tr>
<tr>
<td>Algebra: Factoring</td>
<td>X0202</td>
</tr>
<tr>
<td>Algebra: Addition and Subtraction of Fractions</td>
<td>X0203</td>
</tr>
<tr>
<td>Algebra: Multiplication and Division of Fractions</td>
<td>X0204</td>
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<td>Algebra: Linear Equations</td>
<td>X0205</td>
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<td>Algebra: Simultaneous Linear Equations</td>
<td>X0206</td>
</tr>
<tr>
<td>Algebra: Determinants</td>
<td>X0207</td>
</tr>
<tr>
<td>Algebra: Quadratic Equations</td>
<td>X0208</td>
</tr>
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<td>Algebra: Exponents</td>
<td>X0209</td>
</tr>
<tr>
<td>Algebra: Radicals and Imaginary Numbers</td>
<td>X0210</td>
</tr>
<tr>
<td>Applied Geometry</td>
<td>X0211</td>
</tr>
<tr>
<td>Practical Trigonometry</td>
<td>X0212</td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
<tr>
<td>Material Handling Safety</td>
<td>186006</td>
</tr>
<tr>
<td>Working Safely with Electricity</td>
<td>4400</td>
</tr>
<tr>
<td>Quality Concepts: Tools and Applications</td>
<td>186036</td>
</tr>
<tr>
<td><strong>Electrical Skills and Principles</strong></td>
<td></td>
</tr>
<tr>
<td>DC Principles</td>
<td>Block A21</td>
</tr>
<tr>
<td>Nature of Electricity</td>
<td>086001</td>
</tr>
<tr>
<td>Circuit Analysis and Ohm's Law</td>
<td>086002</td>
</tr>
<tr>
<td>Capacitors and Inductors</td>
<td>086003</td>
</tr>
<tr>
<td>Magnetism and Electromagnetism</td>
<td>086004</td>
</tr>
<tr>
<td>Conductors, Insulators, and Batteries</td>
<td>086005</td>
</tr>
<tr>
<td>DC Motors and Generator Theory</td>
<td>086006</td>
</tr>
<tr>
<td><strong>Optional Laboratory Experiments:</strong></td>
<td></td>
</tr>
<tr>
<td>Electronic Simulation Software</td>
<td>086800</td>
</tr>
<tr>
<td>Experiments with Basic DC Theory – Lab Manual</td>
<td>086807</td>
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<tr>
<td>AC Principles</td>
<td>Block A22</td>
</tr>
<tr>
<td>Alternating Current</td>
<td>086807</td>
</tr>
<tr>
<td>Alternating Current Circuits</td>
<td>086808</td>
</tr>
<tr>
<td>Inductors in AC Circuits</td>
<td>086809</td>
</tr>
<tr>
<td>Capacitors in AC Circuits</td>
<td>086810</td>
</tr>
<tr>
<td>Transformers</td>
<td>086811</td>
</tr>
<tr>
<td>Alternators</td>
<td>086812</td>
</tr>
<tr>
<td>Electrical Energy Distribution</td>
<td>086813</td>
</tr>
<tr>
<td>Rectification and Basic Electronic Devices</td>
<td>086814</td>
</tr>
<tr>
<td>Experiments with Basic AC Theory – Lab Manual</td>
<td>086808</td>
</tr>
<tr>
<td>Electrical Safety for the Trades</td>
<td>186005</td>
</tr>
<tr>
<td><strong>Lineman Skills and Equipment Knowledge</strong></td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Linework</td>
<td>786016</td>
</tr>
<tr>
<td>Linework: Tools</td>
<td></td>
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<tr>
<td><strong>Electrical Power Distribution, Transmission and Systems</strong></td>
<td></td>
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<td>– Operations and Skills</td>
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<tr>
<td>Safety for Linework</td>
<td>786E02</td>
</tr>
<tr>
<td>Electrical Concepts for Lineworks</td>
<td>786E03</td>
</tr>
<tr>
<td>Rigging for Lineworks</td>
<td>786E04</td>
</tr>
<tr>
<td>Transformation for Lineworkers</td>
<td>786E05</td>
</tr>
<tr>
<td>Underground Distribution for Lineworks</td>
<td>786E06</td>
</tr>
<tr>
<td>Reading Electrical Schematic Diagrams</td>
<td>006022</td>
</tr>
<tr>
<td>Electrical Blueprint Reading</td>
<td>006036</td>
</tr>
<tr>
<td>Local Distribution of Electrical Power</td>
<td>006038</td>
</tr>
<tr>
<td>Transmission Lines</td>
<td>4358</td>
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<tr>
<td>Undergrond Power Systems</td>
<td>006039</td>
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<td>Telemetering</td>
<td>4048</td>
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<td>Power Line Calculations</td>
<td>6256</td>
</tr>
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<td>Industrial Motor Control</td>
<td>6699A-C</td>
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<td>Efficiency Tests</td>
<td>4342</td>
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<tr>
<td>Instrument Transformers</td>
<td>6793</td>
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<td>Electric Power Measurements</td>
<td>4019A-B</td>
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<td>Switchgear</td>
<td>080692</td>
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<td>Protective Relaying</td>
<td>6538A-B</td>
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<td>Electric Power Substations</td>
<td>6590A-B</td>
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<td>Electrical Power Distribution and Transmission for the Technician</td>
<td>786E01</td>
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Estimated Curriculum Duration: 942 hours (excluding optional lab experiments).

Number of Exams: 117.

**Optional Laboratory Experiments:**
Measurements Trainer                      XK-100
Digital Trainer                           XK-200
Meter Reader

This Utilities Industry specific skills curriculum provides trainees with the courseware that enables them to perform the tasks associated with a Meter Reader. This print-based curriculum has been developed to meet the subject requirements of either an apprenticeship or an organization’s skills development program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

This curriculum starts with the mathematics foundation needed to perform electrical calculations. The training focuses next on AC/DC principles and their applications. Utilities specific courses provide the theory and instructional skills for the use of the components, equipment, and the electrical power distribution systems that a Meter Reader works with regularly.

This curriculum, as modified by custom assembling the appropriate courses, applies to utilities positions such as: Electrical Meter Reader, Meter Technician, Relay and Meter Reader Specialist. This training is appropriate for both entry level and experienced utilities employees.

Upon completion of this program, students will be able to:

- Perform calculations using algebra, geometry, and trigonometry.
- Understand the principles and components associated with AC and DC electricity.
- Perform efficiency tests on transformers and AC and DC machines.
- Select the proper type of test equipment for general electrical/electronic measurement techniques.
- Explain the functions of common electronic components used in utilities meters.
- List the types of devices that are part of an assembled switchgear.
- Describe the functions of the equipment used in power distribution stations.

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<table>
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<tr>
<td><strong>Pre-Technical Foundation Skills</strong></td>
<td></td>
</tr>
<tr>
<td>Basic Industrial Math ..................................</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction ................................</td>
<td>186001</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>186023</td>
</tr>
<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
</tr>
<tr>
<td>Fluid Measurement</td>
<td>186025</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
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<td>Introduction to Algebra, Geometry, and Trigonometry</td>
<td>Block X2</td>
</tr>
<tr>
<td>Algebra: Monomials and Polynomials</td>
<td>X0201</td>
</tr>
<tr>
<td>Algebra: Factoring</td>
<td>X0202</td>
</tr>
<tr>
<td>Algebra: Addition and Subtraction of Fractions</td>
<td>X0203</td>
</tr>
<tr>
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<td>X0204</td>
</tr>
<tr>
<td>Algebra: Linear Equations</td>
<td>X0205</td>
</tr>
<tr>
<td>Algebra: Simultaneous Linear Equations</td>
<td>X0206</td>
</tr>
<tr>
<td>Algebra: Determinants</td>
<td>X0207</td>
</tr>
<tr>
<td>Algebra: Quadratic Equations</td>
<td>X0208</td>
</tr>
<tr>
<td>Algebra: Exponents</td>
<td>X0209</td>
</tr>
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<td>X0210</td>
</tr>
<tr>
<td>Applied Geometry</td>
<td>X0211</td>
</tr>
<tr>
<td>Practical Trigonometry</td>
<td>X0212</td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
<tr>
<td>Material Handling Safety</td>
<td>186006</td>
</tr>
<tr>
<td>Working Safely with Electricity</td>
<td>4400</td>
</tr>
<tr>
<td>Quality Concepts: Tools and Applications</td>
<td>186036</td>
</tr>
<tr>
<td><strong>Electrical Skills and Principles</strong></td>
<td></td>
</tr>
<tr>
<td>DC Principles</td>
<td>Block A21</td>
</tr>
<tr>
<td>Nature of Electricity</td>
<td>086001</td>
</tr>
<tr>
<td>Circuit Analysis and Ohm’s Law</td>
<td>086002</td>
</tr>
<tr>
<td>Capacitors and Inductors</td>
<td>086003</td>
</tr>
<tr>
<td>Magnetism and Electromagnetism</td>
<td>086004</td>
</tr>
<tr>
<td>Conductors, Insulators, and Batteries</td>
<td>086005</td>
</tr>
<tr>
<td>DC Motors and Generator Theory</td>
<td>086006</td>
</tr>
<tr>
<td><strong>Optional Laboratory Experiment:</strong></td>
<td></td>
</tr>
<tr>
<td>Electronic Simulation Software</td>
<td>086800</td>
</tr>
<tr>
<td>Experiments with Basic DC Theory – Lab Manual</td>
<td>086087</td>
</tr>
<tr>
<td>AC Principles</td>
<td>Block A22</td>
</tr>
<tr>
<td>Alternating Current</td>
<td>086007</td>
</tr>
<tr>
<td>Alternating Current Circuits</td>
<td>086008</td>
</tr>
<tr>
<td>Inductors in AC Circuits</td>
<td>086009</td>
</tr>
<tr>
<td>Capacitors in AC Circuits</td>
<td>086010</td>
</tr>
<tr>
<td>Transformers</td>
<td>086011</td>
</tr>
<tr>
<td>Alternators</td>
<td>086012</td>
</tr>
<tr>
<td>Electrical Energy Distribution</td>
<td>086013</td>
</tr>
<tr>
<td>Rectification and Basic Electronic Devices</td>
<td>086014</td>
</tr>
<tr>
<td>Experiments with Basic AC Theory – Lab Manual</td>
<td>086088</td>
</tr>
<tr>
<td>Reading Electrical Schematic Diagrams</td>
<td>006022</td>
</tr>
<tr>
<td>Analog Circuit Measurement</td>
<td>Block A23</td>
</tr>
<tr>
<td>Basic Test Equipment</td>
<td>086025</td>
</tr>
<tr>
<td>Troubleshooting with Volt-Ohm-Milliamp Meters</td>
<td>(VOMs)</td>
</tr>
<tr>
<td>Using Basic Oscilloscopes</td>
<td>086027</td>
</tr>
<tr>
<td>Experiments in Electrical Measurements</td>
<td>086089</td>
</tr>
<tr>
<td>Electrical Safety for the Trades</td>
<td>186005</td>
</tr>
<tr>
<td>Analog Electronic Components</td>
<td>Block B23</td>
</tr>
<tr>
<td>Basic Semiconductor Components: Diodes</td>
<td>086019</td>
</tr>
<tr>
<td>Basic Semiconductor Components: Transistors</td>
<td>086020</td>
</tr>
<tr>
<td>Switching Devices</td>
<td>086021</td>
</tr>
<tr>
<td>Electronic Sensors</td>
<td>086022</td>
</tr>
<tr>
<td>Special Rectifiers: Electron Tubes</td>
<td>086023</td>
</tr>
<tr>
<td>Optoelectronic and Fiber Optic Components</td>
<td>086024</td>
</tr>
<tr>
<td>Electronics Hardware</td>
<td>086040</td>
</tr>
<tr>
<td>Transformers</td>
<td>4040</td>
</tr>
<tr>
<td>Transformer Operation</td>
<td>4041</td>
</tr>
<tr>
<td>Distribution and Power Transformers</td>
<td>4042</td>
</tr>
<tr>
<td>Instrument Transformers</td>
<td>6793</td>
</tr>
</tbody>
</table>
Electrical Power Distribution Systems – Operations and Skills

Fundamentals of Linework............................................................786016
Lineworker's Tools ......................................................................786017
Safety for Lineworkers ..............................................................786E02
Electrical Concepts for Lineworkers..............................................786E03
Transformation for Lineworkers..................................................786E05
Underground Distribution for Lineworkers.................................786E06
Electric Power Measurements......................................................4019A-B
Telemetering..............................................................................4048
Local Distribution of Electrical Power .........................................006038
Underground Power Systems ......................................................006039
Switchgear ..................................................................................6613
Electric Power Substations .........................................................6590A-B
Electrical Power Distribution and Transmission for the Technician..................................................786E01

Estimated Curriculum Duration: 654 hours
(excluding optional lab experiments).
Number of Exams: 90.

Optional Laboratory Experiments:
Measurements Trainer .................................................................XK-100
Digital Trainer ............................................................................XK-200
006038

Local Distribution of Electrical Power

Duration: 10 hours (includes 1 test)

Course Prerequisites:
- Basic Industrial Math (Block X21)
- AC Principles (Block A22)
- Transformers (4040)

What Students Learn:
- Characteristics of Electric Loads; Primary Distribution Circuits;
- Distribution Transformers; Secondary Distribution Circuits; Voltage
  Regulation; Protection Provided by Circuit Breakers; Primary Fuse
  Cutouts; Secondary Fuses; Lightning Arresters; Construction of
  Overhead Distribution Lines; Construction of Poles; Conductors;
  Splices; Guys; Cost Consideration; Economical Design.

Special Note:
- This updated course replaces, Local Distribution of Electrical Power, course 6686.

006039

Underground Power Systems

Duration: 10 hours (includes 1 test)

Course Prerequisites:
- Basic Industrial Math (Block X21)
- AC Principles (Block A22)

What Students Learn:
- Conductors; Cable Insulation Material; Paper Insulated Pressure and
  Solid Cables; Current Carrying Capacity of Conductors; Transmission
  Conduit and Manholes; Distribution Conduit; Installation of Conduit;
  Pulling Cable; Underground Residential Distribution Systems.
- Construction of Low-Voltage; Distribution Voltage and High Voltage
  Cable Joints; Construction of Cable Terminations; Methods of
  Preventing Corrosion; Cable Fault Location Equipment and Methods;
  Future of Underground Power Lines.

Special Note:
- This updated course replaces, Underground Power Systems, course 5959A-B.

086084

Distributed Control Systems,
Part 1

Duration: 10 hours (includes 1 test)

What Students Learn:
- Basic types of control loops and their elements
- Define basic process control characteristics and terms
- Identify the five control modes found in industrial systems
- How control system components interface
- Basic components found in DCS architecture

086085

Distributed Control Systems,
Part 2

Duration: 10 hours (includes 1 test)

What Students Learn:
- The characteristics and development of the HART protocol
- OSI layers used in HART messaging
- Distinguish between point-to-point and multidrop HART devices
- Functions of a device management system
- Seven layers of the OSI standard

086086

Distributed Control Systems,
Part 3

Duration: 10 hours (includes 1 test)

What Students Learn:
- How Foundation Fieldbus works
- Functions and applications served with Foundation Fieldbus
- Determine existing fail-safe conditions
- Commands for opening a download
- Addressing thermal inertia

086E16

Data, Voice, and Video Cabling

Duration: 20 hours (includes 4 tests)

Course Prerequisites:
- Electrical Equipment (Block A24)

What Students Learn:
- Lesson 1 – Communication Cabling Systems:
  - Early wired and wireless technologies; Planning the wiring
    installation; Applicable standards organizations; UTP cabling.
- Lesson 2 – Copper Wiring for Telephone, Video, and Network Systems:
  - Details of cable installation; Assess quality of work performed;
    Materials required; Handling cable without damage; Workplace
    security and safety.
- Lesson 3 – Terminating and Testing Communication Wiring:
  - Advantages and disadvantages of wireless networking; Installing
    wireless access points; Site testing of wireless networks; Cableworking
    and testing tools; Recognizing common cable problems; Terminating
    popular types of coaxial and copper-cable connectors.
- Lesson 4 – Working with Fiber Optics:
  - Principles of optical fiber transmission; Different types of fiber-optic
    cabling; Optical fiber connections, terminations, and splices; Pulling,
    cleaving, connecting, and polishing optical fiber cables; Testing fiber
    optic connections; Allowable tolerances for loss in fiber-optic
    connections; Safe practices.

Special Note:
- This course consists of a textbook and a supplemental study guide.
2505

Types of Steam Turbines

Duration: 10 hours (includes 1 test)

Course Prerequisites:
- Practical Measurements (Block X22)
- Steam (2620)

What Students Learn:
- Definition of Steam Turbines; Classification of Steam Turbines; Stages in Turbine Work; Energy Changes in Turbines; Flow of Steam Through Nozzles; Steam Turbine Construction; Turbine Blading; Turbine Governors; Specific Turbine Designs.

2506

Steam Turbine Management and Governing

Duration: 10 hours (includes 1 test)

Course Prerequisites:
- Practical Measurements (Block X22)
- Steam (2620)
- Types of Steam Turbines (2505)

What Students Learn:
- Principles of Governing; Governor Uses; Steam Admission to Turbines; Description of Governors; Miscellaneous Equipment; Steam Turbine Operation; Steam Turbine Maintenance; Turbine Blade Deposits and Cleaning; Maintenance Management.

2507

Steam Turbine Calculations

Duration: 10 hours (includes 1 test)

Course Prerequisites:
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Logarithms (5254)
- Heat, Parts 1-2 (686001-686002)
- Types of Steam Turbines (2505)

What Students Learn:
- Energy Changes in the Steam; Flow of Steam through Nozzles; Impulse or Rateau Stage Turbines; Design of Multiple Expansion Turbines; Reaction Turbines; Turbine-Performance Calculations.

2514

Power Plant Economy

Duration: 10 hours (includes 1 test)

Course Prerequisite:
- Practical Measurements (Block X22)

What Students Learn:
- Basic Definitions; Factors Affecting Power Rates; Factors Affecting Power Plant Design; Design of Plant and Purchase Lists; Initial Starting and Testing Plan; Energy Rates; Heat Exchangers; Air and Heat Pollution; Development of Mine-Mouth Power Plants; Power Pooling.

2523A-C

Steam Engines and Their Management

Duration: 30 hours (includes 3 tests)

Course Prerequisite:
- Steam (2620)

What Students Learn:
Part 1 (2523A).
- History and Development of Steam Engines; Parts of the Steam Engine; Classification of Steam Engines; Valve Gears; Indicating Steam Engines; Engine Testing; Characteristics and Features of Steam Engines.

Part 2 (2523B).
- Automatic High Speed Engines; Compound Engines; Uniflow Engines; Economic Considerations in Engine Selection; Practical Considerations in Engine Selection.

Part 3 (2523C).
- Engine Operation; Starting and Stopping Engines; Engine Bearings; Pounding of Engines; Setting Steam Engine Valves.

2525

Principles of the I-C Engine

Duration: 10 hours (includes 1 test)

Course Prerequisite:
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)

What Students Learn:
- Cycles of Operation; Indicator Diagrams; Spark-Ignition Engines; Compression Ignition Engines-Diesel; Heat Loss; Friction; Lubrication and Wear; Supercharging.
2526

I-C Engine Fuels and Combustion

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)

What Students Learn:
Types of Fuel; Liquid Fuels; Gaseous Fuels; Liquefied Petroleum Gas; Fundamentals of Chemistry; Chemistry of Combustion; Effect of Air-Fuel Ratio on Engine Performance; Liquid Fuel Testing; Gasoline Characteristics; Diesel Fuel Characteristics; Road Knock Test Procedures.

2527

I-C Engine Testing

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)

What Students Learn:
Purpose of Engine Testing; Preliminary Test Operations; Performance Factors; Measuring Indicated Horsepower; Calculation of Indicated Horsepower from PT Diagrams; Measurement of Shaft or Brake Horsepower; Typical Test Installations; Standard Engine Tests; Instruments Used in Testing.

2585

Steam Generator Accessories

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Practical Measurements (Block X22)
Types of Steam Generators (6632)

What Students Learn:
A.S.M.E. Boiler Code; Safety Valves; Water Level Indicating Equipment; Steam Gages; Steam Generator Piping Systems and Valves; Soot Blowers; Air Preheaters; Dust Collectors; Monitoring Equipment; Sealing Systems.

2588

Pressure Parts for Steam Generators

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Practical Measurements (Block X22)
Types of Steam Generators (6632)

What Students Learn:
The A.S.M.E. Boiler and Pressure Vessel Code; Rules for Calculating Steam Generator Pressure Parts.

2589

Steam Generator Supporting Steel Structures

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Engineering Mechanics, Parts 1-4 (286036-286039)
Mechanics of Materials (5282A-C)
Types of Steam Generators (6632)

What Students Learn:
Introduction; Main Support Roof Framing; Vertical Framing Systems; Horizontal Framing Systems.

2592

Oil and Gas Firing for Steam Generation

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Practical Measurements (Block X22)
Elements of Chemistry (5011)
Fuels (5340)

What Students Learn:
Fuels; Boiler Elements; Oil Firing; Gas Firing; Operating Procedures; Start-Up and Shutdown Procedures; Troubles and Remedies; Maintenance Lighters; Safety and Efficiency.
### 2598A-B

**Steam Generator Design**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Logarithms (5254)
- Heat, Parts 1-2 (686001-686002)
- Steam (2620)
- Types of Steam Generators (6632)

**What Students Learn:**
- Part 1 (2598A). Purpose of Steam Generators; Utility Company Boilers; Industrial Boilers; Design Considerations.
- Part 2 (2598B). Conduction Heat Transfer; Thermal Conductivities of Common Steam Generator Materials; Radiant Heat Transfer; Radiation in Furnaces; Heat Balance for Steam Generator Furnaces; Convection Heat Transfer; Convection Equation for Cross Flow; Longitudinal Flow of Gases and Steam-Film Resistance; Combined Heat Transfer Modes.

### 2620

**Steam**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Heat, Part 1 (686001)
- Logarithms (5254)

**What Students Learn:**
- Theory of Vaporization; Saturated Steam; Temperature-Heat Diagram; Generating Steam Heat Required for Evaporation at Different Pressures; Steam Tables; Definition of Entropy; Calculation of Change of Entropy; Use of Super-Heated Steam Table; Use of Mollier Heat Chart.

### 4368

**Voltage Regulators for Generators**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Principles of AC Circuits (4018A-D)
- AC Principles (Block A22)

**What Students Learn:**
- Need for Proper Voltage Regulation; Characteristics of Voltage Regulation; Causes and Effects of Poor Voltage Regulation; Types of Voltage Regulators for Generators; Direct-Acting Regulator; Indirect-Acting Regulator; Rotating-Amplifier Regulator; Regulator with Inductor-Alternator Excitation System; Electron-Tube Regulator; Saturable-Reactor Regulator; Silicon-Controlled Rectifier Regulator; Regulator with Static Excitation System.

### 4370

**Voltage Regulation of Distribution Systems**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Principles of AC Circuits (4018A-D)
- AC Principles (Block A22)
- Voltage Regulators for Generators (4368)

**What Students Learn:**
- Fundamentals of Voltage Regulation Methods; Losses in a Distribution System; Minimizing the Voltage Loss in Lines and Distribution Transformers; Line Replacement; Series Capacitors; Shunt Capacitors; Booster Autotransformers and Tap-Changing Transformers; Line-Voltage Regulator Equipment; Induction Regulators; Step-Type Regulators; Switched Shunt Capacitors; Types of Bridging Impedances; Preventive Autotransformer Bridging Method; Transfer Switches and Selector Switches; Series Transformers and Reversing Switches; Tap Changing Arrangements; Step-Type Regulator; Line-Drop Compensator; Induction-Disc Relay; Static Relays – the Zener Diode; Applications of Regulators; Single- and Three-Phase Regulators; Regulator Connections; Adjustment of Regulators; Location and Connection of Regulators; Voltage Profile; Series of Parallel Operation; Installation and Maintenance.

### 4358

**Transmission Lines**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
- AC Principles (Block A22)

**What Students Learn:**
- Economics of Electric Transmission Line Systems; Designing and Routing of Lines; Transmission Line Conductors and Suspension Hardware; Types of Towers and Stresses on Towers; Conductor Sag and Tension; Construction Methods and Tower Erection; Maintenance of Overhead Lines.

### 5340

**Fuels**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Formulas (186012)
- Practical Measurements (Block X22)

**What Students Learn:**
- Theory of Combustion; Types of Fuels; Fuel Analysis; Heat Loss; Burning Fuels for Maximum Energy; Other Sources of Energy.
**6070A-I**

**The Lineman’s and Cableman’s Handbook**

**Duration:** 90 hours (includes 9 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- AC Principles (Block A22)

**What Students Learn:**

Part 1 (6070A).
- Elementary Electrical Principles; Electrical Formulas and Calculations; Electric System; Substations; Transmission Circuits; Distribution Circuits; Construction Specifications; Wood-Pole Structures; Aluminum, Concrete, Fiberglass, Steel and Polysil Structures; Locating and Skating Line.

Part 2 (6070B).
- Unloading and Hauling Wood Poles; Erecting and Setting Poles; Guying Poles; Insulators.

Part 3 (6070C).
- Line Conductors; Distribution Transformers; Lighting and Surge Protection; Fuses.

Part 4 (6070D).
- Switches; Voltage Regulators; Transmission Tower Erection; Stringing Line Conductors; Sagging Line Conductors; Joining Line Conductors.

Part 5 (6070E).
- Live-Line Maintenance with Hot-Line Tools; Live-Line Maintenance from Insulated Aerial Platforms; Grounding; Protective Grounds.

Part 6 (6070F).
- Street Lighting; Underground System; Laying Conduit: Manhole Construction; Pulling Cable; Splicing Cable; Underground Residential Distribution.

Part 7 (6070G).
- Tree Trimming; Distribution Transformer Installation; Maintenance of Transmission and Distribution Lines.

Part 8 (6070H).
- Electrical Drawing Symbols; Single-Line Diagrams; Schematic Diagrams; Voltage Regulation.

Part 9 (6070I).
- Ropes, Knots, Splices, and Gear; Climbing Wood Poles; Protective Equipment; Safety Rules; Resuscitation; Heart-Lung Resuscitation; Pole-Top and Bucket Truck Rescue.

**6472**

**Testing Solid and Liquid Boiler Fuels**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
- Practical Measurements (Block X22)

**What Students Learn:**

- Sampling Solid Fuels; Methods of Sampling; Determining and Calculating Moisture Content; Laboratory Testing of Samples; Classification and Basic Characteristics of Liquid Fuels; Metering and Tank Gaging; Collection of Samples; Sampling Methods and Devices; Laboratory Processes.

**6473**

**Solid and Pulverized Fuel Burning**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
- Practical Measurements (Block X22)

**What Students Learn:**

- Principles of Solid Fuel Burning; Methods of Fixing; Types of Grates; Mechanical Stokers; Waste Fuel Firing; Principles of Pulverized Coal Burning; Pulverized Coal Installations; Auxiliary Equipment; Steam Generator Design Features for Pulverized Coal Burning; Operation of Pulverized Coal Installations.

**6589A-B**

**Electric Power Generating Stations**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- AC Principles (Block A22)

**What Students Learn:**

Part 1 (6589A).
- Electric Generating Stations as a Part of Generating System; Electric Equipment of Generating Stations; Control and Protective Equipment; Electric Components and Station-Service Supply in Steam- and Gas-Turbine Stations; Hydroelectric Stations and Their Equipment; Generation of Nuclear Power and Nuclear Power Plants.

Part 2 (6589B).
- Alternators, Main-Power Transformers, and Main-Power Switchgear in Generating Stations; Control-Feedback Systems; Governors; Excitation System; Automatic-Control Equipment; Supervisory-Control and Unattended Stations; Power-Feedback Systems for Station-Service Supply; Auxiliary Electric Equipment; Lighting, Heating, Cooling, and Communication Equipment in Generating Stations.
**6590A-B**

*Electric Power Substations*

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- AC Principles (Block A22)

**What Students Learn:**
- Part 1 (6590A). Types, Purpose, Location, and Rating of Transmission and Subtransmission Substations; Protection of Substations; Switching Systems; Switchgear Ratings; Types of Circuit Breakers; Disconnecting Switches; Transformation in Substations; Voltage Control in Substations; Control and Operation of Substations; Construction of Substations.
- Part 2 (6590B). Distribution Systems and Arrangement of Primary and Secondary Feeders; Subtransmission-Supply Arrangement; High-Voltage and Low-Voltage Structures; Transformers; Voltage-Control Equipment; Metering Devices, Control Instruments, and Protective Relays; Rural Substations; Industrial Substations; Direct-Current Substations; Types of Rectifiers Used in Substations.

**6632**

*Types of Steam Generators*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
- Basic Industrial Math (Block X21)

**What Students Learn:**
- Introduction to Steam Generators; Water Tube Steam Boilers; Water Walls; Superheaters; Heat Recovery in Steam Generators; Industrial Applications of Steam Generators; Central Station Steam Generators; Types of Steam Generators - Marine Units, Waste-Heat Units, Packaged Boilers, Nuclear Units, and Hot Water Generators.

**6683**

*Principles and Uses of Nuclear Energy*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Elements of Chemistry (5011)
- Types of Steam Generators (6632)

**What Students Learn:**
- Structure of the Atom; Theory of Radioactivity; Fission and Fusion Processes; Research, Production, and Power Reactors; Instruments for Measuring Radiation; Control of Nuclear Reactors; Construction Materials and Equipment for Reactors Safety Considerations; Use of Industrial Isotopes.

**6718A-C**

*Hydraulic Turbines*

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Logarithms (5254)
- Plane Trigonometry (2309A-B)
- Engineering Mechanics, Parts 1-4 (286036-286039)
- Fluid Mechanics, Parts 1-3 (286010-286012)

**What Students Learn:**
- Part 1 (6718A). Hydroelectric Stations; Waterwheels; Classes and Types of Turbines; Head and Energy of Water; Force Exerted on Fixed Surface by Jet; Force Exerted on Moving Vanes; Power Losses and Efficiency; Design of Impulse Turbine; Control of Water Supplied to Impulse Turbine; Characteristics of Impulse Turbines.
- Part 2 (6718B). Reaction Turbines; Design of Francis Turbines; Design of Propeller Turbines; Characteristics of Reaction Turbines; Reservoir for Hydroelectric Power Plant; Surveys; Stream Flow; Pondage and Storage; Location of Dam and Powerhouse.
- Part 3 (6718C). Selection of Turbine Type; Tests on Turbines; Computation of Efficiency; Measurement of Power Output; Governors; Waterways to Powerhouse; Penstocks; Surge Tanks; Turbine Settings; Comparison of Horizontal and Vertical Reaction Turbines; Estimates of Cost.

**6802**

*Steam Generator Testing*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Steam (2620)

**What Students Learn:**
- Performance Tests; Steam Purity; Steam Temperature; Sampling and Analysis of Refuse; Combustion Air and Flue Gas Weight; Air Leakage; Steam Generator Efficiency.

**6810**

*Flue Gas Analysis*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Elements of Chemistry (5011)

**What Students Learn:**
- Performance Tests; Steam Purity; Steam Temperature; Sampling and Analysis of Refuse; Combustion Air and Flue Gas Weight; Air Leakage; Steam Generator Efficiency; Factors Affecting Efficiency; Constituents of Flue Gas; Methods of Analysis; Effects of Excess Air; Causes of Carbon Monoxide Formation and Prevention; Methods of Sampling; Types of Gas-Analyzer Equipment; Oxygen Analyzers; Carbon Dioxide Analyzers; Miscellaneous Analyzers; Auxiliary Apparatus.
786E01

**Electrical Power Distribution and Transmission for the Technician**

**Duration:** 80 hours (includes 8 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- DC Principles (Block A21)
- AC Principles (Block A22)
- Analog Circuit Measurement (Block A23)
- Analog Electronic Components (Block B23)

**What Students Learn:**

**Part 1 (786003).**
- **Lesson 1 - Electrical Power Systems:**
  - Relationship Between Utilities, Customers and Regulatory Authorities; Electrical Power System Considerations: Generation, Transmission, and Distribution; Three Phase Review; The Per-Unit Concept.
- **Lesson 2 - Distribution Systems: Layout and Use of Transformers:**
  - Load Classifications; Power Factor Correction; System Layout and Voltage Levels; Transformer Uses, Equivalent Circuit, Three Phase Connections, Voltage Regulation and Testing.
- **Lesson 3 - Distribution Equipment:**
  - Breakers; Reclosers; Sectionalizers; Protective Relays; Metering Equipment; Disconnect Switches.
- **Lesson 4 - Distribution Substations and Power Lines:**

**Part 2 (786004).** Lesson 5 - Transmission Systems:
- Transmission System Operation, Stability, Voltage Levels, and Line Considerations; HVDC Transmission; Superconductors; Six-Phase; Static VAR Compensation.
- **Lesson 6 - Transmission Line Theory:**
- **Lesson 7 - Transmission Line Construction, Part 1:**
  - Line Fault Calculations and Protection; Bulk Power Substations.
- **Lesson 8 - Transmission Line Construction, Part 2:**
  - Line Support Structures; Tower and Pole Foundations; Conductors and Conductor Tension; Conductor Sag and Vibration; Line Planning and Construction Example.

**Special Note:**
This course consists of a textbook and two supplemental study guides. We recommend the course be purchased in its entirety. However, if needed due to targeted training, study guides (Parts 1 and 2) can be purchased separately, with or without the textbook. Note that the textbook is required for the Part 1 study guide. Call Customer Service for pricing and ordering information.

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786E02

**Safety for Lineworkers**

**Duration:** 10 hours (includes 2 tests)

**Course Prerequisites:**
- Trade Safety – Getting Started (186001)
- Working Safely with Chemicals (186002)
- Working Safely with Electricity (4400)

**What Students Learn:**

**Lesson 1 – General Safety Practices:**
- Working safely around energized equipment; Understanding the concept of “limits of approach” and how they apply to linework; Safe inspection practices; Working limits of various safety equipment; Importance of safety meetings.

**Lesson 2 – Lineworker Safety:**
- Safe use of lineworking tools and equipment; Responding to emergencies; Substation safety; Safe installation of meters.

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786E03

**Electrical Concepts for Lineworkers**

**Duration:** 20 hours (includes 4 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- DC Principles (Block A21)
- AC Principles (Block A22)
- Analog Circuit Measurement (Block A23)

**What Students Learn:**

**Lesson 1 - Fundamentals of Electrical Power Distribution and Transmission:**
- Fundamental electrical principles that apply to the generation and transmission of electrical energy; Differences between transmitting AC and DC; Electrical potential, current and resistance; Measuring circuit current.

**Lesson 2 - Constructing and Protecting Circuits:**
- Circuit connections for delta and wye three-phase power systems; Three-phase circuit operating characteristics; How distribution switchgear operate; Protecting power distribution circuits.

**Lesson 3 - Linework Practices:**
- Connecting loads in parallel with a circuit; Calculating the required distance between a phase line and a grounded object; Installing and removing protective grounds; Troubleshooting voltage problems.

**Lesson 4 - Connecting Equipment:**
- Differences between underground cable and overhead conductors; Transformer applications; Street-lighting systems; How revenue metering systems operate.

**Special Note:**
This course consists of a textbook and a supplemental study guide.
**786E04**

**Rigging for Lineworkers**

**Duration:** 20 hours (includes 4 tests)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
Industrial Measurements (Block X22)

**What Students Learn:**
Lesson 1 - Rigging Formulas and Wire Rope Fundamentals:
- Basic mechanics of rigging; Calculating friction and forces; Working with wire rope; Proper care and maintenance of wire rope.
Lesson 2 - Using Fiber Rope, Knots, Bends, and Hitches:
- The characteristics of various fiber-rope types; Select the correct fiber rope type and size for a job; Maintaining fiber ropes; Identify and create the knots, bends, and hitches used in rigging.
Lesson 3 – Rope Splicing Techniques:
- Whip the ends of a rope; Using fids to estimate rope length; Apply proper braiding techniques for three-strand and single-strand fiber ropes.
Lesson 4 - Applications of Blocks, Line Angles, Hooks and Shackles, Hoists, and Slings and Chains:
- Mechanical advantage gained by using blocks; Estimate angles; Use hooks and shackles during a lift; Identify different types of hoists and their common applications; Using slings and chains.

**Special Note:**
- This course consists of a textbook and a supplemental study guide.

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**786E05**

**Transformation for Lineworkers**

**Duration:** 25 hours (includes 5 tests)

**Course Prerequisites:**
Electrical Concepts for Lineworkers (786E03)

**What Students Learn:**
Lesson 1 - Transformer Fundamentals:
- Electrical theories that apply to transformers; Transformer construction; How transformers are used in distribution and transmission systems; Alternating current and induction in transformers.
Lesson 2 - Transformer Operating Principles:
- Transformer characteristics; Practical operation; Maintaining correct polarity during connections; Recognize and service tap changers used in older transformers.
Lesson 3 - Installing Single-Phase Transformers:
- Standard installation procedures; Ways to connect single-phase transformers; Installing long-term parallel transformers; Load checks; Checks to perform prior to energizing a transformer.
Lesson 4 - Three-Phase Transformer Theory:
- Characteristics of delta and wye systems; Where various transformer connections are used; Applying vectors when connecting three-phase transformers; Effect on power supply of various transformer connections.
Lesson 5 - Installing Three-Phase Transformers:
- Pre- and post-installation transformer checks; Load checks for delta and wye banks; Phasing and paralleling procedures for three-phase circuits; Cause and effects of ferroresonance; Where ferroresonance occurs.

**Special Note:**
- This course consists of a textbook and a supplemental study guide.

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**786E06**

**Underground Distribution for Lineworkers**

**Duration:** 30 hours (includes 6 tests)

**Course Prerequisites:**
Electrical Concepts for Lineworkers (786E03)

**What Students Learn:**
Lesson 1 – Introduction to Underground Power Systems:
- Various underground system designs and their components; Understanding underground distribution diagrams (UDDs); Power cable construction.
Lesson 2 – Installing, Splicing, and Terminating Underground Cables, Part 1:
- Cable pulling procedures; Proper identification and tagging of cables; Locating cables on poles; Splicing and energizing feeder cables.
Lesson 3 - Installing, Splicing, and Terminating Underground Cables, Part 1:
- Terminating primary underground cables; Installing heat-shrinkable terminators and elbows; Energizing a low-profile transformer; The bonding and grounding processes.
Lesson 4 – Fusing Underground Systems:
- Bay-O-Net and NX current-limiting fuses; Identifying and inspecting faults; Work with Fuse Mark II switchgear; Checking fuses with a continuity set.
Lesson 5 – Maintaining Underground Systems:
- Using a Modiwark to check for potential; Loadbreak elbow operations; Identify acceptable switching points; Proper safety techniques.
Lesson 6 – Troubleshooting Underground Systems:
- Causes of underground-system faults; Replacing faulted primary and secondary cables; Repairing transformers and junction boxes; Troubleshooting a three-phase transformer.

**Special Note:**
- This course consists of a textbook and a supplemental study guide.

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**786005**

**Fundamentals of Power Plant Operation, Part 1**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
History of Electrical Generation; Development of Modern Electrical Theory; Why the Distribution System Uses AC instead of DC; Major Theories That Contributed to the Modern-Day Power Plant; Classifications of Power Plants; Hydro-Turbines, Wind Turbines, Solar Plants, and Fuel Cells; Job Duties of a Power Plant Operator; Working Conditions in a Power Plant.
**786006**

**Fundamentals of Power Plant Operation, Part 2**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Fundamentals of Power Plant Operation, Part 1 (786005)

**What Students Learn:**
Calculating Areas and Volumes; Calculating Forces; Relationship between Pressure, Volume, and Area; Calculating Pressures; Temperature Scales; Converting between Temperature Scales; Latent and Sensible Heat; Modes of Heat Transfer; Using a Steam Table.

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**786007**

**Fundamentals of Power Plant Operation, Part 3**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Fundamentals of Power Plant Operation, Part 1 (786005)  
Fundamentals of Power Plant Operation, Part 2 (786006)

**What Students Learn:**
Types of Turbines and Their Components; Purpose and Function of Condensers; Operation and Components of Generators; Power Transmission from Generating Source to End User.

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**786008**

**Power Plant Water Treatment Part 1**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
This first of three units will introduce students to the hydrologic cycle, the earth’s natural water treatment process; the fundamentals of chemistry, including how to use a periodic table; chemical formulas; chemical equations; and ions and the pH scale.

Students will be able to:
- Define an element and locate an element and its atomic weight and atomic number on a periodic table.
- Differentiate between an atomic weight and an atomic number.
- Calculate the molecular weight of compounds and molecules.
- Balance a chemical equation.
- Explain the relationship between ions and the pH scale.

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**786009**

**Power Plant Water Treatment Part 2**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Power Plant Water Treatment Part 1 (786008)

**What Students Learn:**
There are three major categories of water usage in a power plant: circulating, drinking, and feed water. The water quality requirements for each are substantially different. The circulating water needs the least amount of treatment to meet the requirements of its intended use. Drinking water in a power plant is typically equivalent to potable water treatment in municipal water treatment plants. It requires more treatment than cooling water but less than boiler water. Before students study the process used to treat the different water systems within a power plant, they need to become familiar with the terminology and methods for quantifying water quality. This study unit discusses the terminology associated with water quality and the treatment process in power plants up to and including the supply of service water.

Students will be able to:
- Distinguish between water quality characteristics and water quality parameters
- Use the terminology associated with the water treatment process
- Describe the first six steps in a power plant’s water treatment process
- Perform chemical calculations to determine the amount of sludge produced by the front-end process

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**786010**

**Power Plant Water Treatment Part 3**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Power Plant Water Treatment Part 2 (786009)

**What Students Learn:**
Water chemistry problems such as carryover, corrosion, and deposits can cause serious damage to the equipment that supports the electricity-generating systems. Equipment failure leads to downtime and the loss of profits. An essential part of an efficient, well-run plant is a water treatment program that prevents such losses. This unit covers some of the common problems associated with the equipment as it relates to water chemistry and the treatments and remedies of those problems. It also covers the basics of chemistry and hazardous materials safety practices.

Students will be able to:
- List the common water chemistry effects on power plant equipment.
- Differentiate between the various pieces of equipment and their associated treatments.
- Describe water softening and ion exchange processes
- Describe distillation, deaeration, and reverse osmosis.
- List and explain the chemical treatments associated with boiler water treatment, feedwater treatment, and cooling water treatment.
- Read a material data sheet and follow safe practices when using chemicals.
Station Power

Duration: 10 hours (includes 1 test)

What Students Learn:
- Terminology associated with the electrical distribution within a power plant
- List and identify the major component parts of an electrical distribution system
- The difference between essential and critical services
- Operating differences in the electrical distribution system under normal and abnormal conditions
- Differences in dealing with high-voltage, medium-voltage, and low-voltage systems

Combustion Turbines, Part 1

Duration: 10 hours (includes 1 test)

What Students Learn:
- Describe the basic operation of a combustion turbine.
- Explain how combustion turbines evolved into important sources of electricity.
- List and discuss the financial advantages of combustion turbine power plants.
- Define the terms axial-flow compressor and centrifugal-flow compressor.
- Discuss the three principal types of combustors.
- Explain the expansion process and how expansion components are cooled.

Combustion Turbines, Part 2

Duration: 10 hours (includes 1 test)

What Students Learn:
- Basic operating characteristics of a combustion-turbine driven power plant
- How the major plant systems work
- How major power plant systems are linked to combustion turbine power sources
- Differences between simple-cycle and combined-cycle power plants
- The importance of safety and efficiency in power plant operations and electricity generation

Combustion Turbines, Part 3

Duration: 10 hours (includes 1 test)

What Students Learn:
- How auxiliary systems in a gas-turbine powered plant operate
- How noise, air flow, and emissions are controlled
- The factors that affect a plant’s power output and efficiency
- The fundamentals of a condition monitoring system

Fundamentals of Linework

Duration: 10 hours (includes 1 test)

What Students Learn:
- The major subdivisions of the power grid and explain the lineworker’s role in each area
- Skills and capabilities that lineworkers must develop to be successful
- Lineworking specialties including transmission, distribution, and URD system work
- Lineworking skills and how they differ depending on the type of linework performed
- Vehicles used by lineworkers

Lineworker’s Tools

Duration: 10 hours (includes 1 test)

What Students Learn:
- Recognize and describe the use of special tools used in linework
- Explain how to safely use lineworking tools safely
- Identify common unsafe practices and how to avoid them
- Understand how to select and use the proper digging tool for a job
- Describe how pole-handling tools and equipment are used
- Describe how to properly use and care for fiberglass tools
- Select and properly used the correct wire-cutting tool for a specific application

Power Plant Fuel and Emission Systems, Part 1

Duration: 10 hours (includes 1 test)

What Students Learn:
- Understand the combustion process for all types of fuel
- The relative importance of all fossil fuels used in U.S. power plants
- Methods for receiving and unloading coal at the power-plant site
- The importance of a good coal-storage system
- The coal flow path from receipt to the combustion site
786019

Power Plant Fuel and Emission Systems, Part 2

Duration: 10 hours (includes 1 test)

What Students Learn:
- Pulverizers and their links to the feeders
- Operation of coal feeders
- Functions and characteristics of burners
- How the boiler is initially lit, before the main fuel is admitted to the furnace
- The role of primary air in the combustion cycle

786020

Power Plant Fuel and Emission Systems, Part 3

Duration: 10 hours (includes 1 test)

What Students Learn:
- Differences between balanced-draft and pressurized boilers
- Overview of the air required by the combustion process and the resultants (ash and flue gas) produced
- Air supply systems including forced- and induced-draft fans
- Types of air heaters and how they operate
- Ash management
- Flue gas cleanup techniques and system components

786021

Power Plant Steam Flow Paths, Part 1

Duration: 10 hours (1 test)

What Students Learn:
- How water and steam behave inside a power plant
- Outline the history of steam engines and boilers and the early evolution of steam technology
- Describe simple boiling and associated phenomena
- Explain the concept of steam quality
- Basic thermodynamic properties
- Calculate the basic thermodynamic properties of steam using the Mollier chart and steam tables
- Understand thermodynamic heat cycles

786022

Power Plant Steam Flow Paths, Part 2

Duration: 10 hours (1 test)

What Students Learn:
- Most common ways of measuring, checking and controlling the various phases of steam generation in the boiler.
- Correctly trace the path of newly made steam from boiler to turbines
- Correctly indicate the location of superheaters and their purposes
- Identify the major elements that affect proper fuel combustion
- Explain how temperatures are measured and controlled in the boiler
- State the major functions of monitors, actuators, and recorders

786023

Power Plant Steam Flow Paths, Part 3

Duration: 10 hours (1 test)

What Students Learn:
- Identify the types of pipes and tubes used to transfer steam, water, waste, and fuel throughout the power plant
- Identify valves and interlocking devices used to control the flow of various materials
- Describe the materials commonly used in the fabrication of power plant piping systems
- Interpret piping diagrams to correctly identify and locate valves, fittings, joints, and control devices.
- Determine likely causes and potential solutions for various common boiler problems
- List the steps followed throughout a normal boiler start-up operation

786024

Power Plant Auxiliary Equipment

Duration: 10 hours (includes 1 test)

What Students Learn:
- Components and operating characteristics of high- and low-pressure feedwater heaters
- Identifying various types of valves and applications for each major category
- Operating principles of deaerating feedwater heaters
- Locate and explain the functionality of induced- and forced-draft fans
- Importance and proper operation of electrostatic precipitator systems in exhaust stacks
786025

**Power Plant Instrumentation Systems**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Recognize the variables that are fundamental to plant operation and control
- Describe how instruments work to measure these variables
- Explain some of the fundamental concepts of plant control, such as feedback and open- or closed-loop systems
- Understand what measurements are required to operate the key systems in the plant, such as the boiler, turbine, and feedwater systems
- Predict how changes in certain variables will impact operation and performance in important plant systems

786026

**Power Plant Boilers and Related Equipment**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Function served by the boiler system’s economizer
- Operating characteristics of the superheater system
- Identify the path followed by newly created saturated steam
- Locate and identify boiler blowdown devices
- Identify and trace the path of the downcomer lines
- Identify the path followed by steam that’s routed back to the boiler for reheating
- Explain the function served by fans in a balanced draft boiler system

786027

**Conveyor Systems**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
- Visually identify and recognize the proper operating characteristics of major components in a bulk handling conveyor system
- Operating principles of auxiliary devices used for loading and unloading the conveyor belt
- Detailed parts that are assembled to form a bulk-handling conveyor belt
- Identify various types of conveyor pulleys and their typical applications
- Identify various types of idlers and their purposes and locations in the system
- Methods and devices used to maintain correct tension on a belt
- Two methods used to make a conveyor belt endless
Chemical Engineering
Chemistry and Physics
Civil/Structural Engineering
Drafting/Mechanical Drafting Technology
Electrical Engineering
Highway Engineering
Industrial Engineering
Mechanical Engineering
Polymers
Pulp and Paper
Sanitary Engineering
Schematic Drawing
Surveying
Water/Wastewater Treatment
# Resource 9

## Engineering Technologies

### Subject Index

<table>
<thead>
<tr>
<th>Technical Foundation Skills</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control of Materials (2600)</td>
<td>319</td>
</tr>
<tr>
<td>Engineering Economy (2549)</td>
<td>318</td>
</tr>
<tr>
<td>Engineering Materials (2536A-C)</td>
<td>318</td>
</tr>
<tr>
<td>Engineering Technology Orientation, Part 1 (062002)</td>
<td>316</td>
</tr>
<tr>
<td>Engineering Technology Orientation, Part 2 (062003)</td>
<td>316</td>
</tr>
<tr>
<td>Fiber Optics (086E03)</td>
<td>137</td>
</tr>
<tr>
<td>Fiber Optics Training Kit (086E03)</td>
<td>136</td>
</tr>
<tr>
<td>Geometric Dimensioning and Tolerancing (386E01)</td>
<td>240</td>
</tr>
<tr>
<td>Introduction to ISO 9000: ISO 6078</td>
<td>334</td>
</tr>
<tr>
<td>Introduction to ISO 9000: ISO for the Technician (186037)</td>
<td>45</td>
</tr>
<tr>
<td>Light (6255A-B)</td>
<td>335</td>
</tr>
<tr>
<td>Manufacturing Processes (186075-186078)</td>
<td>230</td>
</tr>
<tr>
<td>Material Handling Safety (186006)</td>
<td>71</td>
</tr>
<tr>
<td>Materials Handling (2512)</td>
<td>318</td>
</tr>
<tr>
<td>Materials Management and Inventory Control (386E03)</td>
<td>320</td>
</tr>
<tr>
<td>Mechanical Testing of Materials (2608A-B)</td>
<td>319</td>
</tr>
<tr>
<td>Operation Analysis (2552A-B)</td>
<td>319</td>
</tr>
<tr>
<td>Plant Layout (2555A-B)</td>
<td>319</td>
</tr>
<tr>
<td>Production Planning and Control (2580)</td>
<td>319</td>
</tr>
<tr>
<td>Productivity Engineering and Management (066904)</td>
<td>316</td>
</tr>
<tr>
<td>Properties of Materials (686005)</td>
<td>339</td>
</tr>
<tr>
<td>Quality Concepts: Terminology for Management (186035)</td>
<td>45</td>
</tr>
<tr>
<td>Quality Concepts: Tools and Applications (186036)</td>
<td>45</td>
</tr>
<tr>
<td>Quality Control for the Technician (386E02)</td>
<td>240</td>
</tr>
<tr>
<td>Quality Control of Manufactured Products (2590)</td>
<td>232</td>
</tr>
<tr>
<td>Sound (6078)</td>
<td>334</td>
</tr>
<tr>
<td>Statistical Quality Control (2521A-E)</td>
<td>232</td>
</tr>
<tr>
<td>Time Study, Part 1 (060016)</td>
<td>316</td>
</tr>
<tr>
<td>Time Study, Part 2 (060017)</td>
<td>316</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemistry and Physics</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Organic Chemistry (5017A-B)</td>
<td>324</td>
</tr>
<tr>
<td>Elements of Chemistry (5011)</td>
<td>323</td>
</tr>
<tr>
<td>Engineering Chemistry (5012)</td>
<td>323</td>
</tr>
<tr>
<td>Heat Transfer (2545)</td>
<td>318</td>
</tr>
<tr>
<td>Heat Treatment of Nonferrous Metals (2897)</td>
<td>320</td>
</tr>
<tr>
<td>Heat, Part 1 (686001)</td>
<td>338</td>
</tr>
<tr>
<td>Heat, Part 2 (686002)</td>
<td>338</td>
</tr>
<tr>
<td>Inorganic Chemicals and Processes (5008A-F)</td>
<td>322</td>
</tr>
<tr>
<td>Inorganic Chemistry (5005A-D)</td>
<td>321</td>
</tr>
<tr>
<td>Instrumental Laboratory Analysis (6588A-D)</td>
<td>336</td>
</tr>
<tr>
<td>Microchemical Analysis (5006)</td>
<td>321</td>
</tr>
<tr>
<td>Organic Chemistry (5814A-G)</td>
<td>333</td>
</tr>
<tr>
<td>Physical Chemistry (5013A-D)</td>
<td>323</td>
</tr>
<tr>
<td>Mechanics (007091)</td>
<td>317</td>
</tr>
<tr>
<td>Heat (007092)</td>
<td>317</td>
</tr>
<tr>
<td>Sound (007093)</td>
<td>317</td>
</tr>
<tr>
<td>Chemistry (007094)</td>
<td>318</td>
</tr>
<tr>
<td>Light (007095)</td>
<td>318</td>
</tr>
<tr>
<td>Electricity and Electronics (007096)</td>
<td>318</td>
</tr>
<tr>
<td>Physics, Part 1 (686003)</td>
<td>339</td>
</tr>
<tr>
<td>Physics, Part 2 (686004)</td>
<td>339</td>
</tr>
<tr>
<td>Qualitative Analysis (6710A-D)</td>
<td>337</td>
</tr>
<tr>
<td>Qualitative Analysis Laboratory Manual (6711)</td>
<td>337</td>
</tr>
<tr>
<td>Quantitative Analysis (5455A-H)</td>
<td>329</td>
</tr>
<tr>
<td>Quantitative Analysis Laboratory Manual (5456)</td>
<td>329</td>
</tr>
<tr>
<td>Surface Protection of Metals (6026)</td>
<td>334</td>
</tr>
<tr>
<td>Working Safely with Chemicals (186002)</td>
<td>71</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Civil Engineering and Structural Engineering</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contracts, Specifications, and Design Drawings (3410)</td>
<td>320</td>
</tr>
<tr>
<td>Design of Prestressed Concrete (6582)</td>
<td>336</td>
</tr>
<tr>
<td>Design of Retaining Walls (5272A-B)</td>
<td>325</td>
</tr>
<tr>
<td>Design of Spread Footings (5290)</td>
<td>326</td>
</tr>
<tr>
<td>Design of Steel Building Frames (5440A-C)</td>
<td>328</td>
</tr>
<tr>
<td>Erection of Steel Building Frames (5261)</td>
<td>325</td>
</tr>
<tr>
<td>Excavations and Foundations (4544)</td>
<td>321</td>
</tr>
<tr>
<td>Field Methods in Concrete Construction (6330A-B)</td>
<td>335</td>
</tr>
<tr>
<td>Fireproofing of Buildings (5891)</td>
<td>334</td>
</tr>
<tr>
<td>Flat Slab Design (5289)</td>
<td>326</td>
</tr>
<tr>
<td>Foundations and Piling (5523)</td>
<td>331</td>
</tr>
<tr>
<td>Hard Pavements (2773A-B)</td>
<td>319</td>
</tr>
<tr>
<td>Highway Drainage (5374)</td>
<td>327</td>
</tr>
<tr>
<td>Highway Embankments and Subgrades (5359)</td>
<td>327</td>
</tr>
<tr>
<td>Loads in Buildings (2766)</td>
<td>319</td>
</tr>
<tr>
<td>Low Cost Road Surfaces (6403A-B)</td>
<td>335</td>
</tr>
<tr>
<td>Mechanics of Materials (5282A-C)</td>
<td>325</td>
</tr>
<tr>
<td>Metallurgy (5338A-B)</td>
<td>327</td>
</tr>
<tr>
<td>Metallurgy of Iron (5110)</td>
<td>325</td>
</tr>
<tr>
<td>Metallurgy of Nonferrous Metals (5337)</td>
<td>327</td>
</tr>
<tr>
<td>Metallurgy of Steel (5111)</td>
<td>325</td>
</tr>
<tr>
<td>Operations Preliminary to Building (2190)</td>
<td>267</td>
</tr>
<tr>
<td>Plate Girders for Steel Buildings (5481)</td>
<td>331</td>
</tr>
<tr>
<td>Reading Structural Steel Drawings (5471A-B)</td>
<td>331</td>
</tr>
<tr>
<td>Reinforced Concrete Design (5450A-C)</td>
<td>328</td>
</tr>
<tr>
<td>Steel Roof Trusses (5587A-C)</td>
<td>332</td>
</tr>
<tr>
<td>Structural Design of Pipe Culverts (5451)</td>
<td>329</td>
</tr>
<tr>
<td>Traffic Control and Operations (5352A-B)</td>
<td>327</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drafting</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architectural Drawing (5637A-B)</td>
<td>332</td>
</tr>
<tr>
<td>Computer Aided Drafting and Design (066901)</td>
<td>316</td>
</tr>
<tr>
<td>Development of Surfaces (5399)</td>
<td>328</td>
</tr>
<tr>
<td>Drafting Kit (1200M)</td>
<td>317</td>
</tr>
<tr>
<td>Drawings for Welded Parts (5645)</td>
<td>332</td>
</tr>
<tr>
<td>Electrical Drafting (6695A-B)</td>
<td>337</td>
</tr>
<tr>
<td>Elementary Architectural Drawings (5893A-C)</td>
<td>334</td>
</tr>
<tr>
<td>Elements of Projection Drawing (5649)</td>
<td>332</td>
</tr>
<tr>
<td>Geometrical Drafting (5544A-B)</td>
<td>331</td>
</tr>
<tr>
<td>Practical Projection (1949A-C)</td>
<td>317</td>
</tr>
<tr>
<td>Sheet Metal Drafting (5551A-B)</td>
<td>331</td>
</tr>
<tr>
<td><strong>Mechanical Drafting Technology</strong></td>
<td>Page</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Advanced Mechanical Drawing (5773A-B)</td>
<td>333</td>
</tr>
<tr>
<td>Elementary Mechanical Drawing (5434)</td>
<td>328</td>
</tr>
<tr>
<td>Geometric Dimensioning and Tolerancing (386E01)</td>
<td>240</td>
</tr>
<tr>
<td>Mechanical Drawing (5739)</td>
<td>332</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Mechanical Engineering</strong></th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering Mechanics, Part 1 (286036)</td>
<td>201</td>
</tr>
<tr>
<td>Engineering Mechanics, Part 2 (286037)</td>
<td>201</td>
</tr>
<tr>
<td>Engineering Mechanics, Part 3 (286038)</td>
<td>201</td>
</tr>
<tr>
<td>Engineering Mechanics, Part 4 (286039)</td>
<td>201</td>
</tr>
<tr>
<td>Fluid Mechanics, Part 1 (286010)</td>
<td>199</td>
</tr>
<tr>
<td>Fluid Mechanics, Part 2 (286011)</td>
<td>199</td>
</tr>
<tr>
<td>Fluid Mechanics, Part 3 (286012)</td>
<td>199</td>
</tr>
<tr>
<td>Mechanical Calculations (5608)</td>
<td>207</td>
</tr>
<tr>
<td>Mechanical Design (186E01)</td>
<td>317</td>
</tr>
<tr>
<td>Principles of Mechanics, Part 1 (286007)</td>
<td>199</td>
</tr>
<tr>
<td>Principles of Mechanics, Part 2 (286008)</td>
<td>199</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Polymers</strong></th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Plastics: Materials, Properties and Manufacturing (686E1)</td>
<td>246</td>
</tr>
<tr>
<td>Plastic Adhesives and Coatings (5001)</td>
<td>240</td>
</tr>
<tr>
<td>Plastics: Films, Sheets, Foams, and Laminates (5002)</td>
<td>240</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Pulp and Paper</strong></th>
<th>Page</th>
</tr>
</thead>
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<tr>
<td>Pulp and Paper Manufacture, Volume 1 (5007A-L)</td>
<td>321</td>
</tr>
<tr>
<td>Pulp and Paper Manufacture, Volume 2 (5009A-I)</td>
<td>322</td>
</tr>
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<td>Pulp and Paper Manufacture, Volume 3 (5010A-L)</td>
<td>323</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th><strong>Schematic Drawings</strong></th>
<th>Page</th>
</tr>
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<tbody>
<tr>
<td>Field Sketching (5810)</td>
<td>333</td>
</tr>
<tr>
<td>Machine Sketching (5807)</td>
<td>333</td>
</tr>
<tr>
<td>Plumbing Drawing (6211)</td>
<td>335</td>
</tr>
<tr>
<td>Reading Electrical Schematic Diagrams (006022)</td>
<td>131</td>
</tr>
<tr>
<td>Reading Prints and Schematics (Block X25)</td>
<td>59</td>
</tr>
<tr>
<td>Reading Structural Steel Drawings (5471A-B)</td>
<td>331</td>
</tr>
<tr>
<td>Structural Steel Drawing (5470A-C)</td>
<td>331</td>
</tr>
<tr>
<td>Understanding and Using Electronic Diagrams (2021)</td>
<td>140</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th><strong>Surveying</strong></th>
<th>Page</th>
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</thead>
<tbody>
<tr>
<td>City Surveying (6818A-C)</td>
<td>338</td>
</tr>
<tr>
<td>Determination of True Meridian (5465)</td>
<td>330</td>
</tr>
<tr>
<td>Earthwork (5468)</td>
<td>330</td>
</tr>
<tr>
<td>Elements of Photogrammetry (6513A-D)</td>
<td>336</td>
</tr>
<tr>
<td>Fundamentals of Law for Surveyors (5463)</td>
<td>330</td>
</tr>
<tr>
<td>Highway Curves (6812A-B)</td>
<td>338</td>
</tr>
<tr>
<td>Highway Location and Design (5353A-C)</td>
<td>327</td>
</tr>
<tr>
<td>Hydrographic Surveying (5751)</td>
<td>333</td>
</tr>
<tr>
<td>Leveling (6671)</td>
<td>336</td>
</tr>
<tr>
<td>Linear Surveying (6670)</td>
<td>336</td>
</tr>
<tr>
<td>Mapping (5462A-B)</td>
<td>330</td>
</tr>
<tr>
<td>Reading Highway Blueprints (6688A-B)</td>
<td>337</td>
</tr>
<tr>
<td>Topographic Surveying (5461A-B)</td>
<td>330</td>
</tr>
<tr>
<td>Transit Surveying (5460A-C)</td>
<td>329</td>
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<tr>
<td>United States Land Surveys (5466A-B)</td>
<td>330</td>
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<tr>
<th><strong>Unit Operations</strong></th>
<th>Page</th>
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<tr>
<td>Distillation (6041)</td>
<td>334</td>
</tr>
<tr>
<td>Drying (5376)</td>
<td>328</td>
</tr>
<tr>
<td>Evaporation and Crystallization (6048)</td>
<td>334</td>
</tr>
<tr>
<td>Filtration (5878)</td>
<td>333</td>
</tr>
<tr>
<td>Fluid Flow (5019)</td>
<td>324</td>
</tr>
<tr>
<td>Material and Energy Balances (5018)</td>
<td>324</td>
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<tr>
<td>Mixing (6209)</td>
<td>335</td>
</tr>
<tr>
<td>Size Reduction (6105)</td>
<td>334</td>
</tr>
<tr>
<td>Size Separation (6106)</td>
<td>335</td>
</tr>
<tr>
<td>Solvent Extraction (6208)</td>
<td>335</td>
</tr>
<tr>
<td>Unit Operations and Equipment (5178)</td>
<td>325</td>
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<table>
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<tr>
<th><strong>Water/Wastewater Treatment</strong></th>
<th>Page</th>
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<tbody>
<tr>
<td>Feedwater Treatment and Equipment (6727)</td>
<td>338</td>
</tr>
<tr>
<td>Operation of Wastewater Treatment Plants (5046A-C)</td>
<td>324</td>
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<tr>
<td>Operation of Water Treatment Plants (5302A-D)</td>
<td>326</td>
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<tr>
<td>Purification of Water (5301A-B)</td>
<td>326</td>
</tr>
<tr>
<td>Sanitary Bacteriology (3048)</td>
<td>320</td>
</tr>
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<td>Sanitary Chemistry (5501)</td>
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<td>Sewage Treatment (5294A-D)</td>
<td>326</td>
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<td>Sewerage (6794A-C)</td>
<td>338</td>
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<td>Tertiary Wastewater Treatment (5045)</td>
<td>324</td>
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<tr>
<td>Water Supply (3395A-C)</td>
<td>320</td>
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Engineering Technologies

Recommended Career/Apprentice Curricula

- Electrical Engineering Technology
- Mechanical Engineering Technology
- Industrial Engineering Technology
- Chemical Engineering Technology
- Civil Engineering Technology/Structural Engineering Technology/Highway Engineering Technology
- Draftsman/Mechanical Drafting Technology Apprentice
  - Land Surveyor
- Pulp and Paper Technician/Engineer
- Sanitary Engineering Technology
- Water/Wastewater Plant Operator

Recommended Topical Program

- Quality Control Technician
The Electrical Engineering Technology program provides trainees with the study materials that enable them to perform the tasks associated with the profession of an Electrical Engineer. This print-based curriculum has been developed to meet the subject requirements of an organization’s skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this technical area.

The Electrical Engineering Technology curriculum starts with comprehensive training in mathematics and technical foundation skills. It progresses through studies in electrical, electronics, and mechanical principles and applications.

This curriculum is appropriate for people who require the technical proficiency for an engineering position in an industrial, electronics or manufacturing organization. An optional Power Plant Engineering curriculum has been developed for the individual who works in a utility company or the power station of a manufacturing plant.

Prior to starting this program, it is essential that the person possess a high school degree or the GED Equivalency Certificate.

Upon completion of this program, students will be able to:

- Explain how voltage, current, and resistance are related by Ohm’s Law and apply these principles to the design and function of electronic circuits.
- Use electrical measuring instruments for troubleshooting.
- Work with electronic measurement components such as multimeters, oscilloscopes, bridge-type instruments, and digital test equipment.
- Explain the operation of electronic equipment and systems such as servo and control systems, numerical control systems, computers, programmable controllers, and microprocessors used in industry.

Special Note:
The Center for Degree Studies (CDS) of Education Direct offers Associate in Specialized Technology (AST) educational degrees in Engineering Technologies. This program requires two years or more of study including a laboratory training session. Many of the courses listed in the following skills curricula are also covered in the CDS program. For more information regarding CDS, refer to Resource 12 or contact your Training Consultant.

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<td>Introduction to Algebra</td>
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<td>Working Safely with Electricity</td>
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<td>Quality Concepts: Terminology for Management</td>
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<td>Preventive Maintenance</td>
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<td>Preventive Maintenance Techniques</td>
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### Electrical Maintenance Principles and Equipment

| DC Principles                                     | Block A21     |
| Nature of Electricity                             | 086001        |
| Circuit Analysis and Ohm’s Law                    | 086002        |
| Capacitors and Inductors                          | 086003        |
| Magnetism and Electromagnetism                    | 086004        |
| Conductors, Insulators, and Batteries             | 086005        |
| DC Motors and Generator Theory                    | 086006        |

### Optional Laboratory Experiments:

- Electronic Simulation Software                  | 086000        |
- Experiments with Basic DC Theory – Lab Manual    | 086087        |

| AC Principles                                     | Block A22     |
| Alternating Current                               | 086007        |
| Alternating Current Circuits                       | 086008        |
| Inductors in AC Circuits                          | 086009        |
| Capacitors in AC Circuits                         | 086010        |
| Transformers                                      | 086011        |
| Alternators                                       | 086012        |
| Electrical Energy Distribution                    | 086013        |
| Rectification and Basic Electronic Devices        | 086014        |

- Experiments with Basic AC Theory – Lab Manual    | 086088        |
- Analog Circuit Measurement                       | Block A23     |
- Basic Test Equipment                              | 086025        |
- Troubleshooting with Volt-Ohm-Milliamp Meters (VOMs)| 086026        |
- Using Basic Oscilloscopes                         | 086027        |
- Experiments in Electrical Measurements            | 086089        |
- Electrical Safety for the Trades                  | 186005        |
Electrical Equipment .......................................................... Block A24
Conductors and Insulators in Industry ................................. 086070
Working with Conduit ...................................................... 086071
Electrical Boxes ................................................................. 086072
Industrial Enclosures and Raceways ................................ 086073
Connecting Electrical Equipment, Part 1 ......................... 086074
Connecting Electrical Equipment, Part 2 ......................... 086075
Industrial Fuses ................................................................. 086076
Industrial Circuit Breakers ................................................. 086077
Plugs, Receptacles, and Lampholders .................................. 086078
Industrial Switches ............................................................ 086079
Industrial Relay Ladder Logic ............................................. 086080
Industrial Relays, Contractors, and Solenoids .................... 086081
Electrical Grounding ......................................................... 086E01
Electrical Wiring Practices ............................................... 086E02
Data, Voice, and Video Cabling ........................................... 086E16

**Electrical Components**

Transformers ................................................................. 4040
Transformer Operation ...................................................... 4041
Distribution and Power Transformers .................................. 4042
Storage Batteries .............................................................. 4334
Alternators ......................................................................... 4031
Efficiency Tests .................................................................. 4342
Electric Heating ............................................................... 006034
Electric Furnaces ............................................................. 4420A-B
Servomechanisms .............................................................. 2028A-B
Telemeasuring ................................................................. 4048
National Electrical Code (NEC Code and Textbook Course) ... 5177EM

**Electrical Motors**

Industrial Motor Applications ........................................... 4341
DC Machines ...................................................................... 4030-A-B
Alternating Current Motors .............................................. 4032
Industrial DC Motors ....................................................... 086051
Industrial AC Motors ....................................................... 086052
Controlling Industrial Motors .......................................... 086053
Fractional Horsepower Motors ......................................... 4033
Predictive Maintenance ..................................................... 286087
Predictive Maintenance: Vibration Analysis ....................... 286088
Predictive Maintenance: Advanced Topics ......................... 286089

**Electronic Concepts and Components**

Component Testers .......................................................... 086062
Digital Test Equipment ...................................................... 086063
Analog Electronic Components ......................................... Block B23
Basic Semiconductor Components: Diodes ....................... 086019
Basic Semiconductor Components: Transistors ................. 086020
Switching Devices ............................................................ 086021
Electronic Sensors ........................................................... 086022
Special Rectifiers: Electron Tubes ..................................... 086023
Opto-electronic and Fiber Optic Components ..................... 086024
Electronics Hardware ......................................................... 086040
Basic Electronic Circuits ................................................... Block B24
Rectifiers and Power Supplies ........................................... 086041
Amplifiers ........................................................................... 086042
Oscillators .......................................................................... 086043
Modulation and Detection Circuits ................................... 086044
Switching Circuits ............................................................ 086054
Logic Circuits ..................................................................... 086055
Gating and Counting Circuits ........................................... 086056
Pulse and Digital Circuits .................................................. 086057
Electronic Systems ............................................................ Block B25
Electronic Devices and Amplification .................................. 086045
Audio and RF Circuits ........................................................ 086046
Oscillators, Feedback, and Waveforms ............................... 086047

Electronic Power Supply Systems ........................................ 086048
Industrial Amplification Systems ........................................ 086058
Servo and Control Systems ................................................. 086059
Pulse and Logic Circuits ..................................................... 086060
Programmable Controllers and Microprocessors ................ 086061
Fiber Optics ........................................................................ 086E03
Troubleshooting Industrial Electronic and Computer Systems ................................ Block B26
Industrial Electronic Troubleshooting .................................. 086064
Electrical Troubleshooting of Industrial Motor Controls ....... 086065
Troubleshooting Sensing Devices and Systems .................. 086066
Troubleshooting Industrial Control Systems and Output Devices ............................................. 086067
Troubleshooting Industrial Computer Systems and Software ............................................. 086068
Industrial Computer Networks ......................................... 086069

**Microprocessor Technology**

Basic Industrial Computer Systems .................................. Block B10
Industrial Computer Fundamentals ..................................... B1001
Digital and Analog Systems .............................................. B1002
Software and Programming .............................................. B1003
Computer-Aided Control Systems ..................................... B1004
Interfacing Principles ....................................................... B1005
Introduction to Microprocessors ........................................ Block B11
Introduction to Computers ................................................ B1101
Introduction to Microprocessor Applications ..................... B1102
Microprocessor Basics, Part 1: Underlying Principles and Concepts ............................................. B1103
Microprocessor Basics, Part 2: Overview of What's in a Microprocessor ....................................... B1104
Industrial Microprocessors .............................................. 086E05

**Engineering Managerial Concepts**

Engineering Economy ....................................................... 2549
Report Writing .................................................................. 05001-24

**Principles of Mechanics**

Engineering Mechanics, Part 1 ........................................... 286036
Engineering Mechanics, Part 2 ........................................... 286037
Engineering Mechanics, Part 3 ........................................... 286038
Engineering Mechanics, Part 4 ........................................... 286039
Fluid Mechanics, Part 1 .................................................... 286010
Fluid Mechanics, Part 2 .................................................... 286011
Fluid Mechanics, Part 3 .................................................... 286012
Mechanics of Materials ..................................................... 5282A-C
Engineering Materials ....................................................... 2536A-C
Light .................................................................................. 6255A-B
Sound .............................................................................. 6078
Heat, Part 1 ........................................................................... 686001
Heat, Part 2 .......................................................................... 686002
Ultrasonics ........................................................................ 6520A-B

**Advanced Electronics Control Applications**

Electronic Process Control ................................................ 086E17
Distributed Control Systems, Part 1 .................................... 086084
Distributed Control Systems, Part 2 ........................................ 086085
Distributed Control Systems, Part 3 ........................................ 086086
Industrial Electronic Circuit Applications ................................. B1401
Interfacing Process Variables ................................................... B1401
Motor Control and Servo Systems ............................................. B1402
Numerical Control Systems ....................................................... B1403
Programmable Controllers ....................................................... B1404
Industrial Robots ..................................................................... B1405
Motor Control Fundamentals
(for Programmable Logic Controllers) ........................................ 006010
Industrial Motor Control
(for Programmable Logic Controllers), Part 1 ............................ 006011
Industrial Motor Control
(for Programmable Logic Controllers), Part 2 ......................... 006012
Basic Industrial Electronic System Applications ......................... B1501
Voltage and Frequency Controllers ........................................... B1502
Nondestructive Test Equipment ................................................ B1502
Resistance Welding Equipment ............................................... B1503
Dielectric and Induction Heating .............................................. B1504
Crane Systems, Scales, and Materials Handling ......................... B1505
Advanced Troubleshooting Techniques ...................................... B1601
Approach to Troubleshooting .................................................. B1601
Analysis of Systems .................................................................. B1602
Test Equipment Applications .................................................... B1603
Safe Troubleshooting Practices ............................................... B1604
Troubleshooting Industrial Systems, Part 1 ................................... B1605
Troubleshooting Industrial Systems, Part 2 ............................... B1606

Estimated Curriculum Duration: 1,754 hours
(excluding optional lab experiments).
Number of Exams: 196.

**Optional Laboratory Experiments:**
Measurements Trainer .............................................................. XK-100
Digital Trainer ........................................................................... XK-200
Fiber Optics Training Kit ............................................................ 086803
Microprocessor Trainer ............................................................... 086802

**Optional: Power Plant Engineering Technology**
Fundamentals of Power Plant Operation, Part 1 .......................... 786005
Fundamentals of Power Plant Operation, Part 2 .......................... 786006
Fundamentals of Power Plant Operation, Part 3 .......................... 786007
Power Plant Water Treatment, Part 1 ......................................... 786008
Power Plant Water Treatment, Part 2 ......................................... 786009
Power Plant Water Treatment, Part 3 ......................................... 786010
Power Plant Station Power ......................................................... 786011
Combustion Turbines, Part 1 ...................................................... 786013
Combustion Turbines, Part 2 ...................................................... 786014
Combustion Turbines, Part 3 ...................................................... 786015
Power Plant Fuel Flow Paths, Part 1 .......................................... 786018
Power Plant Fuel Flow Paths, Part 2 .......................................... 786019
Power Plant Fuel Flow Paths, Part 3 .......................................... 786020
Power Plant Steam Flow Paths, Part 1 ........................................ 786021
Power Plant Steam Flow Paths, Part 2 ........................................ 786022

Power Plant Steam Flow Paths, Part 3 ........................................ 786023
Power Plant Auxiliary Equipment ............................................. 786024
Power Plant Instrumentation Systems ....................................... 786025
Power Plant Boilers and Related Equipment ............................. 786026
Conveyor Systems ................................................................. 786027
Switchgear .............................................................................. 6613
Instrument Transformers ......................................................... 6793
Protective Relaying ................................................................. 6538A-B
Electric Power Measurements................................................... 4019A-B
Transmission Lines ................................................................. 4358
Underground Power Systems .................................................... 006039
Power Line Calculations ............................................................ 6256
Symmetrical Components ........................................................ 6728
Voltage Regulators for Generators ............................................. 4368
Voltage Regulation of Distribution Systems .............................. 4370
Electric Power Generating Stations ......................................... 6589A-B
Electric Power Substations ..................................................... 6590A-B

Estimated Duration: 360 hours.
Number of Exams: 36.

**Optional: Advanced Mathematics**
Analytic Geometry ................................................................. 6561A-B
Calculus: Function and Use ....................................................... 6618A-D

Estimated Duration: 60 hours.
Number of Exams: 6.

**Optional: Introduction to Chemistry**
Elements of Chemistry .............................................................. 5011
Engineering Chemistry .............................................................. 5012

Estimated Duration: 20 hours.
Number of Exams: 2.

**Optional: Mechanical Drafting Applications**
Drafting Kit .............................................................................. 1200M
Elementary Mechanical Drawing (includes 8 plates) .................. 5434

Estimated Duration: 130 hours.
Mechanical Engineering Technology

The Mechanical Engineering Technology curriculum provides trainees with the study materials that enable them to perform the tasks associated with the profession of a Mechanical Engineer. This print-based curriculum has been developed to meet the subject requirements of a student's skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this technical area.

The Mechanical Engineering Technology program provides comprehensive training in mathematics, the basic sciences, manufacturing processes, mechanical design, and instrumentation, and process control systems. Optional course outlines are assembled focusing on the generation, transmission, and utilization of mechanical power.

This curriculum is appropriate for people who require the technical proficiency for an engineering position in a manufacturing organization. Other positions that would benefit from this training are Plant Engineer, Production Manager, and Machine/Tool Designer.

Prior to starting this program, it is essential that the person possess a high school degree or the GED Equivalency Certificate.

Upon completion of this program, students will be able to:

• Describe the principles of basic science, chemistry, and engineering mechanics.
• Explain the composition of materials and metals and how they are affected by common scientific and engineering applications used in manufacturing.
• Understand the principles of fluid power and hydraulics, the common types of components, how they operate and how these systems can be tested and maintained.
• Incorporate the principles and components that comprise a mechanical power transmission system, how they operate, and how they can be maintained in everyday work experiences.
• Describe the principles of automatic process control systems and how the various control instruments function.
• Learn how mechanical, hydraulic, and pneumatic components used in control systems measure parameters and convert these measurements into useful data or appropriate control system responses.

Special Note:
The Center for Degree Studies (CDS) of Education Direct offers Associate in Specialized Technology (AST) educational degrees in Mechanical Engineering Technology. This program requires two years or more of study including a laboratory training session. Many of the courses listed in the following skills curricula are also covered in the CDS program. For more information regarding CDS, refer to Resource 12 or contact your Training Consultant.

Base Curriculum

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<td>2511A-E</td>
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<td>5254</td>
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<td>Trades Safety: Getting Started</td>
<td>186001</td>
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<td>186003</td>
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<td>186006</td>
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<tr>
<td>Preventive Maintenance Techniques</td>
<td>286086</td>
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Mechanical Manufacturing Processes

Mechanical Testing of Materials                        | 2608A-B       |
Engineering Materials                                   | 2536A-C       |
Manufacturing Processes, Part 1                         | 186075        |
Manufacturing Processes, Part 2                         | 186076        |
Manufacturing Processes, Part 3                         | 186077        |
Manufacturing Processes, Part 4                         | 186078        |
Geometric Dimensioning and Tolerancing                  | 386E01        |
CNC Technology and Programming                          | 066903        |
Transfer Devices for Machine Tools                      | 6569A-B       |
Quality Control for the Technician                      | 386E02        |

Fluid Power and Hydraulic Systems:

Operations and Maintenance

Pumps, Part 1                                          | 286001        |
Pumps, Part 2                                          | 286002        |
Pumps, Part 3                                          | 286003        |
Introduction to Fluid Power                            | Block Y01     |
Introduction to Fluid Power                            | Y0101         |
The Physics of Fluid Power                             | Y0102         |
Transmission and Storage of Energy by Fluid Power, Part 1| Y0103         |
Transmission and Storage of Energy by Fluid Power, Part 2| Y0104         |
The Components of Fluid Power, Part 1                 | Y0105         |
The Components of Fluid Power, Part 2                 | Y0106         |
The Components of Fluid Power, Part 3                 | Y0107         |
A Summary of Fluid Power                               | Y0108         |
Hydraulics Power Basics                                 | 286060        |
Hydraulic Components:
Actuators, Pumps, and Motors                           | 286061        |
Hydraulic Components:
- Conductors, Conditioners, and Fluids ........................................... 286062
- Hydraulic Power System Control ..................................................... 286063
- Interpreting Hydraulic System Schematics ........................................ 286064
- Hydraulic Power System Troubleshooting ......................................... 286065

Mechanical Systems:
Operations and Maintenance
- Pneumatics, Part 1 ............................................................... 286098
- Pneumatics, Part 2 ............................................................... 286099
- Pneumatics, Part 3 ............................................................... 286100
- Air Compressors, Part 1 ......................................................... 286096
- Air Compressors, Part 2 ......................................................... 286097
- Industrial Robotics: Technology, Programming, and Applications ... 066902

Design and Applications of Mechanical Components/Power Transmission Systems
- Lubrication, Part 1 ................................................................. 286091
- Lubrication, Part 2 ................................................................. 286092
- Link Mechanisms .................................................................. 2603
- Gearing ................................................................................. 2446
- Gear Trains ............................................................................ 2604
- Cams ...................................................................................... 2605
- Mechanical Power Transmission ............................................... 286015
- Belt Power Transmission ......................................................... 2607A-B
- Mechanical Design ............................................................... 286101-03
- Jigs and Fixtures .................................................................... 5099
- Fundamentals of Tool Design .................................................. 3535A-G
- Gear Making ........................................................................... 5532A-B
- Servomechanisms .................................................................. 2028A-B
- Predictive Maintenance .......................................................... 286087
- Predictive Maintenance: Vibration Analysis ................................. 286088
- Predictive Maintenance: Advanced Topics .................................. 286089

Engineering Managerial Concepts
- Engineering Economy ............................................................. 2549
- Materials Management and Inventory Control ....................... 386E03
- Plant Layout .......................................................................... 2555A-B
- Production Planning and Control ............................................. 2580
- Quality Control of Manufactured Products ............................. 2590
- Control of Materials .............................................................. 2600
- Time Study, Part 1 .................................................................. 066016
- Time Study, Part 2 .................................................................. 066017
- Operation Analysis ............................................................... 2552A-B
- Report Writing ....................................................................... 05001-24
- Productivity Engineering and Management ............................... 066904

Instrumentation and Process Control
- Pneumatic Instrumentation for the Technician .......................... 286M01
- Control Technology for Technicians ........................................ 286M04
- Electronic Process Control ....................................................... 086E17
- Distributed Control Systems, Part 1 ....................................... 086084
- Distributed Control Systems, Part 2 ....................................... 086085
- Distributed Control Systems, Part 3 ....................................... 086086
- Principles of Automatic Process Control Instruments .................. 6305A-B
- Temperature Measuring and Control Instruments ...................... 6306A-B
- Automatic Process Control Valves .......................................... 6307
- Fluid Flow Measuring and Control Instruments ......................... 6308A-B
- Process Pressure Measuring and Control Instruments .............. 6309A-B
- Liquid Level Measuring and Control Instruments ...................... 6338A-B

Estimated Curriculum Duration: 1,555 hours.
Number of Exams: 180.

Optional: Advanced Mathematics
- Analytic Geometry .................................................................. 6561A-B
- Calculus: Function and Use .................................................. 6618A-D

Estimated Duration: 60 hours.
Number of Exams: 6.

Optional: Principles of Chemistry
- Elements of Chemistry ........................................................... 5011
- Engineering Chemistry ........................................................... 5012
- Light ....................................................................................... 6255A-B
- Sound ..................................................................................... 6078
- Metallurgy of Iron .................................................................. 5110
- Metallurgy of Steel .................................................................. 5111
- Metallurgy of Nonferrous Metals ........................................... 5337
- Metallurgy ................................................................. 5338A-B

Estimated Duration: 100 hours.
Number of Exams: 10.

Optional: Principals of Thermodynamics
- Heat, Part 1 ........................................................................... 686001
- Heat, Part 2 ........................................................................... 686002
- Steam ...................................................................................... 2620
- Heat Transfer .......................................................................... 2545
- Fuels ....................................................................................... 5340
- Types of Steam Generators ................................................... 6632
- Steam Generator Accessories .................................................. 2585
- Principles of Heating, Ventilating, and Air Conditioning .......... 6447A-B
- Refrigeration in Air Conditioning ........................................... 5383

Estimated Duration: 180 hours.
Number of Exams: 10.

Optional: Creation, Transmission, and Utilization of Mechanical Power
- Steam Engines and Their Management ................................... 2523A-C
- Types of Steam Turbines ......................................................... 2505
- Steam Turbine Management and Governing ........................... 2506
- Steam Turbine Calculations .................................................... 2507
- Pressure Vessel and Tank Print Reading ................................... 6691
- Condensers .......................................................................... 6553
- Pressure Parts for Steam Generators ...................................... 2588
- Steam Generator Supporting Steel Structures ......................... 2589
- Steam Generator Sets, Ducts, and Stacks ................................. 2587
- Steam Generator Design ....................................................... 2598A-B
- Feedwater Treatment and Equipment ..................................... 6727
- Testing Solid and Liquid Boiler Fuels ..................................... 6472
- Solid and Pulverized Fuel Burning ........................................ 6473
- Oil and Gas Firing for Steam Generation ................................. 2592
- Automatic Combustion Control .............................................. 2596A-C
- Flue Gas Analysis ................................................................. 6810
- Steam Boiler Operation and Maintenance ............................... 6734
- Steam Generator Testing ....................................................... 6802
- Power Plant Economy .......................................................... 2514
- Principles and Uses of Nuclear Energy .................................... 6683
- Principles of the I-C Engine .................................................. 2525
- I-C Engine Fuels and Combustion ......................................... 2526
- I-C Engine Testing ............................................................... 2527

Estimated Duration: 280 hours.
Number of Exams: 28.
**Industrial Engineering Technology**

The Industrial Engineering Technology curriculum provides trainees with the study materials that enable them to perform the tasks associated with the profession of an Industrial Engineer. This print-based curriculum has been developed to meet the subject requirements of an organization's skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this technical area.

The Industrial Engineering Technology curriculum starts with comprehensive training in mathematics and technical foundation skills. It progresses through studies in mechanical engineering design, electronic components and circuits, instrumentation and process control systems, and fluid power/power transmission systems applications.

This curriculum is appropriate for people who require the technical proficiency for an engineering position in industry. Other positions that would benefit from this training are Plant Layout Engineer, Production Planner, and Manufacturing Processes Engineer.

Prior to starting this program, it is essential that the person possess a high school degree or the GED Equivalency Certificate.

Upon completion of this program, students will be able to:
- Identify the basics of basic science, chemistry, and engineering mechanics.
- Explain how common electronic components function and achieve circuit operations.
- Learn the basics of microprocessors, what they are comprised of, and how they apply within industry.
- Describe the principles of automatic process control systems and how the various control instruments function.
- Identify the principles of fluid power and hydraulics, the common types of components, how they operate, and how these systems can be troubleshoot and maintained.
- Explain the principles and components that comprise a mechanical power transmission system, how they operate, and how they can be maintained.

**Special Note:**

The Center for Degree Studies (CDS) of Education Direct offers an Associates in Specialized Technology (AST) educational degree in **Industrial Engineering Technology**. This program requires two years or more of study including a laboratory training session. Many of the courses listed in the following skills curricula are also covered in the CDS program. For more information regarding CDS, refer to Resource 12 or contact your Training Consultant.

**Estimated Duration:** 120 hours.
**Number of Exams:** 12.

**Optional: Mechanical Drafting Technology**

| Drafting Kit | 1200M |
| Machine Sketching | 5807 |
| Elementary Mechanical Drawing (includes 8 plates) | 5434 |
| Mechanical Drawing (includes 6 plates) | 5739 |

**Estimated Duration:** 240 hours.
**Number of Exams:** 1.

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<td>Problem Solving and Troubleshooting</td>
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Chemical Engineering Technology

The Chemical Engineering Technology curriculum provides trainees with the study materials that enable them to perform the tasks associated with the profession of a Chemical Engineer. This print-based curriculum has been developed to meet the subject requirements of an organization’s skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this technical area.

The Chemical Engineering Technology curriculum starts with comprehensive training in mathematics and technical foundation skills including inorganic chemistry and basic physics. The program builds on these studies to cover analytical chemistry, organic chemistry, thermodynamics, unit operations (filtration and distillation), qualitative and quantitative analysis, and instrumentation.

This training is appropriate for people who require the technical proficiency for an engineering position in a chemical plant or in industries such as pulp and paper, petroleum, plastics and food processing. Other positions that would benefit from this training are Research and Development Engineer, Chemical Production Manager, Chemical Plant Engineer, and Field Sales/Service Technician for chemical equipment.

Prior to starting this program, it is essential that the person possess a high school degree or the GED Equivalency Certificate.

Upon completion of this program, students will be able to:

• Describe the principles of inorganic and organic chemistry and basic physics.
• Identify the applications of fluid mechanics, heat and metallurgy and compare them to the chemical process.
• Identify what happens to liquid, solid, and gaseous elements and materials as they are exposed to chemical processes utilized in industry manufacturing operations.
• Perform analytical experiments and laboratory tests related to common chemical elements.
• Explain the chemical properties and industrial applications of plastics.
• Describe the principles of automatic process control and how the various control instruments function.

Special Note:
The Center for Degree Studies (CDS) of Education Direct offers an Associates in Specialized Technology (AST) educational degree in Chemical Engineering Technology. This program requires two years or more of study including a laboratory training session. Many of the courses listed in the following skills curricula are also covered in the CDS program. For more information regarding CDS, refer to Resource 12 or contact your Training Consultant.

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Advanced Mathematics

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Unit Operations

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Special Note:
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Drying .................................................................5376
Distillation .........................................................6041
Solvent Extraction ..............................................6208
Sanitary Bacteriology ........................................3048
Purification of Water ...........................................5301A-B

Chemical Analysis Techniques
Qualitative Analysis ...........................................6710A-D
Qualitative Analysis Laboratory Manual ...............6711
Quantitative Analysis .........................................5455A-H
Quantitative Analysis Laboratory Manual ...............5456
Instrumental Laboratory Analysis .......................6588A-D
Microchemical Analysis ......................................5006

Introduction to Polymers
Industrial Plastics: Materials, Properties and Manufacturing...........686E1
Plastic Adhesives and Coatings ..................................5001
Plastics: Films, Sheets, Foams, and Laminates .................5002

Instrumentation and Process Control
Pneumatic Instrumentation for the Technician ........286M01
Control Technology for Technicians ......................286M04
Electronic Process Control ...................................086E17
Distributed Control Systems, Part 1 .......................086084
Distributed Control Systems, Part 2 .......................086085
Distributed Control Systems, Part 3 .......................086086
Principles of Automatic Process Control Instruments ..6305A-B
Temperature Measuring and Control Instruments ...6306A-B
Automatic Process Control Valves ..............6307
Fluid Flow Measuring and Control Instruments ..6308A-B
Process Pressure Measuring and Control Instruments .6309A-B
Liquid Level Measuring and Control Instruments ....6388A-B

Engineering Managerial Concepts
Quality Concepts: Terminology for Management ..........186035
Report Writing ..................................................05001-24
Engineering Economy .........................................2549
Engineering Materials ........................................2536A-C
Materials Management and Inventory Control ....386E03
Plant Layout ......................................................2555A-B
Production Planning and Control .........................2580
Quality Control of Manufactured Products ..............2590
Control of Materials ........................................2600
Geometric Dimensioning and Tolerancing ..............386E01
Time Study, Part 1 ...........................................066016
Time Study, Part 2 ...........................................066017
Operation Analysis ..........................................2552A-B
Productivity Engineering and Management ............066904
Quality Control for the Technician ......................386E02

Estimated Curriculum Duration: 1,734 hours.
Number of Exams: 183.

Optional: Electrical Maintenance Principles and
Electrical Motors
DC Principles .....................................................Block A21
  Nature of Electricity ........................................086001
  Circuit Analysis and Ohm's Law .........................086002
  Capacitors and Inductors ................................086003
  Magnetism and Electromagnetism .....................086004
  Conductors, Insulators, and Batteries ..............086005
  DC Motors and Generator Theory .................086006

Optional Laboratory Experiment:
Electronic Simulation Software ..........................086800
Experiments with Basic DC Theory – Lab Manual ......086087
AC Principles ..................................................Block A22

Alternating Current ..........................................086007
Alternating Current Circuits ............................086008
Inductors in AC Circuits ..................................086009
Capacitors in AC Circuits ................................086010
Transformers ..................................................086011
Alternators ......................................................086012
Electrical Energy Distribution .........................086013
Rectification and Basic Electronic Devices ...........086014
Experiments with Basic AC Theory – Lab Manual ...086088
Analog Circuit Measurement .........................Block A23
Basic Test Equipment .....................................086025
Troubleshooting with Volt-Ohm-Milliammeter
(VOMs) .........................................................086026
Using Basic Oscilloscopes ................................086027

Experiments in Electrical Measurements ...............086089
Electrical Safety for the Trades ..........................286005
Industrial DC Motors ......................................086051
Industrial AC Motors ......................................086052
Transformers ...................................................4040
Telemetering ...................................................4048

Estimated Duration: 160 hours
(excluding optional lab experiments).
Number of Exams: 25.

Optional: Mechanical Systems Operations and
Maintenance
Mechanical Testing of Materials ..........................2608A-B
Pneumatics, Part 1 ..........................................286098
Pneumatics, Part 2 ..........................................286099
Pneumatics, Part 3 ..........................................286100
Air Compressors, Part 1 ..................................286096
Air Compressors, Part 2 ..................................286097
Bearings and Seals, Part 1 .................................286093
Bearings and Seals, Part 2 .................................286094
Predictive Maintenance .................................286087
Predictive Maintenance: Vibration Analysis .........286088
Predictive Maintenance: Advanced Topics ..........286089

Estimated Duration: 75 hours.
Number of Exams: 9.

Optional: Steam Engine Principles
Types of Steam Turbines .....................................2505
Principles of the I-C Engine ..............................2525
I-C Engine Fuels and Combustion ......................2526

Estimated Duration: 30 hours.
Number of Exams: 3.
The Civil Engineering Technology curriculum provides trainees with the study materials that enable them to perform the tasks associated with the profession of a Civil Engineer, Structural Engineer, or Highway Engineer. This print-based curriculum has been developed to meet the subject requirements of an organization’s skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this technical area.

The Civil Engineering Technology curriculum starts with comprehensive training in mathematics and the principles of measurement. The curriculum prepares trainees to perform land and construction surveys, and to prepare topographic maps and right-of-way layouts. The training progresses to the design and construction of structures such as buildings, bridges, roads, tunnels, water-supply, and sewerage systems.

This curriculum is appropriate for people who require the technical proficiency of a surveyor; an engineer for a construction company, public works department or a transportation company; a drafter-designer for an engineering or architectural firm.

Prior to starting this program, it is essential that the person possess a high school degree or the GED Equivalency Certificate.

Upon completion of this program, students will be able to:

- Explain the principles associated with linear surveying, transit surveying, topographic surveying, hydrographic surveying and city surveying, and the related engineering applications and operations.
- Apply mathematical and scientific principles in the engineering context.
- Design and detail foundations, steel and concrete building frames, roof trusses, plate girders, flat slabs, retaining walls, masonry arches, rigid frames, and steel bridges.
- Design, prepare, and construct roads paved with concrete and asphalt.

Special Note:
The Center for Degree Studies (CDS) of Education Direct offers an Associates in Specialized Technology (AST) educational degree in Civil Engineering Technology. This program requires two years or more of study including a laboratory training session. Many of the courses listed in the following skills curricula are also covered in the CDS program. For more information regarding CDS, refer to Resource 12 or contact your Training Consultant.

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mathematics and Technical Foundation Skills</strong></td>
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</tr>
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<td>Basic Industrial Math</td>
<td>Block X21</td>
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<td>Addition and Subtraction</td>
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<td>Multiplication and Division</td>
<td>186009</td>
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<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
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<td>Metric System</td>
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<td>Formulas</td>
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<td>Introduction to Algebra</td>
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<td>Problem Solving and Troubleshooting</td>
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<td>Introduction to Algebra, Geometry, and Trigonometry</td>
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<td>Transit Surveying</td>
<td>5460A-C</td>
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<td>Geometrical Drawing (includes 5 plates)</td>
<td>5544A-B</td>
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<tr>
<td>Topographic Surveying</td>
<td>5461A-B</td>
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<td>Mapping (includes 4 plates)</td>
<td>5462A-B</td>
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<td>Highway Curves</td>
<td>6812A-B</td>
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<td>Hydrographic Surveying</td>
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<td><strong>Advanced Surveying Skills</strong></td>
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<td>Determination of True Meridian</td>
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<td>United States Land Surveys</td>
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<td>Fundamentals of Law for Surveyors</td>
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<td>Elements of Photogrammetry</td>
<td>6513A-D</td>
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<td>City Surveying</td>
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<td>Engineering Mechanics, Part 1</td>
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<td>286039</td>
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<td>Earthwork</td>
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<td><strong>Design and Construction Applications for Roads</strong></td>
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<td>Elements of Chemistry</td>
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<td>Engineering Materials</td>
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<td>Production of Concrete</td>
<td>5469A-C</td>
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<td>Field Methods in Concrete Construction</td>
<td>6330A-B</td>
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<td>Highway Embankments and Subgrades</td>
<td>5359</td>
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<td>Highway Drainage</td>
<td>5374</td>
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<tr>
<td>Low Cost Road Surfaces</td>
<td>6403A-B</td>
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<td>Hard Pavements</td>
<td>2773A-B</td>
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<tr>
<td>Highway Location and Design</td>
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Advanced Mathematics
Analytic Geometry ......................................................... 6561A-B
Calculus: Function and Use ............................................. 6618A-D

Principles of Engineering
Nature of Electricity ......................................................... 086001
Circuit Analysis and Ohm’s Law ...................................... 086002
Conductors, Insulators and Batteries .............................. 086005
Alternating Current ...................................................... 086007
Alternating Current Circuits ....................................... 086008
Heat, Part 1 ..................................................................... 686001
Heat, Part 2 ..................................................................... 686002
Light ............................................................................... 6255A-B
Sound ............................................................................. 6078

Engineering Managerial Skills
Quality Concepts: Terminology for Management ............ 186035
Engineering Economy .................................................... 2549
Time Study, Part 1 ............................................................ 066016
Time Study, Part 2 ............................................................ 066017
Report Writing ................................................................. 7000A-E

Design and Construction Applications for Buildings,
Tunnels, and Bridges
Mechanics of Materials ............................................... 5282A-C
Design of Steel Building Frames ..................................... 5440A-C
Structural Design of Pipe Culverts .............................. 5451
Reinforced Concrete Design ........................................... 5450A-C
Design of Prestressed Concrete .................................... 6582
Elements of Projection Drawing (includes 5 plates) ....... 5649
Structural Steel Drawing (includes 3 plates) .................. 5470A-C
Plate Girders for Steel Buildings .................................... 5481
Loads in Buildings ...................................................... 2766
Erection of Steel Building Frames ............................... 5261
Contracts, Specifications, and Design Drawings ............ 3410
Steel Roof Trusses ......................................................... 5587A-C
Flat Slab Design .............................................................. 5289
Foundations and Piling ................................................ 5523
Design of Spread Footings .......................................... 5290
Design of Retaining Walls .......................................... 5272A-B
Fireproofing of Buildings ............................................. 5891

Design and Construction Applications for
Water Supply Systems
Fluid Mechanics, Part 1 ............................................... 286010
Fluid Mechanics, Part 2 ............................................... 286011
Fluid Mechanics, Part 3 ............................................... 286012
Hydraulic Turbines ...................................................... 6718A-C
Environmental Technology for Technicians ................ 286M03
Water Supply ................................................................. 3395A-C
Sewerage ....................................................................... 6794A-C
Engineering Chemistry .............................................. 5012
Sanitary Chemistry ...................................................... 5501
Sanitary Bacteriology .................................................. 3048
Sewage Treatment ....................................................... 5294A-D
Purification of Water .................................................... 5301A-B

Estimated Curriculum Duration: 1,732 hours.
Number of Exams: 149.

Draftsman/Mechanical Drafting Technology

Apprentice

The Mechanical Drafting Technology curriculum is designed for people wanting to learn the fundamentals of mechanical drawing. The courses included in the basic drafting skills and practices section are prerequisites for the mechanical drafting and applied technologies courses. The trainees learn about basic physics, measuring instruments, testing of materials, and drawings for welded parts, as well as mechanical drafting techniques. A total of 45 drawing plates must be completed as part of the program requirements.

After successful completion of this curriculum, trainees will have the qualifications necessary for entry level positions as Detailers, General Drafters, Detail Drafters, and Layout Drafters.

Upon completion of this curriculum, students will be able to:
• Understand geometrical terms, lines, angles, triangles, circles, lettering, and projections used in geometrical, mechanical, and projection drawing/drafting.
• Understand the uses of the equipment and materials associated with mechanical drawing.
• Draw in detail the component parts that make up a typical mechanical power transmission system.
• Draw industrial applications of sheet metal.
• Describe the principles of mechanical technology, physics, and advanced mathematical calculations and measurements as they relate to mechanical drafting skills.

Special Notes:
• Students taking the Draftsman/Mechanical Drafting Technology curriculum should have completed or demonstrated knowledge of the Personal Computing Applications Software courses in Resource 1.
• Education Direct also offers a career study program titled, Drafting with AutoCAD®. Many of the courses listed in the following skills curricula are also covered in the Education Direct program. The Education Direct program contains the AutoCAD® software application and requires the use of a personal computer. For more information, refer to Resource 12 or contact your Training Consultant.

Base Curriculum

Course Title
Pre-Technical Foundation Skills
Basic Industrial Math .........................................................Block X21
Addition and Subtraction ..................................................186008
Multiplication and Division .............................................186009
Fractions, Percents, Proportions, and Angles ................. 186010
Metric System ............................................................... 186011
Formulas ................................................................... 186012
Introduction to Algebra .................................................186013
Practical Measurements .................................................Block X22
Linear and Distance Measurement ............................... 186021

Course Number
Prior to starting this program, it is essential that the person possess a high school degree or the GED Equivalency Certificate.

Upon completion of this program, students will be able to:
- Discuss the principles involved in measuring lengths and angles used in surveying.
- Identify and use the various common surveying instruments.
- Explain the fundamentals of law for surveyors.
- Describe the methods used to perform topographic and city surveying.
- Explain the surveying techniques used for laying out highways and highway curves.
- Read and interpret architects’ drawings and construction blueprints.

The **Land Surveyor** curriculum provides trainees with the study materials that enable them to perform the tasks associated with this trade. This print-based curriculum has been developed to meet the general subject requirements for both the state certification program/examination and an organization’s skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this technical area.

The Land Surveyor curriculum starts with comprehensive training in mathematics and the principles of measurement. The curriculum prepares trainees to perform linear surveying, transit surveying, topographic surveying, hydrographic surveying, and city surveying.

This curriculum is appropriate for people who require the technical proficiency to be a Surveyor or a Topographic Drafter. This curriculum is also appropriate for a Civil Engineer or one entering that field. This training applies for employees of public works departments, industrial manufacturing/construction organizations, and engineering architectural firms.

### Basic Drafting Skills and Practices

- Introduction to Print Reading
- Print Reading: Symbols and Abbreviations
- Dimensioning and Tolerancing
- Print Reading Applications
- Reading Shop Prints, Part 1
- Reading Shop Prints, Part 2
- Geometric Dimensioning and Tolerancing
- Computer Aided Drafting and Design
- Drafting Kit
- Geometrical Drawing (includes 5 plates)
- Elements of Projection Drawing (includes 5 plates)
- Machine Sketching
- Elementary Mechanical Drawing (includes 8 plates)

### Mechanical Drafting and Applied Technologies

- Principles of Mechanics, Part 1
- Principles of Mechanics, Part 2
- Mechanical Drawing (includes 6 plates)
- Physics, Part 1
- Physics, Part 2
- Sheet Metal Drafting (includes 4 plates)
- Precision Measuring Instruments, Part 1
- Precision Measuring Instruments, Part 2
- Precision Measuring Instruments, Part 3
- Advanced Mechanical Drawing (includes 17 plates)
- Mechanical Testing of Materials
- Mechanical Power Transmission

Estimated Curriculum Duration: 1,111 hours.
Number of Exams: 40.

### Land Surveyor

The Land Surveyor curriculum provides trainees with the study materials that enable them to perform the tasks associated with this trade. This print-based curriculum has been developed to meet the general subject requirements for both the state certification program/examination and an organization’s skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this technical area.

The Land Surveyor curriculum starts with comprehensive training in mathematics and the principles of measurement. The curriculum prepares trainees to perform linear surveying, transit surveying, topographic surveying, hydrographic surveying, and city surveying.

This curriculum is appropriate for people who require the technical proficiency to be a Surveyor or a Topographic Drafter. This curriculum is also appropriate for a Civil Engineer or one entering that field. This training applies for employees of public works departments, industrial manufacturing/construction organizations, and engineering architectural firms.

Prior to starting this program, it is essential that the person possess a high school degree or the GED Equivalency Certificate.

Upon completion of this program, students will be able to:
- Discuss the principles involved in measuring lengths and angles used in surveying.
- Identify and use the various common surveying instruments.
- Explain the fundamentals of law for surveyors.
- Describe the methods used to perform topographic and city surveying.
- Explain the surveying techniques used for laying out highways and highway curves.
- Read and interpret architects’ drawings and construction blueprints.
Pulp and Paper Technician/Engineer

The Pulp and Paper Technician/Engineer curriculum provides trainees with the study materials that enable them to perform the tasks associated with this trade. This print-based curriculum has been developed to meet the subject requirements of an organization’s skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this technical area.

The Pulp and Paper Technician/Engineer curriculum starts with comprehensive training in mathematics and the basic principles of chemistry and physics. The curriculum progresses to in-depth instruction on the preparation of pulp and its subsequent use in the manufacture of paper.

This curriculum is appropriate for people who require the technical proficiency as a Production Supervisor or Technician in a pulp and paper mill. This training is also appropriate for a plant engineering staff employee who designs new processes or machinery for this industry.

Prior to starting this program, it is essential that the person possess a high school degree or the GED Equivalency Certificate.

Upon completion of this program, students will be able to:

• Understand the creation of the preparation of pulp from wood, rags, and other fibrous materials.
• Study various common pulping processes: mechanical, semi-chemical and chemi-mechanical, sulfite and alkaline.
• Utilize various common processes related to pulp preparations: deinking, pulp testing, process control, coating, and waste utilization.
• Describe the operation of common paper making and pulp preparation machinery and equipment; fourdrinier and cylinder machines, dryers, calendars, reeling and winding equipment, and their control instrumentation.

Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics and Technical Foundation Skills</td>
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<tr>
<td>Quality Concepts: Terminology for Management</td>
<td>186035</td>
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<tr>
<td>Basic Industrial Math.</td>
<td>Block X21</td>
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<td>Addition and Subtraction</td>
<td>186008</td>
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<tr>
<td>Multiplication and Division</td>
<td>186009</td>
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<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
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<td>Metric System</td>
<td>186011</td>
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<td>Formulas</td>
<td>186012</td>
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<td>Introduction to Algebra</td>
<td>186013</td>
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<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
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<td>Introduction to Algebra, Geometry, and Trigonometry</td>
<td>Block X02</td>
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<td>Algebra: Monomials and Polynomials</td>
<td>X0201</td>
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<td>X0210</td>
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<td>Applied Geometry</td>
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<td>Practical Trigonometry</td>
<td>X0212</td>
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<td>Logarithms</td>
<td>5254</td>
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<td>Trades Safety: Getting Started</td>
<td>186001</td>
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<td>Working Safely with Chemicals</td>
<td>186002</td>
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<td>Fire Safety</td>
<td>186003</td>
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<td>Preventive Maintenance</td>
<td>286085</td>
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<td>Preventive Maintenance Techniques</td>
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Principles of Chemistry and Physics

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<tr>
<td>Elements of Chemistry</td>
<td>5011</td>
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<td>Engineering Chemistry</td>
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<td>Physics, Part 1</td>
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Basic Mechanical Principles

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<th>Course Title</th>
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<tr>
<td>Fluid Mechanics, Part 1</td>
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</tr>
<tr>
<td>Fluid Mechanics, Part 2</td>
<td>286011</td>
</tr>
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<td>Fluid Mechanics, Part 3</td>
<td>286012</td>
</tr>
<tr>
<td>Introduction to Print Reading</td>
<td>186080</td>
</tr>
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<td>Print Reading Symbols and Abbreviations</td>
<td>186081</td>
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<tr>
<td>Dimensioning and Tolerancing</td>
<td>186082</td>
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<td>Print Reading Applications</td>
<td>186083</td>
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<tr>
<td>Reading Piping Prints</td>
<td>6732</td>
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</table>

Pulp and Paper Manufacturing Applications and Concepts

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
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<tbody>
<tr>
<td>Pulp and Paper Manufacture, Volume 1</td>
<td>5007A-L</td>
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<td>Pulp and Paper Manufacture, Volume 3</td>
<td>5010A-L</td>
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<td>Predictive Maintenance</td>
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<td>Predictive Maintenance: Vibration Analysis</td>
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<td>Predictive Maintenance: Advanced Topics</td>
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Estimated Curriculum Duration: 658 hours (excluding video).
Number of Exams: 66

Sanitary Engineering Technology

The Sanitary Engineering Technology curriculum provides trainees with the study materials that enable them to perform the tasks associated with the profession of Sanitary Engineer. This print-based curriculum has been developed to meet the subject requirements of an organization’s skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this technical area.

The Sanitary Engineering Technology curriculum starts with comprehensive training in mathematics and the principles of surveying and mapping. The courses progress to the design and construction of water supply systems, water treatment plants, sewage systems, sewage treatment plants, and irrigation. This training is appropriate for people who require the technical proficiency for a sanitary engineering position with a construction company, a public works department, or an engineering/architectural firm.

Prior to starting this program, it is essential that the person possess a high school degree or the GED Equivalency Certificate.
Upon completion of this program, students will be able to:

- Explain the principles associated with linear surveying, transit surveying, topographic surveying, hydrographic surveying and city surveying, and the related engineering applications and operations.
- Utilize the principles of chemistry and bacteriology as they apply to water treatment and purification.
- Design and coordinate the construction of projects and systems related to the environment.

**Base Curriculum**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mathematics and Technical Foundation Skills</strong></td>
<td></td>
</tr>
<tr>
<td>Quality Concepts: Terminology for Management</td>
<td>186035</td>
</tr>
<tr>
<td>Engineering Technology Orientation, Part 1</td>
<td>062002</td>
</tr>
<tr>
<td>Engineering Technology Orientation, Part 2</td>
<td>062003</td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
<tr>
<td>Introduction to Algebra, Geometry, and Trigonometry</td>
<td>Block X02</td>
</tr>
<tr>
<td>Algebra: Monomials and Polynomials</td>
<td>X0201</td>
</tr>
<tr>
<td>Algebra: Factoring</td>
<td>X0202</td>
</tr>
<tr>
<td>Algebra: Addition and Subtraction of Fractions</td>
<td>X0203</td>
</tr>
<tr>
<td>Algebra: Multiplication and Division of Fractions</td>
<td>X0204</td>
</tr>
<tr>
<td>Algebra: Linear Equations</td>
<td>X0205</td>
</tr>
<tr>
<td>Algebra: Simultaneous Linear Equations</td>
<td>X0206</td>
</tr>
<tr>
<td>Algebra: Determinants</td>
<td>X0207</td>
</tr>
<tr>
<td>Algebra: Quadratic Equations</td>
<td>X0208</td>
</tr>
<tr>
<td>Algebra: Exponents</td>
<td>X0209</td>
</tr>
<tr>
<td>Algebra: Radicals and Imaginary Numbers</td>
<td>X0210</td>
</tr>
<tr>
<td>Applied Geometry</td>
<td>X0211</td>
</tr>
<tr>
<td>Practical Trigonometry</td>
<td>X0212</td>
</tr>
<tr>
<td>Logarithms</td>
<td>5254</td>
</tr>
<tr>
<td>Practical Geometry</td>
<td>5983A-B</td>
</tr>
<tr>
<td>Plane Trigonometry</td>
<td>2309A-B</td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Preventive Maintenance</td>
<td>286085</td>
</tr>
<tr>
<td>Preventive Maintenance Techniques</td>
<td>286086</td>
</tr>
<tr>
<td><strong>Introduction to Surveying and Mapping Principles</strong></td>
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<tr>
<td>Linear Surveying</td>
<td>6670</td>
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<tr>
<td>Leveling</td>
<td>6671</td>
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<td>Transit Surveying</td>
<td>5460A-C</td>
</tr>
<tr>
<td>Drafting Kit</td>
<td>1200M</td>
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<tr>
<td>Geometrical Drawing (includes 5 plates)</td>
<td>5544A-B</td>
</tr>
<tr>
<td>Topographic Surveying</td>
<td>5461A-B</td>
</tr>
<tr>
<td>Mapping (includes 4 plates)</td>
<td>5462A-B</td>
</tr>
<tr>
<td><strong>Principles of Mechanics</strong></td>
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<tr>
<td>Elements of Chemistry</td>
<td>5011</td>
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<tr>
<td>Engineering Materials</td>
<td>2536A-C</td>
</tr>
<tr>
<td>Production of Concrete</td>
<td>5469A-C</td>
</tr>
<tr>
<td>Field Methods in Concrete Construction</td>
<td>6330A-B</td>
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<td>Engineering Mechanics, Part 1</td>
<td>286036</td>
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<tr>
<td>Engineering Mechanics, Part 2</td>
<td>286037</td>
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<td>Engineering Mechanics, Part 3</td>
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<td>Engineering Mechanics, Part 4</td>
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</table>

**Water/Wastewater Treatment: Concepts and Applications**

- Fluid Mechanics, Part 1: 286010
- Fluid Mechanics, Part 2: 286011
- Fluid Mechanics, Part 3: 286012
- Hydraulic Turbines: 6718A-C
- Environmental Technology for Technicians: 286M03
- Water Supply: 3395A-C
- Sewerage: 6794A-C
- Engineering Chemistry: 5012
- Sanitary Chemistry: 5501
- Sanitary Bacteriology: 3048
- Sewage Treatment: 5294A-D
- Purification of Water: 5301A-B

**Advanced Surveying Skills**

- Elements of Photogrammetry: 6513A-D
- Highway Curves: 6812A-B
- Hydrographic Surveying: 5751
- Determination of True Meridian: 5465
- United States Land Surveys: 5466A-B
- Fundamentals of Law for Surveyors: 5463
- City Surveying: 6818A-C

Estimated Curriculum Duration: 1,017 hours.
Number of Exams: 90.

**Water/Wastewater Plant Operator**

The Water/Wastewater Plant Operator curriculum provides trainees with the study materials that enable them to perform the tasks associated with this trade. This print-based curriculum has been developed to meet the subject requirements of an organization's skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this technical area.

The Water/Wastewater Plant Operator curriculum starts with comprehensive training in mathematics and the principles of chemistry. The courses progress to the operation of sewage treatment, sludge processing, and disposal equipment. This training is appropriate for people who require the technical proficiency to be a Water/Wastewater Treatment Plant Operator or a Waterworks Operator for either a public works department or a manufacturing processing plant.

Upon completion of this program, students will be able to:

- Describe the principles of chemistry, physics, and bacteriology.
- Discuss the basic principles involved for fluids in motion.
- Identify the various sampling procedures and the methods used to obtain the sample for the physical test of wastewater.
- Apply the common methods of operating various types of equipment to test, treat, and process raw water.
- Describe the operation and maintenance of the primary, secondary, and tertiary treatment stages of wastewater.
- Explain how wastewater is generated, collected, and transported.
Quality Control Technician

The Quality Control Technician topical program provides instruction in evaluating and improving the quality processes for materials and production techniques used in manufacturing organizations. This training is needed by managers, supervisors, engineers and technicians, production personnel, planners, and time- and motion-study analysts, materials managers, receiving managers, inspectors of plant production, and people working in production control or quality control departments. The training covers the inspection and quality control methods used by industry, applying these principles to establishing and implementing a quality control system.

Upon completion of this program, students will be able to:

- Use mathematics and measurement skills in the application of quality techniques.
- Understand the basic concepts of quality control.
- Implement and understand control charts and how to analyze process variations.
- Understand the statistical principles of normal distribution and probability.
- Understand the use of acceptance sampling in a manufacturing production operation.

Base Program

<table>
<thead>
<tr>
<th>Course Title</th>
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<tbody>
<tr>
<td>Basic Industrial Math</td>
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<tr>
<td>Addition and Subtraction</td>
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<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
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<tr>
<td>Practical Measurements</td>
<td>Block X22</td>
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<tr>
<td>Linear and Distance Measurement</td>
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<td>Bulk Measurement</td>
<td>186022</td>
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<tr>
<td>Temperature Measurement</td>
<td>186023</td>
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<tr>
<td>Energy, Force, and Power</td>
<td>186024</td>
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<tr>
<td>Fluid Measurement</td>
<td>186025</td>
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<tr>
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Introduction to Chemistry

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
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<tbody>
<tr>
<td>Elements of Chemistry</td>
<td>5011</td>
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<tr>
<td>Sanitary Chemistry</td>
<td>5501</td>
</tr>
<tr>
<td>Sanitary Bacteriology</td>
<td>3048</td>
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<tr>
<td>Physics, Part 1</td>
<td>666003</td>
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<td>Physics, Part 2</td>
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Introduction to Mechanics

<table>
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<tbody>
<tr>
<td>Principles of Mechanics, Part 1</td>
<td>286007</td>
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<tr>
<td>Principles of Mechanics, Part 2</td>
<td>286008</td>
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<td>Fluid Mechanics, Part 1</td>
<td>286010</td>
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<td>Fluid Mechanics, Part 2</td>
<td>286011</td>
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<tr>
<td>Fluid Mechanics, Part 3</td>
<td>286012</td>
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</table>

Water/Wastewater Treatment: Concepts and Applications

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<tr>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>Environmental Technology for Technicians</td>
<td>286M03</td>
</tr>
<tr>
<td>Operation of Water Treatment Plants</td>
<td>5302A-D</td>
</tr>
<tr>
<td>Operation of Wastewater Treatment Plants</td>
<td>5046A-C</td>
</tr>
<tr>
<td>Tertiary Wastewater Treatment</td>
<td>5045</td>
</tr>
<tr>
<td>Purification of Water</td>
<td>5301A-B</td>
</tr>
<tr>
<td>Sewerage</td>
<td>6794A-C</td>
</tr>
<tr>
<td>Sewage Treatment</td>
<td>5294A-D</td>
</tr>
</tbody>
</table>

Estimated Curriculum Duration: 457 hours.
Number of Exams: 54.
062002

**Engineering Technology Orientation, Part 1**

*Duration:* 10 hours (includes 1 test)

*What Students Learn:*
Engineering Technology: Engineering’s Effect on History; Iron Age and the development of Steel; Steam Power and the launch of the Transportation Age; Electricity; Flight and Space; Technology’s impact on the world; The Technician Today; Tools for Success; Teamwork and the ability to communicate; Solving Problems analytically; The Problem Solving process; Defining the Root Problem; Identifying, Evaluating and Selecting the best solutions; Implementing the Solution and checking the results. Mathematically Thinking; Angles, Vectors, and Trigonometry; Statistically Speaking; Using Calculators and Computers; Units, Standards and Conversions; Using Units to solve problems accurately.

*Special Notes:*
- This updated course replaces, *Engineering Orientation, Part 1*, course 4102A.
- The entire course consists of study units 062002 and 062003.

062003

**Engineering Technology Orientation, Part 2**

*Duration:* 10 hours (includes 1 test)

*What Students Learn:*
Introduction: Types of Data; Accuracy; Data Collection and Graphing; Creating Charts and Graphs; The Computer’s Role in data collection and interpretation; Engineering Technician’s Meeting the Needs of Industry: Competition and Productivity; Quality and the Engineering Technician; The Working Technician: Manufacturing Technology; Construction Manufacturing Technology; Civil Engineering; Electrical Engineering; Electronics Engineering; Industrial Engineering; Mechanical Engineering; Chemical Engineering; Specialists in the Product Development Cycle; The Value of getting a Degree.

*Special Notes:*
- This updated course replaces, *Engineering Orientation, Part 2*, course 4102B.
- The entire course consists of study units 062002 and 062003.

062004

**Productivity Engineering and Management**

*Duration:* 45 hours (includes 3 tests)

*Course Prerequisites:*
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Introduction to Microprocessors (Block B11)

*What Students Learn:*
- Definitions, Measurement, and Basic Concepts of Productivity; Importance of and Factors Affecting Productivity; Productivity Engineering and Management; Measurement at the International, National, and Industrial Levels; The Need for Productivity Measurement; The Total Productivity Model.
- Productivity Improvement Techniques; Technology-Based Productivity Improvement Techniques; Materials-Based Productivity Improvement Techniques; Employee-Based Productivity Improvement Techniques.
- Productivity Improvement Case Studies; Product-Based Productivity Improvement Techniques; Task-Based Productivity Improvement Techniques; Setting Up a Formal Productivity Improvement Program; Productivity Improvement in Selected Manufacturing Companies and Service Organizations; Productivity Improvement Strategies Used Worldwide.

066017

**Time Study, Part 2**

*Duration:* 10 hours (includes 1 test)

*Course Prerequisite:*
Jobs, Companies, and the Economy: Basic Concepts for Employees (186034)

*What Students Learn:*
Derivation and Application of Standard Data; Fundamental Motion Data; Time Formula Construction.

*Special Notes:*
- This updated course replaces course 2519B.
- The entire course consists of study units 066016 and 066017.

066901

**Computer Aided Drafting and Design**

*Duration:* 45 hours (includes 3 tests)

*Course Prerequisites:*
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Introduction to Microprocessors (Block B11)

*What Students Learn:*
- Becoming Familiar with CAD Systems; The Concept of Computer Aided Drafting; The CAD System; Shape and Size Description or Generation.
- Constructing Engineering Drawings; Editing Engineering Drawings; Editing and Facilitation; The Effect of Color.
- 3-D Modeling and CAD/CAM; Graphics Partial Programming; CAD/CAM Process, and Industrial Applications; Manufacturer’s Equipment.
**1200M**

**Drafting Kit**

What Students Learn:
This drawing board includes a straight-edge rather than a separate T-square, a setup preferred by professionals. The drawing instruments are tools trainees will use on the job. The drafting outfit includes: one set of drawing instruments, one 180° 240° drawing board/straight-edge combination, one 60° protractor, one 100° 30°/60° triangle, one 80° 45° triangle, one 120° architect's scale, one 120° engineer's scale, one 300 mm metric scale, one irregular curve, one lettering guide, one erasing shield, one roll drafting tape, two mechanical pencils, two tubes of lead, one lead pointer, one pink eraser, and one pad 25 sheets of 150° 3 200° transparent paper.

**Special Note:**
- The Drafting Kit must be used for the study of all texts that teach drafting techniques, in which the trainee is required to prepare drawings or architectural plates. Refer to the special notes of the individual print course when this kit is required.

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**186E01**

**Mechanical Design**

**Duration:** 48 hours (includes 8 tests)

What Students Learn:
The Nature of Mechanical Design; Materials in Mechanical Design; Stress and Deformation Analysis; Combined Stresses and Mohr's Circle; Design for Different Types of Loading; Columns; Belt Drives and Chain Drives; Kinematics of Gears; Spur Gear Design; Helical Gears, Bevel Gears, and Worm Gearing; Keys, Couplings, and Seals; Shaft Design; Tolerances and Fits; Rolling Contact Bearings; Completion of the Design of a Power Transmission; Plain Surface Bearings; Power Screws and Bail Screws; Fasteners; Springs; Machine Frames, Bolted Connections, and Welded Joints; Electric Motors; Motion Control: Clutches and Brakes; Design Projects.

**Special Notes:**
- This course consists of a textbook and two supplemental study guides.
- This new course replaces Machine Design, course number 2572A-H.
- Covers subject at an advanced, in-depth level.

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**007091**

**Mechanics**

**Duration:** 10 hours (includes 1 test)

What Students Learn:
- Velocity and acceleration
- Motion, force, and gravity
- Energy and power
- Behavior of gasses

**Special Notes:**
- This course replaces Physical Science, Part 1 (2418A)

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**007092**

**Heat**

**Duration:** 10 hours (includes 1 test)

What Students Learn:
- Temperature verses heat energy
- Units for measuring heat and temperature
- Calculating heat loss and gain
- Change in size due to temperature change
- Heat transmission
- Practical application of heat energy and change of state
- Heat energy in engines

**Special Notes:**
- This course replaces Physical Science, Part 2 (2418B)

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**007093**

**Sound**

**Duration:** 10 hours (includes 1 test)

What Students Learn:
- Sound as a wave motion and how it's heard
- Distinguish between transverse and longitudinal waves
- Determine amplitude, frequency, period, and velocity of sound waves
- Characteristics of sound waves (reflection, refraction, diffraction, absorption, and reverberation)
- Velocity and harmonics of sound waves

**Special Notes:**
- This course replaces Physical Science, Part 3 (2418C)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Duration</th>
<th>What Students Learn</th>
<th>Special Notes</th>
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</thead>
<tbody>
<tr>
<td>007094</td>
<td>Chemistry</td>
<td>10 hours (includes 1 test)</td>
<td>• Chemical classification and molecular mass calculation</td>
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<td></td>
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<td>• Use the periodic table of elements</td>
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<td>• Formulas of elements and compounds</td>
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<td>• Balance chemical formulas</td>
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<td>• Properties of acids, bases, and salts</td>
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<td>• Characteristics of nonmetallic and metallic elements</td>
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<td>• Nuclear energy</td>
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<td>• Characteristics of organic compounds</td>
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<td><strong>Special Notes:</strong> This course replaces Physical Science, Part 4 (2418D)</td>
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<tr>
<td>007095</td>
<td>Light</td>
<td>10 hours (includes 1 test)</td>
<td>• Velocity of light</td>
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<td>• Light reflection and refraction</td>
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<td>• Determine what images are obtained by lenses</td>
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<td>• Optical instruments, including the human eye</td>
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<td>• Colors resulting from wave characterization of light</td>
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<td></td>
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<td>• Light polarization</td>
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<td>• Calculating the illuminance of a surface</td>
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<td><strong>Special Notes:</strong> This course replaces Physical Science, Part 5 (2418E)</td>
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<tr>
<td>007096</td>
<td>Electricity and Electronics</td>
<td>10 hours (includes 1 test)</td>
<td>• Sources of electricity, static electricity, and magnetic fields</td>
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<td>• Insulators and conductors</td>
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<td>• Ohm’s law and basic circuit analysis</td>
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<td>• Electric power and energy</td>
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<td>• Magnetic effects to electric current</td>
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<td>• Electron tubes, semiconductors, transistors</td>
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<td>• Principles of radio and television</td>
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<td><strong>Special Notes:</strong> This course replaces Physical Science, Part 6 (2418F)</td>
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<tr>
<td>2512</td>
<td>Materials Handling</td>
<td>10 hours (includes 1 test)</td>
<td><strong>Materials Handling</strong> Drug Use; Sealing Equipment; Trucks; Conveyors; Pneumatic Systems; Bulk Handling Systems and Components; Grab Attachments; Long Distance Transportation; Auxiliary Equipment; Specialized Components.</td>
<td></td>
</tr>
<tr>
<td>2536A-C</td>
<td>Engineering Materials</td>
<td>30 hours (includes 3 tests)</td>
<td><strong>Engineering Materials</strong> Introduction to Algebra, Geometry, and Trigonometry (Block X02)</td>
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<td><strong>Special Notes:</strong> This course replaces Physical Science, Part 4 (2418D)</td>
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<tr>
<td>2545</td>
<td>Heat Transfer</td>
<td>10 hours (includes 1 test)</td>
<td><strong>Heat Transfer</strong> Steady-State Conduction; Forced Convection; Natural Convection; Radiation; Boiling and Condensing; Heat Exchanger Design and Performance; Unsteady-State Heat Transfer.</td>
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<td><strong>Course Prerequisite:</strong> Introduction to Algebra, Geometry, and Trigonometry (Block X02)</td>
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<td><strong>What Students Learn:</strong> Nature of Engineering Economy; Operating Costs; Investment Methods; Annual-Cost Method; Present-Worth Method; Interest Tables; Bonds; Rate-of-Return Method; Engineering Valuation; Break-Even and Changeover Charts; Canons of Ethics for Engineers.</td>
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<td>2549</td>
<td>Engineering Economy</td>
<td>10 hours (includes 1 test)</td>
<td><strong>Engineering Economy</strong> Nature of Engineering Economy; Operating Costs; Investment Methods; Annual-Cost Method; Present-Worth Method; Interest Tables; Bonds; Rate-of-Return Method; Engineering Valuation; Break-Even and Changeover Charts; Canons of Ethics for Engineers.</td>
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<td><strong>Course Prerequisite:</strong> Introduction to Algebra, Geometry, and Trigonometry (Block X02)</td>
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### 2552A-B
**Operation Analysis**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
- Basic Industrial Math (Block X21)
- Practical Measurements (Block X22)
- Jobs, Companies, and the Economy: Basic Concepts for Employees (186034)

**What Students Learn:**
- Part 2 (2552B). Working Conditions; Plant Layout and Material Handling; Motion Study.

### 2555A-B
**Plant Layout**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
- Engineering Technology Orientation, Parts 1-2 (062002-062003)

**What Students Learn:**
- Part 1 (2555A). Definition; Scope, Importance, Advantages, and Nature of Layout Projects; Effect of Storage, Services, and Materials Handling on Plant Layout; Collection and Analysis of Data Necessary for the Development of Layout; Procedure and Tools Used for Development and Presentation of Layouts.
- Part 2 (2555B). Industrial Layout; Growth Planning; Manufacturing Plant Layouts; Warehouse Design; Types of Warehouses; Use of Computer; Design Factors; Alternatives and Implementation.

### 2580
**Production Planning and Control**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Engineering Technology Orientation, Parts 1-2 (062002-062003)

**What Students Learn:**
- Nature of Production Control; Functions and Documents in Manufacturing Industry; Demand Forecasting; Economic Order Quantity; Make-or-Buy Decisions; Inventory Systems; Planning Production; Critical Path Method.

### 2600
**Control of Materials**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Practical Measurements (Block X22)
- Engineering Technology Orientation, Parts 1-2 (062002-062003)

**What Students Learn:**
- Fundamentals of Material Control; Acquisition of Materials; Storage of Materials; Control of Materials during Manufacture; Paperwork Control; Systems Approach to Materials Control.

### 2608A-B
**Mechanical Testing of Materials**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisite:**
- Practical Measurements (Block X22)

**What Students Learn:**
- Part 1 (2608A). Purpose of Testing Physical Properties of Materials; Mechanical Testing Machines; Tension Test; Compression Test.
- Part 2 (2608B). Transverse or Beam Test; Shear and Torsion Tests; Hardness Testing, Impact Testing; Miscellaneous Tests for Ductile Materials; Testing of Nonmetals.

### 2766
**Loads in Buildings**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Practical Geometry and Trigonometry (5567)
- Logarithms (5254)

**What Students Learn:**
- Dead Loads: Weight of Floor Construction; Weight of Roof Construction; Live Loads, Floor Loads; Other Live Loads; Reduction in Live Loads; Wind Loads; Basic Wind Resistance; Wind Forces on Structure; Snow Loads; Earthquake Loads.

### 2773A-B
**Hard Pavements**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisite:**
- Low Cost Road Surfaces (6403A-B)

**What Students Learn:**
- Part 1 (2773A). Design of Concrete Pavements; Thickness and Crown; Joints; Reinforcement; Construction of Concrete Pavements; Proportioning Pavement Mixtures; Batching Plants; Preparation of Subgrade; Placing Concrete and Reinforcement; Expansion Joints; Finishing, Protecting, and Curing Pavement; Maintenance and Repairs; Base Courses.
- Part 2 (2773B). Required Thickness of Flexible Pavements; Design of Hot-Mix Asphaltic Pavements; Requirements of Aggregates; Quantity of Bituminous Material; Plant Production of Hot-Mix Paving; Placing and Compacting Bituminous Mixture; Correcting Defects in Hot-Mix Paving.
2897

**Heat Treatment of Nonferrous Metals**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Metallurgy of Nonferrous Metals (5337)
Heat Treatment (3541A-D)

**What Students Learn:**
Crystalline Form of Metals; Copper; Aluminum; Lead; Nickel; Zinc; Tin; Effect of Alloying; Nonferrous Alloys; Cooling Curves; Control of Structure; Aluminum as Base Metal; Aluminum Alloys for Forging and Heat-Treating; Brass; Bronze; Nickel Alloys; Temperature Control; Cleaning Alloys; Hardness Testing; Tests for Strength; Microscopic Tests; Etching Reagents; X-Ray Testing; Radiographs; Unsuitability of Magnetic Tests.

3048

**Sanitary Bacteriology**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Elements of Chemistry (5011)

**What Students Learn:**
Characteristics of Bacteria; Reproduction; Requirements for Life; Effects of Environment on Development; Bacterial Metabolism; Physical Effects of Bacterial Action; Biochemical Effects; Bacteria in Air, in Soil, in Water, in Sewage; Laboratory Practice; Apparatus; Sterilization; Culture Media; Observation of Bacteria; The Microscope; Staining Methods; Examination of Water for Bacteria; Bacterial Count; Multiple-Tube Fermentation Method; Membrane Filter Method.

3395A-C

**Water Supply**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
Engineering Mechanics, Parts 1-4 (286036-286039)
Plane Trigonometry (2309A-B)
Fluid Mechanics, Parts 1-3 (286010-286012)

**What Students Learn:**
Part 1 (3395A), Planning of Water-Supply System; Choice of Source; Distribution System; Consumption of Water; Rainfall; Evaporation; Percolation and Absorption; Surface Water; Stream Flow and Run-Off; River and Lake Intakes; Flow of Wells and Springs.

Part 2 (3395B), Distributing Reservoirs; Types and Location of Conduits; Gravity Conduits; Canals and Flumes; Aqueducts; Cast-Iron Pipe; Steel Pipe; Wood-Stave Pipe; Concrete Pipe; Transit Pipe; Service Pipes; Valves; Meters; Hydrants; Laying Pipe; Laying Submerged Pipe; Bridge Crossings.

Part 3 (3395C), Design of Distribution System; Planning of Systems; Flow in Gravity Conduits; Flow in Simple Pressure Conduits; Design of Dead-End Distribution System; Design of Continuous-Flow System; Displacement Pumps; Centrifugal Pumps; Air-Lift Pumps; General Design of Pumping Installations.

3410

**Contracts, Specifications, and Design Drawings**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Practical Measurements (Block X22)

**What Students Learn:**
Notice to Contractors; Proposal; Agreement; General Conditions of the Contract; Specifications for Fabrication and Erection of Structural Steel for Buildings; Specifications for Quality of Steel; Specifications for Concrete Work; Design Drawings; Architectural Considerations; Loading; Allowable Unit Stresses; Beams and Girders; Roof Trusses; Columns; Preparation of Design Drawings; Responsibilities of Owner and Contractor During Erection.

386E03

**Materials Management and Inventory Control**

**Duration:** 25 hours (includes 5 tests)

**Course Prerequisites:**
Basic Industrial Math (Block X21)
Practical Measurements (Block X22)

**What Students Learn:**
This advanced course deals with production planning, modern purchasing strategies, managing inventory, and forecasting material requirements. The subject matter does not require an advanced understanding of mathematical concepts. The course audience includes production control specialists, warehousing operations employees, production supervisors, and journeyman machine operators. Students are provided with a thorough understanding of the production management strategies that are followed in the modern manufacturing environment.

Lesson 1 - Production Scheduling, Planning and MRP:
- Importance of Materials Management; How Production Planning Systems Work; Manufacturing Resource Planning (MRP II); Master Production Schedules; Material Requirements Planning (MRP).

Lesson 2 - Advanced Material Management
- Capacity Management; Capacity Requirements Planning (CRP); Scheduling Orders; Production Activity Control: Purchasing Specifications; Demand Forecasting Systems.

Lesson 3 - Basic Inventory Processes:
- Systems for Managing Inventory; Setting Order Quantities; Order Point Systems.

Lesson 4 - Advanced Inventory Processes:
- Warehouse Management; Inventory Record Accuracy; Physical Distribution; Packaging Materials Handling; Planning in the Just-In-Time Manufacturing Environment.

Lesson 5 - Product Control and Quality Management:
- Factors Influencing Design and Production; Continuous Process Improvement; Process Control and Total Quality Management.

**Special Notes:**
- This course consists of a textbook and supplemental study guide.
- This new course replaces Materials Handling, course 2512, and Inventory Control, course 6235A-C.
Preparation, Liquor Preparation, Digesters, Washing and Cleaning, Instrumentation, Chemical Recovery, and Effluent Disposal, Uses of Unbleached NSSC Pulps, Bleached NSSC Pulps; Acid Sulfito
Semichemical Pulping; Bisulfite Semichemical Pulping; Kraft Semichemical Pulping; Cold-Soda Chemimechanical Pulping; Wood, Chemical Treatment, Bleaching, Properties and Uses of Cold-Soda Pulps; Hot-Sulfite Chemimechanical Pulping; Equipment and Mill Operation, Properties, and Uses; Chemigroundwood Pulping; Steam Cooking.
Part 6 (5007F). Sulfite Pulping: Mechanics and Kinetics; Outline of the Sulfite Process; Lignosulfonic Acids; Delignification; Effect of Temperature; Influence of Hydrogen Ion; Raw Materials and Technology; Batch Digester Cooking Procedure; Sodium-Base Sulfite Pulping; Multistage Processes; Ammonium-Base Sulfite Pulping; Magnesium-Base Sulfite Pulping; Continuous Sulfite Pulping; Recovery Systems.
Part 7 (5007G). The Chemistry of Alkaline Pulping: Introduction; Origin of Alkaline Pulping; Alkali as a Delignifying Agent; The Kraft (Sulfate) Process; Influence of Bleaching Methods, Description of Process; Composition of Kraft Liquors; Standard Kraft Pulping Terms; TAPPI United States Definitions, Canadian and Scandinavian Definitions; Reactions of Wood Constituents; Process Variables; Variables Associated with the Wood; Variables Associated with the Pulping Operation; Continuous Alkaline Pulping; Modified Alkaline Processes.
Part 8 (5007H). Alkaline Pulping, Section 1; Digester Room; Construction and Equipment; Digester Corrosion; Digester Capacities and Types; Digester Details; Direct-Cooking Digesters; Indirect-Cooking Digesters; Heater Design; Digester Operation; Duties of the Cook; Chip and Liquor Charge Requirements; Time; Temperature; Pressure Schedules; H Factor; Relieving Digester; Blowing; Preparing for Next Cook; Heat Balance; Digester Instrumentation; Blowdown Heat Recovery; Continuous Cooking; Blow Tanks and Washers; Knotting, Prebreaking, Fine Screening; and Refining.
Part 9 (5007I). Alkaline Pulping, Section 2; Evaporation of Black Liquor; Properties and Analysis of Black Liquor; Purpose of Evaporation; Multiple-Effect Evaporation; Operating Technique; Evaporation Types; Evaporator Instrumentation; Oxidation of Black Liquor; Reactions, Economics, Equipment, Gaseous Emissions; Causticizing; Lime Recovery; Control Methods in Alkaline Pulp Mills, Kraft Mill Construction Materials.
Part 11 (5007K). Bleaching of Wood Pulps; Brightness; General Optical Principles and Measurement, Stability, Theory; Basic Principles, Chlorination; Alkali Extraction; Oxidative Bleaching Agents; Hypochlorites, Chlorine Dioxide, Peroxides, Other Oxidative Agents; Reducing Agents; Acidification and Combination Stages; Bleaching Practices for Different Pulp Types; Sulfite Pulp, Sulfate Pulp, High-Yield Sulfite Pulps; NSSC Pulp, Cold-Soda Pulp, Dissolving Pulps; Equipment and Materials of Construction; Raw Materials; Process Control.
Part 12 (5007L). Treatment of Pulp; Scope of the Chapter; Screening; Theory, Course Screening, Fine Screening; Operation of Pulp Treatment Systems; Mechanical Pulp; Chemical Pulp; Refining of Rejects; Theory, Refining of Mechanical Pulp Rejects, Refining Chemical Pulp Rejects; Cleaning of Pulp; Thickening of Pulp; Gravity Thickening, Vacuum Thickening; Storage; Preparation of Pulp for Shipment; Dry Market Pulp, Wet Market Pulp.

5008A-F
Inorganic Chemicals and Processes

Duration: 60 hours (includes 6 tests)

Course Prerequisite:
Inorganic Chemistry (5005A-D)

What Students Learn:
Part 1 (5008A). Chemical Apparatus and Laboratory Methods; Oxygen; Ozone; Hydrogen; Hydrogen Peroxide; Water.
Part 2 (5008B). Atmosphere and Rare Gases; Nitrogen and its Compounds; Ammonia; Nitric Acid; Carbon: its Compounds and Uses; Silicon and Boron.
Part 3 (5008C). Group VIII Elements; Copper Family; Zinc Family; Manganese Family.
Part 4 (5008D). Alkali Metals; Alkali Earth Metals; Group IIIB Elements.
Part 5 (5008E). Titanium Family; Vanadium Family; Aluminum Family; Tin and Lead Group; Phosphorus Family.
Part 6 (5008F). Sulfur Family; Halogen Family.

5009A-I
Pulp and Paper Manufacture, Volume 2

Duration: 108 hours (includes 9 tests)

Course Prerequisite:
Pulp and Paper Manufacture, Volume 1 (5007A-L)

What Students Learn:
Part 1 (5009A). Annual Crop Fibers and the Bamboos; Sugarcane Bagasse; Cereal Grain Straws; Esparto; Bamboo; Other Stalks, Grasses, and Reeds; By-Product and Salvaged Vegetable Fibers; Potential Crop Fibers; Pulping Processes for Annual Plant Fibers; Structural Fiberboards from Annual Plants.
Part 2 (5009B). Pulping of Rags and Other Fibers; Grading, Sorting, and Treatment of Rags; Fibers other than Rags.
Part 3 (5009C). Deinking; History, Nature, and Economics of Deinking; Wastepaper, Coating, and Ink Classification; Cooking; Equipment; Shrinkage and Yield; Bleaching; Records and Control; Waste Disposal.
Part 6 (5009F). Services; Wastewater Treatment; Air Pollution Control; Steam; Electricity; Heating and Ventilating; Flash Drying of Pulp; Materials Handling; Pumping.
Part 7 (5009G). By-Products and Waste Utilization; By-Products from Bark; Turpentine; Tall Oil; Lignosulphonates; Alcohol; Other SSL By-Products.
Part 8 (5009H). Structural Board; Insulating Board; Forming Machines; Dryers; Fabricating and Finishing; Hardboard; Wet-Machine Board.
Part 9 (5009I). Coating; Paper for Coating; White Pigments; Colored Pigments and Dyes; Adhesives; Miscellaneous Materials; Coating Mixture; Coating Machine; Drying Systems; Finishing Operations; Gummed Papers; Waxed Paper; Polyethylene Coating of Paper and Paperboard.

5010A-L
Pulp and Paper Manufacture, Volume 3

Duration: 144 hours (includes 12 tests)

Course Prerequisites:
Pulp and Paper Manufacture, Volume 2 (5009A-I)
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Electricity (4210A-C)

What Students Learn:
Part 1 (5010A). Handmade Papers; Apparatus and Details; Felts and Mats; Watermarking Handmade Papers; Uses and Qualities of Handmade Paper; Imitation Handmade Paper.
Part 2 (5010B). Nonfibrous Material; Fillers and Loading; Sizing and Adhesives; Surface Treatments; Paper Coloring.
Part 3 (5010C). Deposits Control; Microbiological Deposits; Non-Microbiological Deposits; Coordinated Approach to Deposits Control.
Part 4 (5010D). Beating and Refining; Effects on Fiber Structure; Effect of Drying; Theory of Beating; Refiner Comparisons; Pulpers; Beaters; Refiners; Stock Preparation Systems for Main Grades of Paper, Board, and Tissue.
Part 5 (5010E). Auxiliary Apparatus and Operations Preliminary to Paper Machines; Auxiliary Equipment; Stock Proportioning; White Water; Savealls; Riffles; Centrifugal Separators; Screens; Broke; Wet-End Instrumentation.
Part 6 (5010F). Papermaking Machines: The Fourdriner; History and Development; Modern Fourdriner Machine; Approach Flow System; Headbox; Slice; Types of Slices; Drainage and Formation on the Fourdriner; Design and Construction; Miscellaneous Equipment; Twin-Wire Forming of Paper.
Part 7 (5010G). Papermaking Machines: Cylinder; Vat Stock Entries; History of the Cylinder Machine; Comparison with the Fourdriner; Products; Stock Delivery Systems; Web-Forming Devices; Cylinder Mold; Couch and Primary Press; Rolls and Whippers; Cylinder Machine Felts; Troubleshooting.
Part 8 (5010H). Pickup and Press Section; Suction Pickup; Pressing Theory; Felts; Press Section Arrangements; Suction Rolls and Crowning; Open Draw.
Part 9 (5010I). The Dryer Section; Function of Dryer Section; Theories of Drying; Cylinder, Air, and Radiant Drying; Auxiliary Equipment; Operation and Control.
Part 10 (5010J). Calendering, Reeling, and Winding: The Calender End; Calender Stack Barring; Reels; Winders and Slitters.
Part 11 (5010K). Paper Machine Drives; Paper Machine Block Process Flow; Drive Fundamentals and Requirements; Secondary Drive Functions; Prime-Mover Types; Drive Comparisons; Mechanical Drives; Helper Drives; Electric Sectional Drives, Sizing of Drives; Future Electric Sectional Possibilities.
Part 12 (5010L). Finishing of Paper; Finishing Room Winders and Rewinders; Calenders and Supercalenders; Embossing.

5011
Elements of Chemistry

Duration: 14 hours (includes 1 test)

Course Prerequisite:
Practical Measurements (Block X22)

What Students Learn:
Chemical and Matter; Chemical and Physical Changes; Chemical Classification of Matter, Elements, Compounds, Mixtures; Atoms and Molecules; Dalton's Atomic Theory; Atomic Weights; Molecular Weights; Electron Theory of the Structure of the Atom; Study of Electrons, Protons, Neutrons, Atomic Structure of Elements; Fundamental Laws of Chemistry; Laws of Conservation of Matter and Energy; Law of Definite Proportions; Valence Formulas; Equations; Typical Problems in Chemistry; Solutions; Metals, Nonmetals, Acids, Bases, and Salts; Ions and Theory of Ionization; Conductivity; pH, Electrolysis, Electroplating; Periodic Grouping of the Elements; Properties and Uses of Metallic and Nonmetallic Elements and Their Compounds; Nuclear Energy; Organic Chemistry; Structural Formulas, Hydrocarbons, Fatty Acids, Carbohydrates, Aromatic Compounds, Plastics.

5012
Engineering Chemistry

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Practical Measurements (Block X22)

What Students Learn:
Chemical Theory; Nuclear Theory; Chemical Laboratories; Industrial Safety; Unit Operations; Industrial Production of Nonmetallic Elements and Materials; Industrial Production of Metallic Elements and Materials; Industrial Production of Organic Chemicals; Generation of Electricity by Chemical Means.

5013A-D
Physical Chemistry

Duration: 40 hours (includes 4 tests)

Course Prerequisites:
Practical Geometry and Trigonometry (5567)
Physics, Parts 1-2 (686003-686004)
Inorganic Chemicals and Processes (5008A-F)

What Students Learn:
Part 1 (5013A). Nature of Physical Chemistry; Properties of Matter; Gas Laws; Molecular Theory Applied to Gases; Specific Heats of Gases; Ideal versus Real Gases; Atomic Theory; Laws of Composition Explained by Atomic Theory; Relation of Atom to Molecule; Structure of the Atom; Energy Levels and Orbit Designations in the Atom.
Part 2 (5013B). Matter in Liquid State; Vapor Pressure; Surface Tension; Latent Heats; Specific Heats; Matter in Solid State; Properties;
Structure; Crystal Lattices; Cathode Rays; X-Rays; Charges on Atomic Particles; Radioactivity; Types of Radioactive Emissions; Radioactive Disintegration; Half-Life; Nuclear Fission Chain Reactions; Types of Nuclear Reactors; Nuclear Fusion; First, Second, and Third Laws of Thermodynamics.

Part 3 (5013C). Spontaneous and Reversible Reactions; Available Energy; Phases and Phase Equilibrium; Chemical Equilibrium; Law of Mass Action; Solutions; Homogeneous and Heterogeneous Systems; Units of Concentration for Solutions; Kinds of Solutions; Properties of Solutions - Raoult's Law and Henry's Law; Ideal Solutions; Osmotic Pressure; Molecular Weight Determinations; Vapor Pressure; Rise in Boiling Points and Lowering of Freezing Points.

Part 4 (5013D). Thermochemistry; Heats of Reactions, of Solutions, of Formation and of Combustion; Rates of Chemical Reactions; Types of Reactions; Effect of Temperature and Concentration; Effect of Catalysts; Solutions of Electrolytes; Electrolysis; Faraday's Laws of Electrolysis; Transfer of Ions; Electrochemistry; Electrode Process; Transport Process; Specific Conductance; Strong and Weak Electrolytes; pH of Aqueous Solutions; Dissociation into Ions; Measuring and Calculating pH of Solutions; Colloids; Particle Sizes; Properties of Colloids, Methods of Preparing Colloids; Lyophobic and Lyophilic Sols.

5017A-B

Basic Organic Chemistry

Duration: 20 hours (includes 2 tests)

Course Prerequisite:
Elements of Chemistry (5011)

What Students Learn:

5018

Material and Energy Balances

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Plane Trigonometry (2309A-B)
Inorganic Chemicals and Processes (5008A-F)

What Students Learn:
Process Flow Diagramming; Behavior of Gases; Mass Balance Techniques; Material Balances on Chemical Processes; Stoichiometry; Energy Balance; Heat Capacity; Enthalpy; Thermochemical Calculations; Heats of Reaction.

5019

Fluid Flow

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Principles of Mechanics, Parts 1-2 (286007-286008)
Fluid Mechanics, Parts 1-3 (286010-286012)

What Students Learn:
Energy and Flowing Systems; Bernoulli’s Formula; Friction Effects and Viscosity; Reynolds Number; Fanning Friction Factor Flow Patterns; Newtonian and Non-Newtonian Liquids; Flowmeters for Liquids and Gases; Flow through Packed Columns; Characteristics of Pumps for Handling Chemicals and Solvents; Specialty Pumps.

Special Note:
- Covers subject at an advanced, in-depth level.

5045

Tertiary Wastewater Treatment

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Operation of Wastewater Treatment Plants (5046A-C)

What Students Learn:
Need for Tertiary Treatment; Government Regulations; Water Reuse; Coagulation; Flocculation and Sedimentation by Chemical Treatment; pH Control; Recarbonation; Acid Treatment; Recovery of Alum, Lime, and Phosphorus from Tertiary Sludges; Filters and Filtration Systems; Activated Carbon Absorption and Regeneration; Processes for Nitrogen Removal including Biological, Breakpoint Chlorination and Ion Exchange; Disinfection Treatments; Land Treatment of Wastewater.

5046A-C

Operation of Wastewater Treatment Plants

Duration: 30 hours (includes 3 tests)

Course Prerequisites:
Elements of Chemistry (5011)
Physics, Parts 1-2 (686003-686004)
Fluid Mechanics, Parts 1-3 (286010-286012)

What Students Learn:
Part 1 (5046A). Characteristics of Wastewater; Wastewater Systems Changes in Composition of Wastewater; Wastewater Analysis, Samples for Analyses; Equipment for Analyses; Physical Tests; Tests for Dissolved Oxygen; Biochemical Oxygen Demand; Chemical Oxygen Demand; Hydrogen-Ion Concentration, Nitrogen, and Chlorine. Part 2 (5046B). Units for Preliminary Treatment Pumps; Metals; Grit Chambers; Screens; Grease-Removal Units; Units for Primary Treatment; Setting Tanks; Sludge Digesters; Combined Units for Setting and Digestion; Sludge-Drying Units. Part 3 (5046C). Units for Secondary Treatment; Biology of Secondary Treatment; Standard-Rate Trickling Filters; High-Rate Trickling Filters; Conventional Activated Sludge Process; Modified Activated Sludge Processes; Other Secondary Treatment Methods; Chlorination of Sewage; Miscellaneous Information; Painting; Safety; Care of Plant Grounds.
5110

**Metallurgy of Iron**

*Duration:* 10 hours (includes 1 test)

*Course Prerequisites:*
Practical Measurements (Block X22)
Elements of Chemistry (5011)

*What Students Learn:*
- Treatment of Iron Ores; Blast Furnace Plant; Slag Blast Furnace Reactions;
- Control of Elements in Furnace Iron; Pig Iron; Cast Iron;
- Malleable Cast Iron; Cast-Iron Founding; Electric Furnace Cast Iron;
- Molding Cast Iron; Specifications for Iron Castings; Alloy Cast Irons;
- Nature of Wrought Iron.

5261

**Erection of Steel Building Frames**

*Duration:* 10 hours (includes 1 test)

*Course Prerequisite:*
Design of Steel Building Frames (5440A-C)

*What Students Learn:*
- Steel Erector; Estimating; Erection Plans; Shipments of Steel;
- Unloading and Handling Steel; Ropes, Slings and Blocks; Gin Poles and Pole Derricks;
- Stiff Leg and Guy Derricks; Power Cranes; Erection of Four Story Office Building;
- Selection of Hoisting Equipment; Erection of Steel with Crawler Crane;
- Plumbing Steel; Bolting; Riveting; Welding; Painting; Errors; Steel Joists;
- Large Erection Jobs; High Strength Bolts.

5111

**Metallurgy of Steel**

*Duration:* 10 hours (includes 1 test)

*Course Prerequisites:*
Practical Measurements (Block X22)
Elements of Chemistry (5011)
Metallurgy of Iron (5110)

*What Students Learn:*
- Steel Production; Raw Materials Used in Steelmaking; Regenerative System of Open-Hearth Furnace;
- Basic and Acid Open-Hearth Process; Oxygen; Process; Bessemer Converter;
- Basic and Acid Electric Process; Crucible Process; Alloy Steels;
- Influence of Melting Practice on Physical Properties of Steel.

5272A-B

**Design of Retaining Walls**

*Duration:* 20 hours (includes 2 tests)

*Course Prerequisite:*
Mechanics of Materials (5282A-C)

*What Students Learn:*
- Part 1 (5272A). Stability of Retaining Walls; Definitions; Possible Failures of Retaining Walls;
- Earth Pressure; Main Theories; Determination of Pressure; Investigation of Stability Against Overturning, Settlement, Sliding and Shear.
- Part 2 (5272B). Design of Gravity Walls; Selection of Cross-Section;
- Specification for Materials; Details of Construction; Design of Reinforced-Concrete Walls;
- General Features; Design of Cantilever Retaining Walls; Design of Counterfort Retaining Wall.

5178

**Unit Operations and Equipment**

*Duration:* 10 hours (includes 1 test)

*Course Prerequisite:*
Elements of Chemistry (5011)

*What Students Learn:*
- General Scope of the Unit Operations; Materials Handling; Size Reduction;
- Size Separation; Filtration; Mixing; Heat Transfer; Evaporation;
- Crystallization; Drying; Distillation; Humidification and Dehumidification;
- Gas Absorption; Absorption; Ion Exchange and Solvent Extraction;
- Description and Application of Equipment.

5282A-C

**Mechanics of Materials**

*Duration:* 30 hours (includes 3 tests)

*Course Prerequisite:*
Introduction to Algebra, Geometry, and Trigonometry (Block X02)

*What Students Learn:*
- Part 1 (5282A). Comparison of Materials; Simple Stresses; Reactions;
- Deformation; Elastic Properties of Materials; Allowable Unit Stresses;
- Factor of Safety; Investigation and Design of Simple Tension and Compression Members;
- Members Subjected to Shear; Hollow Thin Cylinders; Temperature Stresses;
- Riveted Joints; Welded Joints; Bolted Connections in Steel Fastenings for Timber.
- Part 2 (5282B). Fixed and Moving Loads on Beams; Reactions at Beam Supports; Cantilever; Simple and Overhanging Beams;
- Continuous Beams and Beams with Fixed Ends; Points of Inflection;
- Maximum Shear and Bending Moment in Beams; Shear and Bending Moment Diagrams.
- Part 3 (5282C). Flexural Stresses in Beams; Moment of Inertia and Section Modulus; Shearing Stresses in Beams; Stresses Due to Torsion;
- Torsion and Bending in Circular Shafts; Deflections of Beams;
- Investigation and Design of Beams; Theory of Column Design Radius of Gyration;
- Investigation and Design of Columns.
5289

**Flat Slab Design**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Reinforced Concrete Design (5450A-C)

**What Students Learn:**
Features of Flat Slab Constructions; General Requirements in Design; Design by Empirical Method; Thickness of Slab; Design of Reinforcement; Design of Spandrel Beams; Openings in Flat Slab Floors.

5290

**Design of Spread Footings**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Reinforced Concrete Design (5450A-C)

**What Students Learn:**
Construction of Footings; Proportioning of Footing Areas; Types of Footings; Design of Concrete Footings; Basic Assumptions; Plain Concrete Footings; Independent Footings of Reinforced Concrete; Combined Footings.

5294A-D

**Sewage Treatment**

**Duration:** 40 hours (includes 4 tests)

**Course Prerequisites:**
Elements of Chemistry (5011)
Sanitary Bacteriology (3048)

**What Students Learn:**
Part 1 (5294A). Sewage Systems; Changes in Composition of Sewage; Samples for Analysis of Sewage; Physical Tests of Sewage; Chemical Tests of Sewage; General Features of Sewage Treatment Plants; Auxiliary Plant Units; Disposal of Sewage.
Part 2 (5294B). Preliminary Treatment of Sewage; Screening; Grit Chambers; Removal of Grease; Preparation of Sewage; Separation of Settleable Solids in Sewage; Plain Settling Tanks; Settling with Aid of Chemical Coagulants.
Part 3 (5294C). Biological Processes in Secondary Treatment; Standard-Rate Trickling Filters; High-Rate Trickling Filters; Developments in Trickling Filters; Conventional Activated Sludge Process; Modified Activated Sludge Processes; Control of Activated Sludge Process.
Part 4 (5294D). Aeration in Activated Sludge Process; Secondary Clarifiers in Activated Sludge Process; Aerobic-Anaerobic Oxidation Ponds; Other Treatment Ponds.

5301A-B

**Purification of Water**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisite:**
Practical Measurements (Block X22)

**What Students Learn:**
Part 1 (5301A). Examination of Water; Impurities in Water; Physical Tests of Water; Temperature, Taste, and Odor; Turbidity; Color; Chemical Analysis of Water; Hardness; Hydrogen-ion Concentration; Alkalinity and Acidity; Chlorides and Residual Chlorine; Iron and Manganese; Organic Matter; Bacteriological Examinations of Water; Microscopic Examinations; Standards of U.S. Public Health Service.
Part 2 (5301B). Screening; Sedimentation and Coagulation; Preparation of Chemicals; Mixing Basins; Sedimentation Tanks or Clarifiers; Filtration; Mechanical Filters; Slow Sand Filters; Disinfection; Liquid Chlorine; Calcium Hypochlorite; Chlorine and Ammonia; Ultraviolet Rays and Ozone; Softening; Lime-Soda Process; Zeolite Process; Iron and Manganese Removal; Control of Corrosiveness; Taste and Odor Control; Copper Sulphate; Ammonia and Chlorine; Activated Carbon; Control of Fluoride; Covering and Fencing Reservoirs; Typical Design of Treatment Plant.

5302A-D

**Operation of Water Treatment Plants**

**Duration:** 40 hours (includes 4 tests)

**Course Prerequisites:**
Purification of Water (5301A-B)
Sanitary Chemistry (5501)
Sanitary Bacteriology (3048)

**What Students Learn:**
Part 1 (5302A). Water Supply Systems; Reservoirs and Wells; Laying Pipe; Care of Distribution System; Contents of Water; Standards of Quality; Water-Borne Diseases; Factors in Treatment of Water; Care of Treatment Plant.
Part 2 (5302B). Water Analyses; Methods of Taking Samples; Equipment Used in Making Analysis; Turbidity; Color; Odor; Temperature; Hardness; Hydrogen-Ion Concentration; Alkalinity and Acidity; Residual Chlorine; Bacteriological Examination; Microscopic Examination.
Part 3 (5302C). Intakes and Screens; Coagulation and Sedimentation; Chemical Aids to Coagulation; Mixing Basins; Sedimentation Tanks for Clarifiers; Materials for Filters; Mechanical Filters; Slow Sand Filters.
Part 4 (5302D). Disinfection; Liquid Chlorine; Calcium Hypochlorite; Chlorine and Ammonia; Ultraviolet Rays and Ozone; Softening; Lime-Soda Process; Zeolite Process; Iron and Manganese Removal; Control of Corrosiveness; Taste and Odor Control; Control of Fluoride; Protection of Treated Water; Displacement Pumps; Centrifugal Pumps; Air-Lift Pumps; Typical Data for Rapid-Sand-Filter Plant.
5337

Metallurgy of Nonferrous Metals

Duration: 10 hours (includes 1 test)
Course Prerequisites:
Practical Measurements (Block X22)
Elements of Chemistry (5011)

What Students Learn:
Ores and Extraction; Copper and Alloys; Lead and Alloys; Zinc;
Aluminum and Alloys; Tin and Alloys; Nickel and Alloys; Magnesium
and Alloys; Gold; Silver; Antimony; Manganese; Molybdenum;
Tungsten; Chromium; Cobalt; Bismuth; Mercury; Cadmium; Tantalum;
Platinum Group; Beryllium; Calcium; Zirconium; Vanadium; Titanium;
Columbium.

5338A-B

Metallography

Duration: 20 hours (includes 2 tests)
Course Prerequisites:
Practical Measurements (Block X22)
Elements of Chemistry (5011)
Metallurgy of Iron (5110)
Metallurgy of Steel (5111)
Metallurgy of Nonferrous Metals (5337)

What Students Learn:
Part 1 (5338A). Methods of Examining Metal Structures; Mounting
and Polishing Specimens by Hand and Machine; Magnifiers; Optical
and Electron Microscopes; Cameras; Illumination; Polarized Light Ultraviolet
Light; Use of Photographic Equipment; Metallography of Nonferrous
Metals; Etching and Coloring Specimens for Macroscope and
Microscopy; Photomicrographs of Copper Aluminum; Magnesium;
Nickel; Zinc and Tin Alloys.
Part 2 (5338B). Importance of Carbon in Iron and Steel;
Macrostructure of Steel; Developing Microstructures; Iron-Carbon
Structures; Ingots; Iron-Carbon System; Carbide or Cementite and
Pearlite; Austenite, Martensite, Spheredized Structure; Structures of
Heat-Treated Alloy Sheets; Decarburized Surface; Overheated Steel;
Quenching Cracks; Fatigue Cracks; Macrostructure of Cast Iron;
Microstructures of Cast Iron; Alloved Gray Irons; Malleable Iron;
Electrolytic and Wrought Irons.

5339

Highway Embankments and Subgrades

Duration: 10 hours (includes 1 test)
Course Prerequisite:
Practical Geometry and Trigonometry (5567)

What Students Learn:
Foundations for Embankments; Investigations and Tests of Embankment
Materials; Construction of Embankments; Grading Operations; Grading
Equipment; Soil Studies; Soil Classification; Important Characteristics of
Subgrade Soils; BPR Grouping of Soils; AASHO Classification of Soils;
Treatment of Embankment and Subgrades; Subgrade Surveys and
Profiles.

5374

Highway Drainage

Duration: 10 hours (includes 1 test)
Course Prerequisite:
Practical Geometry and Trigonometry (5567)

What Students Learn:
Subdrains; Construction of Surface Drainage Channels; Requirements of
Surface Drainage Channels; Design of Surface Drainage Channels; Types of
Culverts; Location of Culverts; Flow of Water through Culverts;
Charts for Flow in Culverts; Selection of type and size of Culvert.

5352A-B

Traffic Control and Operations

Duration: 20 hours (includes 2 tests)

What Students Learn:
Part 1 (5352A). Trends in Highway Transportation; Methods of
Controlling Traffic; Signs, Pavement Markings, and Signals; Timing of
Signals; Signal Schemes; Pretimed Signals.
Part 2 (5352B). Advantages and Disadvantages of One-Way Streets;
Operation of Reversible Lanes; Electronic Surveillance and Control of
Traffic; Volume and Speed Studies; Accident Studies; Law Observance
Studies; Provisions for Parking; Safety Appurtenances; Lighting Systems.

5353A-C

Highway Location and Design

Duration: 30 hours (includes 3 tests)
Course Prerequisite:
Transit Surveying (5460A-C)

What Students Learn:
Part 1 (5353A). Highway Planning; Classification of Highways;
Planning Surveys; Location of Highways; Reconnaissance; Preliminary
and Final Location Surveys; Selection of Route; Preparation of Plans;
Highway Development; Highway Economics.
Part 2 (5353B). Geometric Design of Highways; Capacity and Level of
Service of Highways; Selection of Number of Lanes; Highway
Alignment; Transition Curves; Sight Distances; Establishing Positions of
Grade Lines; Rates of Grade for Streets; Crown and Superelevation;
Requirements for Urban Streets and Rural Roads; Development of
Right-of-Way.
Part 3 (5353C). Roadside Development; Comparison of Intersections
and Interchanges; Intersections at Grade; Rotary Intersections; Design of
Interchanges; Acceleration and Deceleration Lanes; Railroad Crossings;
Estimates of Cost and Time; Contract Forms and Specifications;
Organization of Departments of Transportation; Highway Finance.
5376  
**Drying**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Heat Transfer (2545)
- Steam (2620)
- Elements of Chemistry (5011)

**What Students Learn:**
Theory of Drying; Design Calculations; Constant-Rate and Falling-Rate Periods; Psychrometry; Description and Use of Various Types of Dryers; Cost Estimation.

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5399  
**Development of Surfaces**

**Duration:** 115 hours

**Course Prerequisites:**
- Introduction to Algebra, Geometry, and Trigonometry (Block X02)
- Elementary Mechanical Drawing (5434)

**What Students Learn:**
- Development by Parallel Lines; Seven Drawing Plates: 629,
- Development of Squares and Hexagonal Prisms: 630,
- Development of Surfaces Cut by Inclined Planes: 631,
- Developments of Pattern for Branch Pipe of a Tee and End Section of a Three-Piece 90˚ Elbow: 632,
- Development of the Pattern of Two Intersecting Cylinders of Unequal Diameters: 633,
- Development of Pattern for an Intersecting Cylinder and Rectangular Pipe: Development on Radial Lines: 634,
- Developments of the Pattern for a Frustum of a Pyramid Having a Square Base and Frustum of a Cone: Development by Triangulation: 635,
- Transition Piece Having a Circular and a Rectangular Base; Additional Problems Illustrating Short Methods of Triangulation; Approximate Development of a Sphere by Zones and Gores.

**Special Note:**
- Includes 7 plates and requires drafting kit.

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5434  
**Elementary Mechanical Drawing**

**Duration:** 130 hours

**Course Prerequisite:**
- Practical Measurements (Block X22)

**What Students Learn:**
- Drawing Equipment; Lettering; Eight Drawing Plates: 721, 722, and 723,
- Geometrical Drawing Problems: 724,
- Projections of Simple Solids: 725,
- Foreshortened Views in Projection: 726,
- Common Conventions: 727,
- Lifting and Test Cover: 728,
- Hanger Assembly.

**Special Note:**
- Includes 8 plates and requires drafting kit.

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5440A-C  
**Design of Steel Building Frames**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
- Plane Trigonometry (2309A-B)
- Logarithms (5254)

**What Students Learn:**
- Part 1 (5440A). Materials Used in Building Frames; Classes of Steel Used for Rolled Shapes; Conventional Symbols for Connecting Devices; Investigation and Design of Tension Members; Eccentric Loads on Connections; Investigation and Design of Riveted or Bolted Connections; Investigation and Design of Welded Connections.
- Part 2 (5440B). Properties of Standard Rolled Shapes; Kinds of Possible Failures of Steel Beams; Allowable Stresses in Beams; Actual Stresses and Deflections in Beams; Investigation and Design of Beams; Design of Framed Connections; Design of Stiffened or Unstiffened Seated Connections; Design of Riveted or Bolted Semirigid Connections; Design of Welded Semirigid Connections.
- Part 3 (5440C). Design of Composite Construction with Steel Beams and Concrete Slabs; Factors Affecting the Strength of Columns; Design of Axially Loaded or Eccentrically Loaded Columns; Use of AISC Tables for Column Design; Design of Riveted or Bolted Column Splices; Design of Welded Column Splices; Shop-Welded and Field-Bolted Column Splices.

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5450A-C  
**Reinforced Concrete Design**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
- Plane Trigonometry (2309A-B)
- Logarithms (5254)

**What Students Learn:**
- Part 1 (5450A). Properties of Reinforced Concrete; Use of Steel Reinforcement; Working Stress Design and Strength Design; Design Loads for Strength Design; Bending Moments and Shears in Beams; Investigation and Design of Singly Reinforced Rectangular Beams; Investigation and Design of Doubly Reinforced Beams; T-Beams; Continuous Beams; Deflections.
- Part 2 (5450B). Arrangement of Shear Reinforcement; Design of Shear Reinforcement; Variation of Shear Stress in Beams; Location of Neutral Axis in Beams; Determination of Balanced Steel Ratio; General Considerations for One-Way Slabs; Required Thickness of Solid Slabs; Design of Principal and Secondary Reinforcement in Slabs; Stairway Slabs; Concrete Joist Floor Construction.
- Part 3 (5450C). General Features of Tied and Spiral Reinforced Concrete Columns; Design Loads and Capacity Reduction Factors; Slenderness Ratio for Columns; Investigation and Design of Short Columns; Design of Column When Compression Controls; Design of Column When Tension Controls; Investigation and Design of Long Columns.
5451
**Structural Design of Pipe Culverts**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Introduction to Algebra, Geometry, and Trigonometry (Block X02)

**What Students Learn:**
Culvert Materials; Culvert Bedding; Backfill Materials; Design Features; Design Procedure; Backfill Loads; Embankment Loads; Live Loads; Load Factor; Design Strength; Rigid Pipe; Flexible Pipe; Elliptical Pipe; Pipe-Arch Culverts.

5455A-H
**Quantitative Analysis**

**Duration:** 80 hours (includes 8 tests)

**Course Prerequisite:**
Qualitative Analysis (6710A-D)

**What Students Learn:**
Part 1 (5455A). Chemical Theory; Laws of Analytical Chemistry; Division of Analysis; Preparation of Solutions; Law of Mass Action; Theory of Neutralization; Solubility Product; Theory of Oxidation-Reduction Reactions; Standard Solutions; Acidimetry and Alkalimetry; Oxidizing and Reducing Reagents.

Part 2 (5455B). Gravimetric Determinations; Moisture; Chlorine in a Soluble Chloride; Iron as Oxide; Aluminum as Oxide; Sulfur as Barium Sulfate; Calcium as Oxide; Calcium as Sulfate; Magnesium as Pyrophosphate; Silicon as Oxide; Phosphoric Anhydride in a Soluble Phosphate; Phosphorus as Ammonium Phosphomolybdate; Arsenic as Trisulfide; Potassium as Potassium Chloroplatinate; Chromium as Oxide; Copper as Oxide; Copper by Electrolysis; Molybdenum as Lead Molybdate; Zinc as Pyrophosphate, Gravimetric Analysis of Limestone.

Part 3 (5455C). Volumetric Determinations; Principles of Volumetric Analysis; Scope and Accuracy of Determination; Volumetric Glassware; Volumetric Solutions; Acidimetry and Alkalimetry; Titration and Indicators; Iodimetry Determination of Iron in Iron Ore; Determination of Available Chlorine in Bleaching Powder; Analysis of Acids; Muratic Acid (Commercial HCl); Nitric Acid; Sodium Hydroxide; Sodium Carbonate; Aqua Ammonia.

Part 4 (5455D). Alloys; Analysis of Bronze; Analysis of Aluminum Alloys; Analysis of Ferrous Alloys.


Part 6 (5455F). Analysis of Waters: Chlorine, Oxygen Consumed, Nitrogen, and Nitrite; Total Solids; Reagents; Alkalinity and Acidity; Total Chlorides; Soap Hardness and Free Carbon Dioxide; Atmospheric Analysis; Analysis of Soap; Examination and Sampling of Soap Stock; Moisture and Free Fatty Acids; Titer Test; Wijs Method for Determination of Iodine Value; Saponification Number; Analysis of Soils: Carbonate Carbon, Organic Carbon, Total Nitrogen, Sulfur, Phosphorus, Potassium and Sodium, Silica, Calcium and Magnesium; Soil Reaction Tests; Analysis of Fertilizers.

Part 7 (5455G). Analysis of Pulp: Moisture, Ash, Alpha Cellulose; Permanganate Number, Water Solubility, and Methoxyol Groups; Analysis of Paper: Moisture, Ash, Cellulose, Water-Soluble Alkalinity or Acidity and Copper Number; Alkali-Staining Number of Paper; Analysis of Paint.

Part 8 (5455H). pH and its Measurement; Assaying for Gold and Silver; Analysis of Dairy Products; Testing of Sugar; Analysis of Explosives; Analysis of Oils, Fats and Waxes; Analysis of Synthetic Detergents.

**Special Note:**
- Covers subject at an advanced, in-depth level.

5456
**Quantitative Analysis Laboratory Manual**

**Duration:** 15 hours

**Course Prerequisite:**
Quantitative Analysis (5455A-H)

**What Students Learn:**
Procedures for Gravimetric Determinations; Chlorine in a Soluble Chloride; Sulfuric Anhydride in Cement; Ferric Oxide and Alumina in Cement; Calcium Oxide in Cement; Magnesia in Cement; Barium in Barium Compound; Tin in Brass; Lead in Brass; Copper in Brass; Znic in Brass; Nickel in Copper-Nickel Alloy; Procedures for Volumetric Determinations; Copper in Copper-Nickel Alloy; Total Alkali in Sodium Carbonate; Chloride in Soluble; Iron in Iron Ore; Appendix: Triple Beam Balance.

**Special Note:**
- Includes 15 laboratory experiments and requires chemicals to be purchased from an outside source.

5460A-C
**Transit Surveying**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
Linear Surveying (6670) Eleving (6671)

**What Students Learn:**
Part 1 (5460A). Meridians; Magnetic Declination; Azimuth of Lines; Bearings of Lines; Angles between Lines; The Engineer’s Transit; Reading Vernier; Reading Compass; Optical-Reading Theodolites; Adjustments of a Transit.

Part 2 (5460B). Operations with Transit; Measurement of Direct Angles; Measurement of Deflection Angles; Details of Transit Surveys; Field Problems; Surveying by Triangulation; Trigonometric Leveling.

Part 3 (5460C). Computations involving Latitudes and Departures; Balancing Closed Traverses; Errors of Closure; Computation of Omitted Measurements; Plotting Traverse by Lengths and Directions of Courses; Plotting Traverse by Latitudes and Departures; Computation of Area; Problems on Partitioning Tracts of Land.
5461A-B

Topographic Surveying

Duration: 20 hours (includes 2 tests)
Course Prerequisite: Transit Surveying (5460A-C)

What Students Learn:
Part 1 (5461A). Determination of Distances by Stadia; Instrument Constants; Formulas for Stadia Distances; Stadia Reduction Table; Beaman Stadia Arc; Field Operations in Stadia Work-Transit-Stadia Surveys for Locating Topography; Indirect Leveling by Stadia; Accuracy of Stadia Work.
Part 2 (5461B). Plane-Table Surveying; Locating Points from Plane Table; Plotting Position of Plane Table; Field Methods for Locating Topography; Accuracy of Plane-Table Work; Topographic Maps; Methods of Control; Locating Topography by Side-Shot Method; Locating Topography by Cross-Section Method.

5462A-B

Mapping

Duration: 60 hours
Course Prerequisites: Practical Measurements (Block X22)
Geometrical Drawing (5544A-B)

What Students Learn:
Part 1 (5462A). Two Drawing Plates; Scale of Map; Azimuths and Bearings of Lines; Plotting Angles; Planning Maps' Locating Points on Traverses; Plotting Open Traverses; Plate 1801, Plotting Closed Traverses; Routes Involving Circular Curves; Plate 1802, Plotting Route Centerlines.
Part 2 (5462B). Two Drawing Plates; Preparation of Topographic Maps; Conventional Symbols; Location of Contours; Plotting Topographic Details; Plate 1803, Topographic Symbols and Contours; Plotting Cross Sections and Profiles; City and Village Maps; Plate 1804, Map of a Portion of Southport; Laying of Tints.

Special Note:
• Includes 4 plates and requires drafting kit.

5463

Fundamentals of Law for Surveyors

Duration: 10 hours (includes 1 test)
Course Prerequisites: Linear Surveying (6670)
Leveling (6671)

What Students Learn:
Identification of Boundaries of Tracts; Responsibility of Surveyor; Methods of Describing Tracts of Land; Rectangular System; Description by Metes and Bounds; Other Old Systems; State Plane-Coordinate Systems Boundaries along Highways; Boundaries along Bodies of Water; Relocating Original Boundaries; Correction of Defects in Original Surveys; Changes in Boundaries along Bodies of Water; Legal Principles Affecting Title to Land; Boundaries Established by Mutual Consent; Title to Public Ways; Limitations of Riparian Rights; Title by Adverse Possession; Land Courts.

5465

Determination of True Meridian

Duration: 10 hours (includes 1 test)
Course Prerequisites:
Linear Surveying (6670)
Leveling (6671)

What Students Learn:
The Sphere; Terrestrial Circles; The Celestial Sphere; Celestial Circles; Motion of Celestial Sphere; Motion of Sun on Celestial Sphere; Position of a Body on the Celestial Sphere; Sidereal, Solar and Standard Time; Determination of Meridian by Observing Polaris at Culmination or at Elongation or by Observing the Sun; The Nautical Almanac; Determination of Altitude; Determination of Azimuth; Determination of Latitude.

5466A-B

United States Land Surveys

Duration: 20 hours (includes 2 tests)
Course Prerequisites:
Linear Surveying (6670)
Leveling (6671)

What Students Learn:
Part 1 (5466A). Characteristics of Land Surveys; Principal Meridians and Base Lines; Theoretical Positions of Township Boundaries; Theoretical Positions of Section Boundaries; Special Conditions; Townships with Defective Boundaries; Private Land Claims; Markings on Iron-Pipe Monuments; Markings on Stone and Tree Monuments; Corner Accessories; Marking Survey Lines between Corners.
Part 2 (5466B). Field Notes and Official Plat; Subdividing Sections; Relocating Corners; Limitations in Resurveys; Dependent Resurveys; Independent Resurveys; Deeds.

5468

Earthwork

Duration: 10 hours (includes 1 test)
Course Prerequisite:
Highway Curves (6812A-B)

What Students Learn:
Field Measurements; Dimensions of Cross Sections; Surveys for Determining Grade; Cross-Sectioning; Earthwork Computations; Prismoids; Three-Level Sections; Irregular Sections; Side-Hill Work; Transition from Cut to Fill; Curvature Correction; Disposal of Cut and Fill; Formation of Embankments; Shrinkage and Swell; Subsidence; Moving Cut to Fill; Mass Diagram.
5470A-C

**Structural Steel Drawing**

**Duration:** 75 hours (includes 3 tests)

**Course Prerequisite:**
Elements of Projection Drawing (5649)

**What Students Learn:**
Part 1 (5470A). Parts of Steel Building Frames; Types of Structural-Steel Drawings; Drafting-Room Organization; Scales and Their Use; Lettering and Dimension Figures; Kinds of Lines; Representation of Rolled-Steel Shapes, Rivets, Bolts, and Welds; Drawing Plate 681, Shapes and Connections.

Part 2 (5470B). Types of Beam Connections; Shapes used for Beams; Details of Bolted or Riveted Connections; Details of Welded Connections; Conventional Practices for Detailing Rolled Beams and Welded Girders; Drawing Plate 682, Details of Beams and Girders.

Part 3 (5470C). Types of Steel Columns; Column Schedules; Column Splices; Lifting Hitches; Connections of Beams to Columns; Details of Columns; Types of Roof Trusses; Bolted, Riveted, and Welded Connections at Panel Points; Drawing Plate 683, Details of Roof Truss.

**Special Note:**
- Includes 3 plates and requires drafting kit.

5471A-B

**Reading Structural Steel Drawings**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisite:**
Practical Measurements (Block X22)

**What Students Learn:**
Part 3 (5471A). Parts of Steel Building Frames; Erection Plans; Detail Drawings; Bills of Material; Conventional Symbols for Rivets, Bolts, and Welds; Connections with High-Strength Bolts; Framed Connections; Seated Connections; Semirigid Connections; Special Beam Connections; Column Connections; Column Schedules; Opposite Members or Opposite Parts.

Part 2 (5471B). Anchor-Bolt Plans for Columns; Base Plates and Leveling Plates; Types of Supports for Beams; Framing Plans for Multistory Buildings; Typical Sections on Framing Plans; Detail Drawings for Beams; Detail Drawings for Columns; Detail Drawings for Plate Girders.

5481

**Plate Girders for Steel Buildings**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Mechanics of Materials (5282A-C)

**What Students Learn:**
Parts of Plate Girders; Materials for Plates and Welds; Investigation of Cross Section: Forces and Stresses; Procedures in Investigation; Design of Welded Plate Girder; Design of Web Plate; Design of Flanges; Web Stiffeners; Connecting Welds; Summary of Design; Box Girders and Hybrid Girders.

5501

**Sanitary Chemistry**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Elements of Chemistry (5011)

**What Students Learn:**
Sanitary Analysis; Solutions; Strengths of Solutions; Titration; Cleaning of Equipment; Indicators and Their Use; Standardization of Acid Reagents with Sodium Carbonate; Standardization of Hydroxide Reagents with Acids; Standardization of Acid Reagents with Hydroxides; Standardization of Reagents for Oxidation or Reduction; Volumetric Analysis; Typical Gravimetric Analysis; Colorimetric Analysis; Spectrographic Analysis.

5523

**Foundations and Pilings**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Production of Concrete (5469A-C)

**What Students Learn:**
Foundation Beds, Materials; Safe Loads; Examination and Tests of Beds; Application of Soil Mechanics to Foundation Beds; Bearing Capacity of Soil; Preparation of Foundation Beds; Dry Beds; Wet Beds; Excavating Equipment; Pile Foundations; Types of Piles; Driving of Piles; Bearing Piles; Supporting Power of Piles; Timber Bearing Piles; Concrete Bearing Piles; Other Bearing Piles; Sheet Piling; Wellpoint Systems.

5544A-B

**Geometrical Drawing**

**Duration:** 95 hours (includes 1 test)

**What Students Learn:**

Part 2 (5544B). Five Drawing Plates Consisting of 26 Problems; Drawing Equipment: Paper, Drawing Board, T-Square, Triangles, Scales, Compasses, Dividers, Protractor, Irregular Curve and Drafting Machine; Ruling; Straight Lines; Care of Drawing Instruments; Protecting Drawings; Erasing; Styles of Lettering; Relative Widths and Spacing of Letters; Vertical Single-Stroke Lettering; Inclined Single-Stroke Lettering.

**Special Notes:**
- Covers subject at an advanced, in-depth level.
- Includes 5 plates and requires drafting kit.

5551A-B

**Sheet Metal Drafting**

**Duration:** 80 hours (includes 1 test)

**Course Prerequisites:**
Practical Measurements (Block X22)
Practical Geometry and Trigonometry (5567)
Elementary Mechanical Drawing (5434)
5587A-C

### Steel Roof Trusses

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
- Design of Steel Building Frames (5440A-C)
- Geometrical Drawing (5544A-B)

**What Students Learn:**

**Part 1 (5587A):** General Features of Roof Trusses; Forms of Roof Trusses; Loads on Roof Trusses; Reactions at Truss Supports; Axial Forces on Truss Members; Frame Diagrams; Force Diagrams.

**Part 2 (5587B):** Construction of Main Members of Trusses; Panel Points; Connections of Bracing; Connections of Members; Design of Main Members; Loads; Stresses; Design of Connections.

**Part 3 (5587C):** Design of Roof Coverings; Design of Purlins; Design of Truss; Design of Typical Fink Truss; Design of Typical Flat Truss.

**Special Note:**
- Includes 4 plates and requires drafting kit.

5637A-B

### Architectural Drawing

**Duration:** 150 hours

**Course Prerequisite:**
- Elementary Architectural Drawings (5893A-C)

**What Students Learn:**

**Part 1 (5637A):** Introduction to Architectural Drawing; Description of Classes; Symbols and Indications; Details of Windows; Doors and Cornices; Miscellaneous Interior Details; Chimneys and Fireplaces.

**Part 2 (5637B):** Preliminary Considerations; Frame Residence; Symmetrical Planes; Working Drawings; Walls and Partitions; Windows and Doors; Kitchen; Dining Room; Living Room; Bedroom; Brick-Veneer and Block-Construction Advantages and Construction; Key to Criticism.

**Special Note:**
- Includes 10 plates and requires drafting kit.

5645

### Drawings for Welded Parts

**Duration:** 70 hours

**Course Prerequisite:**
- Elementary Mechanical Drawing (5434)

**What Students Learn:**

- Welding Processes and Types; Materials Suitable for Welding; Fillet and T-Welds; Corner Welds; Lap Welds; Plug and Slot Welds; Vertical and Overhead Welding; Inaccessible Fusion Welds; Electric Resistance Welds; Strength of Welds; Designating Welds on Drawings; Four Drawing Plates: 1024A, Application of Welding Symbols; 1025A, Bedplate for Motor-Generator Set; 1026A, Welding Drawing of Drill Jig; 1027A, Welded Gear.

**Special Note:**
- Includes 4 plates and requires drafting kit.

5649

### Elements of Projection Drawing

**Duration:** 85 hours

**Course Prerequisites:**
- Practical Measurements (Block X22)
- Geometrical Drawing (5544A-B)

**What Students Learn:**

- Views of Objects; Lines Used on Projection Drawings; Orthographic Projection Problems; Pictorial Drawing; Five Drawing Plates: 704, Projection of Simple Solids; 705, Foreshortened Views in Projection; 706, Sections of Cones and Cylinder; 707, Intersections and Developments; 708, Isometric and Oblique Projection.

**Special Notes:**
- Covers subject at an advanced, in-depth level.
- Includes 5 plates and requires drafting kit.

5739

### Mechanical Drawing

**Duration:** 100 hours

**Course Prerequisites:**
- Practical Measurements (Block X22)
- Elementary Mechanical Drawing (5434)

**What Students Learn:**

- Classification of Mechanical Drawings; Drafter Duties; Simplified Drawing; Reproduction Methods; Microfilming; Six Drawing Plates: 931, Tailstock Clamp, Flange, Bracket, and Yoke; 932, Clamp, Circular Plate, Angle Bracket, T-Bracket, and Circular Flange; 933, Head Attachment, Bearing, Locating Lug and Pulley; 934, Clamp Block, Clamp Plate, Scribing Block, and Tool Clamp; 935, Details of a Belt Drive; 936, Assembly of a Belt Drive.

**Special Note:**
- Includes 6 plates and requires drafting kit.
5751

Hydrographic Surveying

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Topographic Surveying (5461A-B)

What Students Learn:
Preparatory Surveys; Control Surveys; Triangulation and Topography; Shore Stations; Control Buoys; Taking Soundings; Equipment for Measuring Depth; Locating and Observing Soundings; Plotting Soundings; Boat Sheet; Smooth Sheet; Volume of Body of Water; Adjustments of the Sextant.

5773A-B

Advanced Mechanical Drawing

Duration: 275 hours

Course Prerequisites:
Geometrical Drawing (5444A-B)
Elements of Projection Drawing (5649)
Mechanical Drawing (5739)

What Students Learn:
Part 1 (5773A). Eight Drawing Plates: 907, Helical Forms; 908, Gear-Teeth Profiles; 909, Gear and Pinion; 910, Bevel and Worn Gearing; 911, Detail of Plate Girder; 912, Blowoff Cock and Rigging; 913, Iron Casting; 914, Automobile Piston; Indication and Application of Tolerances; Changes on Drawings; Auxiliary Views.
Part 2 (5773B). Nine Drawing Plates: 915, Machine Component; 916 and 917, Bench Vise Details; 918, Bench Vise Assembly; 919, Pump Casting; 920, Pump Casting and Assembly; 921, Details of Bearing; 922, Assembly and Details of Housing; 923, Sliding Bracket and Pillow Block; Procedure in Making Blueprints; Other Types of Prints.

Special Notes:
• Covers subject at an advanced, in-depth level.
• Includes 17 plates and requires drafting kit.

5807

Machine Sketching

Duration: 10 hours (includes 1 test)

What Students Learn:
Sketches of Machine Details; Drawing Straight and Curved Lines; Finish Marks; Surface Roughness; Arrangement of Dimensions; Partial Section; Conventional Sections; Shaft Coupling; Spur Gear; Bevel Gear; Pieces Requiring More Than Two Views; Foreshortening; Measurements; Curved Outlines and Fillets; Pictorial Sketching; Isometric Drawing; Oblique Drawing; Conventional Symbols; Piping Diagrams.

5810

Field Sketching

Duration: 10 hours (includes 1 test)

What Students Learn:
Introduction to Useful Sketching; Sketching Materials and Techniques; Conventions; Multi-view Sketching Concepts; Measuring Instruments; Types of Measurements; Dimensioning; Two-Dimensional Sketching; Pictorial Sketching; Pictorial Sketching of Piping.

5814A-G

Organic Chemistry

Duration: 70 hours (includes 7 tests)

Course Prerequisites:
Basic Organic Chemistry (5017A-B)
Inorganic Chemistry (5005A-D)

What Students Learn:
Part 3 (5814C). Properties, Preparation, and Applications of Aromatic and Aliphatic Halides, Alcohols, and Ethers; Chemical and Physical Properties of Phenols.
Part 4 (5814D). Properties, Preparation, and Applications of Aliphatic and Aromatic Aldehydes; Ketones and Acids; Aliphatic and Aromatic Nitro Compounds.
Part 5 (5814E). Amines; Chemical and Physical Properties of Nitriles, Isonitriles, Cyanates, and Isocyanates; Urethane Plastic Resins; Acylichalides.
Part 6 (5814F). Chemical and Physical Properties of Aliphatic and Aromatic Acid Anhydrides, Esters, and Amides; Nitrogen Derivatives of Carbonic Acids; Urea Formaldehyde and Melamine Formaldehyde Plastics.
Part 7 (5814G). Substituted Acids and Derivatives; Chemical and Physical Properties of Aliphatic and Aromatic Halogen-Substituted Acids, Dicarboxylic Acids, Hydroxy-Substituted Acids and Amino Acids; Petrochemicals.

5878

Filtration

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Elements of Chemistry (5011)

What Students Learn:
Basic Types of Filters; Filtration Theory Description and Application of Industrial Filters; Gravity Filters; Pressure Filters; Intermittent and Continuous Vacuum Filters; Filter Mediums; Selection of Filters.
Fireproofing of Buildings

Duration: 10 hours (includes 1 test)

What Students Learn:
Materials of Construction; Protecting the Structural Frame; Fireproof Partitions; Fireproofing of Openings; Fire-Extinguishing Equipment.

Elementary Architectural Drawings

Duration: 150 hours (includes 1 test)

What Students Learn:
Part 2 (5893B). Lettering; Drawing Problems.
Part 3 (5893C). Isometric, Oblique, and Projection Drawing; Application of Projection Drawing.

Special Note:
• Includes 8 plates and requires drafting kit.

Surface Protection of Metals

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Metallurgy (5338A-B)

What Students Learn:
Mechanical Cleaning of Metals; Chemical Cleaning of Metals; Corrosion; Metallic Coating on Ferrous Metals; Chemical Coatings on Ferrous Metals; Organic Finishes on Ferrous Metals; Petroleum-Base Rust Preventatives; Chemical Coatings on Aluminum and Aluminum Alloys; Organic Finishes on Aluminum; Chemical Coatings on Magnesium; Organic Coatings on Magnesium; Chemical Coatings on Zinc-Alloy Die Casting; Organic Coatings on Zinc Alloys; Coatings on Copper Alloys; Testing Protective Surface Coatings.

Distillation

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Plane Trigonometry (2309A-B)
Elements of Chemistry (5011)
Steam (2620)
Heat Transfer (2545)

What Students Learn:
Basic Principles of Distillation; Distillation Methods; Equilibrium; Simple Fractional, Batch, and Continuous Distillation; Rectification; Binary Systems; Calculations for Theoretical Plates; Sorrels Method; McCabe-Thiele Method, Design, Application, and Operation of Packed Columns; Plate Columns.

Evaporation and Crystallization

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Plane Trigonometry (2309A-B)
Elements of Chemistry (5011)
Steam (2620)
Heat Transfer (2545)

What Students Learn:
Operation and Application of Evaporator Equipment; Multiple-Effect Evaporation; Evaporator Calculations; Crystallization Equipment; Batch and Continuous Crystallizers; Crystallization Theory; Saturation; Fractional Crystallization.

Sound

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Plane Trigonometry (2309A-B)
Logarithms (5254)

What Students Learn:
Relation of Sound to Wave Motion; Motion of Particles in a Medium; Harmonic Motion; Velocity, Frequency, and Wave-Length; Nature, Properties and Sources of Sound; Transmission Media; Wave Fronts; Sensitivity of Human Ear; Infrasonics and Ultrasonics; Velocity of Sound in Air, Water, and Solids; Doppler Effect; Reflection; Diffusion; Reverberation; Focusing of Sound; Absorption of Sound; Refraction; Diffraction; Reinforcement and Interference; Resonance; Forced Vibration; Musical Sounds; Vibration of Stretched Strings; Overtones in Harmonics; Vibrations of Air Columns; Closed Pipes and Open Pipes; Vibrations of Reeds, Membranes, and Plates; Sirens; Harmony and Discord; Diatonic Scale; Characteristics of Sound; Loudness; Decibels; Determining Sound Direction; Quality and Waveform; Reproduction of Sound; Transducers; Microphones.

Size Reduction

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Practical Geometry and Trigonometry (5567)

What Students Learn:
Materials Encountered in Size Reduction; Physical Structure; Particle Size; Description and Use of Industrial Equipment; Jaw Crushers; Gyratory Crushers; Roll Crushers; Grinding Machines; Ball Mills; Rod Mills; Hammer Mills; Fluid Energy Mills; Closed and Open Circuit Grindings; Theory and Principles of Size Reduction.
**6106**

**Size Separation**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:** Size Reduction (6105)

**What Students Learn:** Design and Application of Size Separation Equipment; Grizzlies; Trommels; Vibrating Screens; Wet Classifiers; Sand Tanks; Cone and Bowl Classifiers; Air Classifiers; Theory of Size Classifications.

**6208**

**Solvent Extraction**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Plane Trigonometry (2309A-B)
- Elements of Chemistry (5011)

**What Students Learn:** Definition; Equipment for Extraction; Design and Application; Separate Stage and Continuous Contact Equipment; Centrifugal Extractors; Theory and Design Calculations.

**6209**

**Mixing**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
- Practical Geometry and Trigonometry (5567)
- Elements of Chemistry (5011)

**What Students Learn:** Mixing Equipment; Types and Application; Operating Characteristics; Paddle Stirrers; Propeller Stirrers; Beaters; Kneaders; Dry Mixers; Mixing Theory.

**6211**

**Plumbing Drawing**

**Duration:** 100 hours

**What Students Learn:**
- Relation of Plumbing Drawing to Other Types of Drawing; General Construction Considerations; Plumbing Symbols; Plumbing Details; Plumbing Drawings for a Residence.

**Special Note:**
- Includes 6 plates and requires drafting kit.

**6255A-B**

**Light**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisites:**
- Plane Trigonometry (2309A-B)
- Logarithms (5254)

**What Students Learn:**
- Part 1 (6255A), Nature of Light; Measuring of Light or Photometry, including Candle Power, Luminous Flux, Illumination, and Brightness; Reflection of Light and its Application on Mirrors; Kinds of Optical Mirrors, such as Plane, Concave and Convex Spherical, Parabolic, and Elliptic; Refraction of Light and Prisms.
- Part 2 (6255B), Images Obtained by Convex and Concave Lenses; Optical Instruments, such as Magnifier, Microscope, Telescope, Projector, Field Glasses, and Others; Interference of Light; Color of Light and Spectra; Polarized Light; Lasers; Examples for Practice in each Section.

**6330A-B**

**Field Methods in Concrete Construction**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisite:**
- Production of Concrete (5469A-C)

**What Students Learn:**
- Part 1 (6330A), Preparation of Aggregates; Handling Cement; Measuring Materials; Mixing Concrete; Producing Concrete; Conveying Concrete; Placing Concrete; Compacting Concrete; Finishing Concrete; Curing Concrete.
- Part 2 (6330B), Materials for Prestressed Concrete; Equipment for Stressing Reinforcement; Forms for Prestressed Concrete; Concreting Prestressed Members; Lift-Slab Method of Construction; Panels and Columns in Tilt-Up Constructions; Parties involved in Concrete Construction; Contractor's Forces; Engineer’s Forces.

**6403A-B**

**Low Cost Road Surfaces**

**Duration:** 20 hours (includes 2 tests)

**What Students Learn:**
- Part 1 (6403A), Materials for Low Cost Roads; Aggregates; Bituminous Materials; Specifications for Bituminous Materials; Treatments of Natural Subgrade; Oil Surface Treatment; Oil Treatment with Gravel Blotter; Oil Processing; Oil Processing of Natural Subgrade; Calcium-Chloride Treatment; Stabilized Soil; Untreated Surfacings; Sand-Clay and Top-Soil Rocks; Soft-Lime Rock, Shell, and Scoria; Gravel; Slag; Waterbound and Traffic-Bound Macadam; Maintenance of Untreated Surfaces; Bituminous Surface Treatments; Stabilized Soil-Bound Surfaces.
Part 2 (6403B). Road-Mixed Bituminous Surfacing; Macadam-Aggregate Mix; Mix with Dense Grade Aggregate; Sand-Asphalt Surfacing; Low-Cost Plant-Mixed Surfacing; Mix with Precoated Macadam Aggregate; Cold-Laid Mixes with Macadam and Dense Graded Aggregates; Plant Mix with Emulsified Asphalt; Hot-Laid Mix of Sand and Asphalt; Hot-Laid Mix with Dense Graded Aggregate; Bituminous-Macadam Pavements Constructed by Penetration Method with Hot Asphalt Cement, Emulsified Asphalt, Cut-Back Asphalt, and Tar.

6513A-D

Elements of Photogrammetry

Duration: 40 hours (includes 4 tests)
Course Prerequisite: Topographic Surveying (5461A-B)

What Students Learn:
Part 1 (6513A). Uses of Photographs; Aircraft and Equipment; Characteristics of Camera Lenses; Procedure for Obtaining Vertical Photographs; Relief Displacement; Location of Ground Points.
Part 2 (6513B). Basic Formulas; Procedures for Orienting Tilted Photographs; Rectification of Tilted Photographs; Use of Control Plot; Plotting Planimetric Features; Mosaics.
Part 3 (6513C). Geometry of Overlapping Vertical Photographs; Stereoscopic and Parallax Measurements; Plotting Contours; Use of High-Precision and Special Plotting Instruments; Completion of Map with Multiplex Instrument.
Part 4 (6513D). Principles and Application of Oblique Photography; Interpretation of Aerial Photographs; Terrestrial Photogrammetry; Mapping from Terrestrial Photographs.

6582

Design of Prestressed Concrete

Duration: 10 hours (includes 1 test)
Course Prerequisites:
Formulas (186012)
Engineering Mechanics, Parts 1-4 (286036-286039)
Mechanics of Materials (5282A-C)

What Students Learn:
Purposes of Prestressing; Application of Prestressing Materials for Prestressed Concrete; Cross Sections of Members; Distribution of Unit Stresses; Loading Conditions; Equations for Resultant Stressed in Beams; Straight and Draped Tendons in Beams; Allowable Unit Stresses in Steel and Concrete; Fatigue Strength under Repetitive Loads; Loss of Prestress; Load Factors for Ultimate Strength Design; Ultimate Resisting Moment; Reinforcement at Ultimate Strength; Web Reinforcement; Bond of Pretensioned Reinforcement; End Blocks; Positioning of Reinforcement; Composite Prestressed and Conventional Construction; Transverse Diaphragms; Design Procedure with Pretensioned and Posttensioned Tendons; Deflection; Non-Prestressed Reinforcement; Prestressed Piles; Columns and Pipe.

6588A-D

Instrumental Laboratory Analysis

Duration: 40 hours (includes 4 tests)
Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02) Qualitative Analysis (6710A-D)

What Students Learn:
Part 2 (6588B). Flame Photometry; Absorptiometry Using Color Comparator, Filter Photometer, and Spectrophotometer; Turbidimetry; Nephelometry; Infrared Analysis; Microwave Spectroscopy; Nuclear Magnetic Resonance; Atomic Absorption Spectroscopy; Electron Probe Microanalysis; Direct-Reading Emission Spectrography; Fluorescence and Phosphorescence Analysis.
Part 3 (6588C). Chromatography; Frontal Analysis; Displacement Development; Elution Development; Liquid-Solid Chromatography; Liquid-Liquid Chromatography; Gas-Liquid Chromatography; Thermal Conductivity; Mass Spectrometry; Electromagnetic Mass Spectrometers; Vacuum Spark Method; Ion Bombardment Method; Isotope Dilution Method; Time-of-Flight Mass Spectrometers; Effluent Analysis.
Part 4 (6588D). Electroanalysis; Conductometry; Polentiometry; Chronoanperometry; Chronopotentiometry; Polarography; Voltammetry; Amperometry; Coulometry; Electrochromatography; Electrophoresis; Chemical Microscopy.

6670

Linear Surveying

Duration: 10 hours (includes 1 test)
Course Prerequisites:
Logarithms (5254)
Plane Trigonometry (2309A-B)

What Students Learn:
Methods of Measurement; Tapes and Accessories; Description of Geodimeter and Tellurometer; Use of Tape; Adjustment of Taped Distances; Use of Geodimeter; Use of Tellurometer; Simple Field Problems; Survey of Tract with Tape.

6671

Leveling

Duration: 10 hours (includes 1 test)
Course Prerequisites:
Introduction to Algebra, Geometry, and Trigonometry (Block X02) Logarithms (5254)
Plane Trigonometry (2309A-B)

What Students Learn:
The Engineer's Level; Definitions; Construction of Levels; Setting Up Level; Leveling Rods; Reading the Rod; Operations of Direct Leveling; Forms for Level Notes; Precision in Leveling; Adjustments of Levels; Profiles; Barometric Leveling.
6688A-B

Reading Highway Blueprints

Duration: 20 hours (includes 2 tests)

Course Prerequisite:
Practical Measurements (Block X22)

What Students Learn:
Part 1 (6688A). Kinds of Highway Drawings; Lines on Drawings; Positions of Points and Lines on Maps; Elements of Highway Routes; Topographic Features on Maps; Profiles; Cross Sections for Grading; Earthwork Quantities; Roadside Development; Test Borings.
Part 2 (6688B). General Features of Structural Drawings; Blueprints for Pavements; Blueprints for Bridges; Reinforced Concrete Beams and Slabs; Retaining Walls; Box Culverts; Guard Fences.

6695A-B

Electrical Drafting

Duration: 170 hours (includes 1 test)

Course Prerequisites:
Practical Measurements (Block X22)
Elementary Mechanical Drawing (5434)

What Students Learn:
Part 1 (6695A). Definitions of Electrical Terms; Usual Drafting-Room Procedure; Preparation of Electrical Drawings; Description, Application, and Drawing Outlines; Motors and Generators; Power Transformers; Instrument Transformers; Induction Voltage Regulator; Circuit Breakers; Protective Equipment; Instruments; Relays; Miscellaneous Equipment; Symbols and Designations; Construction Drawings and Wiring Diagrams; Switchboard Wiring Diagrams.
Part 2 (6695B). Useful Formulas and Tables: Conduit and Cable List; Construction of Drawing Plates; Plate 301, One-Line Diagram; Plate 302, Three-Line Diagram; Plate 303, 66-kv Electrical Arrangement; Plate 304, 12-kv Electrical Arrangement; Plate 305, 12-kv Section Details; Plate 306, Grounding, Conduit, and Lighting Plan; Plate 307, Relay Panel; Plate 308, Switchboard Wiring Diagram; Plate 309, Elementary or Schematic Diagram; Plate 310, Lighting and Receptacle Plan.

Special Note:
- Includes 10 plates and requires drafting kit.

6710A-D

Qualitative Analysis

Duration: 40 hours (includes 4 tests)

Course Prerequisites:
Physics, Parts 1-2 (686003-686004)
Inorganic Chemicals and Processes (5008A-F)

What Students Learn:
Part 1 (6710A). Study of Solutions; Henry's Law; Units of Concentration - Mole Fraction, Molality, and Molarity; Colligative Properties of Solutions; Law of Mass Action; Rates of Reaction; Chemical Equilibrium; Solubility Product; Wet and Dry Methods of Analysis; Separation and Filtration of Precipitates; Neutralization of Solution; Laboratory Generation of Reagent Gas; Preparation of Reagents and Solutions for Analytical Work; Detailed Procedure for Testing by Wet Methods and Dry Methods.
Part 2 (6710B). Ionization of Electrolytes; Calculating Equilibrium Constants of Electrolytes; pH Measurements; Hydrolysis of Salts; Buffer Solutions; General Properties and Wet and Dry Reactions for Identification of all Important Metals, Starting Alphabetically with Aluminum and Ending with Zinc.
Part 3 (6710C). Oxidation and Reduction; Oxidation Potentials; Nernst Equation; Analytical Tests for Inorganic and Organic Acids; Qualitative Analysis of Water to Determine its Fitness for Drinking and Cooking Purposes; Instrumental Analyses; Spectrum Analysis, Fluorescence Analysis, Chromatography and X-Ray Analysis.
Part 4 (6710D). Description of Group Method of Analysis; Detailed Discussion of Procedures for Separating and Identifying Metals (Cations) of Groups I, II, III, IV, V, and VI; Procedures for the Systematic Analysis of Acids (Anions); Preparation of Testing Solutions; Special Tests for Anions; Making Reports of Results of Analysis.

Special Note:
- Covers subject at an advanced, in-depth level.

6711

Qualitative Analysis Laboratory Manual

Duration: 24 hours

Course Prerequisite:
Qualitative Analysis (6710A-D)

What Students Learn:
Description of Laboratory Outfit Needed to Perform Required Laboratory Determinations; Setting up the Laboratory; Safety Precautions and Cleanliness; Preparation of Reagent Gas; Flow Sheets Showing Step-by-Step Analytical Procedures; Practice Determinations; Reports of Analysis; Samples of Analysis; Listing of Required Laboratory Analysis.

Special Note:
- Includes 24 laboratory experiments and requires chemicals to be purchased from an outside source.
**6727 Feedwater Treatment and Equipment**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Practical Measurements (Block X22)
Elements of Chemistry (5011)

**What Students Learn:**
Common Impurities Found in Feedwater; Types of Treatment; Boiler Feedwater; Regulating the Flow of Feedwater; Heating; Chemical Feeding; Testing of Feedwater.

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**6794A-C Sewerage**

**Duration:** 30 hours (includes 3 tests)

**What Students Learn:**
Part 1 (6794A). Hydraulics of Sewers; Velocity of Flow in Sewers; Design of Circular Sewers; Vitrified-Clay Pipe; Concrete Pipe; Loads on Sewer Pipcs; Laying Sewer Pipe; Sewers Built in Place; Manholes; Inlets and Catch Basins; Flush Tanks; Overflows and Regulators; House Sewers; Sewer Intersections; Stream Crossings; Outlets.
Part 2 (6794B). Design of Sewerage Systems; Planning of Systems; Surveys and Maps; General Layout of Systems; Design of Sanitary Sewers; Required Capacity; Location of Sewers; Determination of Sizes and Sewers; Design of Systems of Storm Sewers; Rate of Rainfall; Amount of Run-Off; Design of Combined Systems.
Part 3 (6794C). Pumping of Sewerage; Construction Materials and Operations; Construction Line and Grades; Trenching; Foundations; Sewer Records; Estimates of Material and Cost; Agreements Governing Construction.

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**6812A-B Highway Curves**

**Duration:** 20 hours (includes 2 tests)

**Course Prerequisite:**
Transit Surveying (5460A-C)

**What Students Learn:**
Part 1 (6812A). Elements of Highway Routes; Tangents and Horizontal Curves; Grades and Vertical Curves; Radius and Degree of Simple Curves; Procedure for Locating Points on Simple Curves; Measurement of Distances on Curves; Field Layout for Simple Curves; Special Problems Relating to Simple Curves; Problems on Relocation of Route.
Part 2 (6812B). Compound and Reverse Curves; Transition Curves; Superelavation on Curve; Spiral Curve; Deflection Angles for Spiral; Coordinates for Spiral; Minimum Length of Spiral; Field Layout of Spiral; Spiral Joining Two Curves; Vertical Parabolic Curves; Elevations on Vertical Curves.

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**6818A-C City Surveying**

**Duration:** 30 hours (includes 3 tests)

**Course Prerequisites:**
Topographic Surveying (5461A-B)
Determination of True Meridian (5465)

**What Students Learn:**
Part 1 (6818A). Horizontal- and Vertical-Control Surveys; Monuments and Markers; Triangulation Surveys; Base Lines; Field Measurements; Corrections to Measured Lengths; Angular Measurements; Types of Theodolites; Field Notes; Adjustment of Angles and Sides of Triangles; Astronomic and Geodetic Azimuths; Latitudes and Longitudes.
Part 2 (6818B). Control Traverses; Choice of Route for Traverse; Computation of Error of Closure; State Plane-Coordinate Systems; Methods of Projection; Calculation for Single Traverse; Adjustment of Traverse Net; Field Work for Vertical-Control Surveys; Corrections to Difference in Elevation.
Part 3 (6818C). Adjustment of Level Net; Construction and Maintenance Surveys; City Planning; Subdivision of Blocks into Lots; Lot Surveys; Grading Surveys; Measurements for Profiles and Cross Sections; City Maps and Records.

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**68601 Heat, Part 1**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Logarithms (5254)

**What Students Learn:**

**Special Notes:**
- This course requires Logarithm Tables (0975).
- This updated course replaces course 2582A.
- The entire course consists of study units 686001-686002.

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**686002 Heat, Part 2**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisites:**
Introduction to Algebra, Geometry, and Trigonometry (Block X02)
Logarithms (5254)

**What Students Learn:**
Relationship between Pressure, Volume, Temperature, Weight of Gases, and the Gas Constant; Expansion of Gases; Compression of Gases; Closed Cycles; Carnot's Engine.

**Special Notes:**
- This course requires Logarithm Tables (0975).
- This updated course replaces course 2582B.
- The entire course consists of study units 686001-686002.
686003

Physics, Part 1

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Formulas (186012)
Practical Measurements (Block X22)

What Students Learn:
Physical Structure of Matter; Temperature; Units of Measurement;
Uniform Motion; Laws of Motion; Vectors; Forces; Center of Gravity;
Pressure of Fluids; Measurement of Pressure; Buoyancy; Molecular Forces in Liquids; Laws of Gases; Application of Pressure of Gases; Potential Energy and Kinetic Energy; Power; Friction; Machine Elements; Nuclear Energy.

Special Notes:
• This updated course replaces course 5850A.
• The entire course consists of study units 686003-686004.

686004

Physics, Part 2

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Formulas (186012)
Practical Measurements (Block X22)

What Students Learn:
Heat and Temperature; Measurement of Heat; Change of State;
Transmission of Heat; Transmission of Sound; Properties of Sound Waves; Ultrasonics; Properties of Light; Reflection of Light; Refraction of Light; Lenses; Spectra; Polarization of Light; Masers and Lasers;
Magnetism; Static Electricity; Sources of Current Electricity; Generation of Electricity by Electromagnetic Induction; Mutual Induction and Self-Induction; Electromagnetic Motor Action; Generation of Electricity by Chemical Means; Conduction of Electricity; Electrolysis; Electron Emission; Radio Communication; Television.

Special Notes:
• This updated course replaces course 5850B.
• The entire course consists of study units 686003-686004.

686005

Properties of Materials

Duration: 10 hours (includes 1 test)

Course Prerequisites:
Formulas (186012)
Practical Measurements (Block X22)

What Students Learn:
Effects of Forces on Materials; Stress and Deformation; Elastic Failure;
Cohesive Properties of Solids; Heat and Cold Treatment; Modulus of Elasticity; Temperature Stresses; Structural Members; Tension Members;
Shear; Connection of Steel Members; Members Subjected to Compound Stress; Beams; Columns; Shafts; Rope Drives; Properties of Metals, Nonferrous Metal, and Alloys.

Special Note:
• This updated course replaces course 5887.
Vehicle Maintenance Technologies

Automotive Mechanics
Caterpillar Equipment Mechanics
Cummins Diesel Engine Mechanics
Detroit Diesel Engine Mechanics
Diesel Engine: Basic Mechanical Skills
Gasoline Engine Mechanics
Heavy Duty Equipment Component Mechanics
Hydraulic Systems
Mack Diesel Engine Mechanics
Power Shift Transmission Systems
Small Engine Repair
Vehicle Maintenance Technologies

**Subject Index**

### Resource 10

**Page**

**Automotive Mechanics**

Advanced Automotive Computer Systems (004022) ................................ 350
Antilock Braking Systems (004031) .................................................. 351
Automotive Braking Systems (004030) ........................................... 350
Automotive Cooling Systems (004006) ........................................... 348
Automotive Drive Trains: Automatic and Manual (ADT02) ............. 357
Automotive Electrical Systems (004020) ......................................... 349
Automotive Engine Components (004003) .................................... 348
Automotive Engine Overhaul (004004) .......................................... 348
Automotive Engine Performance/Troubleshooting (004023) ............ 350
Automotive Engines: Theory and Servicing (AE01) ...................... 358
Automotive Fuel Systems, Part 1 (004009) ...................................... 349
Automotive Fuel Systems, Part 2 (004010) ...................................... 349
Automotive Heating and Air Conditioning Systems, Part 1 (004028) ... 350
Automotive Heating and Air Conditioning Systems, Part 2 (004029) ... 350
Automotive Lubrication Systems (004005) ...................................... 348
Automotive Steering Systems and Wheel Alignment (004014) .......... 349
Automotive Suspension Systems (004013) ...................................... 349
Computerized Engine Controls (Automotive) (004021) .................... 350
Ignition System Components and Operation (Automotive) (004007) ... 348
Ignition System Maintenance (Automotive) (004008) ....................... 349
Introduction to Automotive Repair (004002) .................................. 348

**Diesel Engine: Basic Mechanical Skills**

Arithmetic for Mechanics (Diesel) (0A15) ........................................ 358
Cooling, Air Intake, and Exhaust Systems (Diesel) (0A09) ................. 363
Diesel Engine Operations, Part 1 (0A11) ........................................ 363
Diesel Engine Operations, Part 2 (0A12) ........................................ 363
Diesel Engine Parts, Part 1 (0A04) .............................................. 363
Diesel Engine Parts, Part 2 (0A05) .............................................. 363
Drawing and Sketching for the Mechanic (Diesel) (0A16) ............... 358
Electrical Systems (Basic Diesel Mechanics) (0A10) ....................... 363
Engine and Allied Equipment Service Manuals (Diesel) (0A18) ......... 358
Failure Analysis (Diesel) (0A20) .................................................. 359
Fuel Systems, Part 1 (Diesel) (0A06) ........................................... 363
Fuel Systems, Part 2 (Diesel) (0A07) ........................................... 363
In-Frame Overhaul, Part 1 (Diesel) (0A24) ................................... 359
In-Frame Overhaul, Part 2 (Diesel) (0A25) ................................... 359
Introduction to Truck Diesel Mechanics (055002) ......................... 353
Lubricating Systems (Diesel) (0A08) ........................................... 363
Maintenance of Air Intake, Exhaust, and Cooling Systems (Diesel) (0A22) ................................................................. 359
Maintenance of Electrical Systems (Diesel) (0A23) ......................... 363
Maintenance of Lubricating and Fuel Systems (Diesel) (0A21) ......... 363
Medium/Heavy Duty Truck Engines, Fuel, and Computerized Management Systems (086E12) ............................................ 355
Reading Micrometers, Dial Gauges, and Other Measuring Instruments (Diesel) (0A17) ................................................................. 363

**Shop and Hand Tools (Diesel) (0A14) ........................................ 363**
**Troubleshooting Diesel Engines (0A19) ..................................... 359**
**Welding (Diesel) (0A13) .......................................................... 358**
**Work Habits and Practices, Part 1 (Diesel) (0A02) ....................... 351**
**Work Habits and Practices, Part 2 (Diesel) (0A03) ....................... 363**

**Gasoline Engine Mechanics**

Arithmetic for Mechanics (Gasoline) (0B12) .................................................. 360
Cooling, Air Intake, and Exhaust Systems (Gasoline) (0B11) ............... 360
Electrical Systems (Gasoline) (0B08) ............................................ 352
Engine Maintenance: Electrical Systems (Gasoline) (0B22) .............. 361
Engine Maintenance: Fuel System Maintenance and Overhaul (Gasoline) (0B20) ................................................................. 361
Engine Maintenance: Ignition System Components Maintenance and Overhaul (Gasoline) (0B21) ........................................... 361
Engine Maintenance: Lubricating, Air Intake, Exhaust, and Cooling Systems (Gasoline) (0B19) ................................................................. 361
Engine Overhaul, Part 1 (Gasoline) (0B23) .................................... 361
Engine Overhaul, Part 2 (Gasoline) (0B24) .................................... 362
Engine Overhaul, Part 3 (Gasoline) (0B25) .................................... 362
Failure Analysis (Gasoline) (0B18) ............................................... 361
Fuel Systems, Part 1 (Gasoline) (0B05) ........................................ 351
Fuel Systems, Part 2 (Gasoline) (0B06) ........................................ 352
Fuel Systems, Part 3 (Gasoline) (0B07) ........................................ 352
Gasoline Engine Mechanics: Introduction (0B01) ......................... 351
Gasoline Engine Parts, Part 1 (0B03) ........................................... 351
Gasoline Engine Parts, Part 2 (0B04) ........................................... 351
Ignition Systems (Gasoline) (0B09) .............................................. 352
Lubricating Systems (Gasoline Engine Mechanics) (0B10) ............. 359
Reading Micrometers, Dial Gauges, and Other Measuring Instruments (Gasoline) (0B13) ................................................................. 360
Shop and Hand Tools, Part 1 (Gasoline) (0B14) ......................... 360
Shop and Hand Tools, Part 2 (Gasoline) (0B15) ......................... 360
Tune-Up of Gasoline Engines (Diagnosics), Part 1 (0B16) ............... 360
Tune-Up of Gasoline Engines (Diagnosics), Part 2 (0B17) ............... 360
Work Habits and Practices (Gasoline) (0B02) ................................ 351

**Caterpillar Equipment Mechanics**

Caterpillar D7, D8, and D9 Tractors, Part 1 (00P5) ......................... 365
Caterpillar D7, D8, and D9 Tractors, Part 2 (00P6) ......................... 365
Caterpillar D7, D8, and D9 Tractors, Part 3 (00P7) ......................... 365
Caterpillar D7, D8, and D9 Tractors, Part 4 (00P8) ......................... 365
Engine Disassembly (Caterpillar) (00E2) ........................................ 364
Introduction to Caterpillar Diesel Engines (00E1) ......................... 364

**Cummins Diesel Engine Mechanics**

Accessory Equipment and Adaptations (Cummins) (0H12) ............... 364
Applications and Installation of Cummins Engines (0H15) ............. 364
Cummins PT Fuel System (0H09) .................................................. 364
Cylinder Block Group, Part 1 (Cummins) (0H06) ......................... 364
Cylinder Block Group, Part 2 (Cummins) (0H07) ......................... 364
Cylinder Heads, Cam Followers, Tappets, and Rocker Levers (Cummins) (0H18) ................................................................. 364
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive Units, Intake and Exhaust Systems (Cummins) (0H11)</td>
<td>364</td>
</tr>
<tr>
<td>Engine Assembly (Cummins) (0H13)</td>
<td>364</td>
</tr>
<tr>
<td>Engine Disassembly (Cummins) (00H5)</td>
<td>364</td>
</tr>
<tr>
<td>Engine Testing and Run-In (Cummins) (0H14)</td>
<td>364</td>
</tr>
<tr>
<td>Introduction to Cummins Diesel Engines (00H1)</td>
<td>364</td>
</tr>
<tr>
<td>Introduction to Engine Rebuilding (Cummins) (00H2)</td>
<td>364</td>
</tr>
<tr>
<td>Lubricating and Cooling Systems (Cummins) (0H10)</td>
<td>364</td>
</tr>
<tr>
<td>Rebuild Shop Practices, Part 1 (Cummins) (00H3)</td>
<td>364</td>
</tr>
<tr>
<td>Rebuild Shop Practices, Part 2 (Cummins) (00H4)</td>
<td>364</td>
</tr>
<tr>
<td><strong>Detroit Diesel Engine Mechanics</strong></td>
<td></td>
</tr>
<tr>
<td>92 Series Engines (Detroit Diesel) (0D17)</td>
<td>364</td>
</tr>
<tr>
<td>Accessory Equipment (Detroit Diesel) (0D12)</td>
<td>364</td>
</tr>
<tr>
<td>Cooling and Lubricating Systems (Detroit Diesel) (0D11)</td>
<td>364</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 1 (Detroit Diesel) (00D3)</td>
<td>363</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 2 (Detroit Diesel) (00D4)</td>
<td>364</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 3 (Detroit Diesel) (00D5)</td>
<td>364</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 4 (Detroit Diesel) (00D6)</td>
<td>364</td>
</tr>
<tr>
<td>Cylinder Heads, Components, and Valve Operating Mechanisms (Detroit Diesel) (00D7)</td>
<td>364</td>
</tr>
<tr>
<td>Detroit Diesel Engine Mechanics: Introduction (00D1)</td>
<td>363</td>
</tr>
<tr>
<td>Detroit Diesel V8 and V8-71T Engines (0D16)</td>
<td>364</td>
</tr>
<tr>
<td>Engine Assembly, Part 1 (Detroit Diesel) (0D13)</td>
<td>364</td>
</tr>
<tr>
<td>Engine Assembly, Part 2 (Detroit Diesel) (0D14)</td>
<td>364</td>
</tr>
<tr>
<td>Engine Disassembly (Detroit Diesel) (00D2)</td>
<td>363</td>
</tr>
<tr>
<td>Engine Tune-Up and Run-In (Detroit Diesel) (0D15)</td>
<td>364</td>
</tr>
<tr>
<td>Fuel Systems (Detroit Diesel) (00D8)</td>
<td>364</td>
</tr>
<tr>
<td>Governors (Detroit Diesel) (00D9)</td>
<td>364</td>
</tr>
<tr>
<td>Intake Systems, Exhaust Systems (Detroit Diesel) (0D10)</td>
<td>364</td>
</tr>
<tr>
<td><strong>Heavy Duty Equipment Component Mechanics</strong></td>
<td></td>
</tr>
<tr>
<td>Air Brake Systems, Part 1 (0KK2)</td>
<td>365</td>
</tr>
<tr>
<td>Air Brake Systems, Part 2 (0KK3)</td>
<td>365</td>
</tr>
<tr>
<td>Clutches and Driveshaft Assemblies (0KK5)</td>
<td>365</td>
</tr>
<tr>
<td>Fifth Wheels, Wheels, and Tires (0K14)</td>
<td>365</td>
</tr>
<tr>
<td>Front Axles, Steering, and Suspensions (0K13)</td>
<td>365</td>
</tr>
<tr>
<td>Fundamentals of Braking Systems (0KK1)</td>
<td>365</td>
</tr>
<tr>
<td>Heavy Duty Truck Systems - HVAC Systems (086E11)</td>
<td>355</td>
</tr>
<tr>
<td>Maintenance and Repair of Drive Axles (0K12)</td>
<td>365</td>
</tr>
<tr>
<td>Rebuilding Automatic Transmissions (0KK8)</td>
<td>365</td>
</tr>
<tr>
<td>Rebuilding Manual Transmissions (0KK7)</td>
<td>365</td>
</tr>
<tr>
<td>Rebuilding Transmissions and Controls (0KK6)</td>
<td>365</td>
</tr>
<tr>
<td>Refrigeration Systems (00K5)</td>
<td>352</td>
</tr>
<tr>
<td>Retarders and Oil Seals (0KK4)</td>
<td>362</td>
</tr>
<tr>
<td>Today's Technician: Medium/Heavy Duty Truck</td>
<td></td>
</tr>
<tr>
<td>Brake Systems (086E09)</td>
<td>354</td>
</tr>
<tr>
<td>Today's Technician: Medium/Heavy Duty Truck Electrical and Electronics Systems (086E07)</td>
<td>353</td>
</tr>
<tr>
<td>Today's Technician: Medium/Heavy Duty Truck Steering and Suspension Systems (086E08)</td>
<td>354</td>
</tr>
<tr>
<td><strong>Hydraulic Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Hydraulic Fundamentals (Diesel and Automotive) (00J1)</td>
<td>352</td>
</tr>
<tr>
<td>Hydraulic System Components (Diesel and Automotive) (00J2)</td>
<td>352</td>
</tr>
<tr>
<td>Hydraulic System Maintenance (Diesel and Automotive) (00J3)</td>
<td>352</td>
</tr>
<tr>
<td><strong>Mack Diesel Engine Mechanics</strong></td>
<td></td>
</tr>
<tr>
<td>Accessory Equipment (Mack) (0C11)</td>
<td>363</td>
</tr>
<tr>
<td>Air Intake and Exhaust Systems (Mack) (00C9)</td>
<td>363</td>
</tr>
<tr>
<td>Cooling and Lubricating Systems (Mack) (0C10)</td>
<td>363</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 1 (Mack) (00C3)</td>
<td>363</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 2 (Mack) (00C4)</td>
<td>363</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 3 (Mack) (00C5)</td>
<td>363</td>
</tr>
<tr>
<td>Cylinder Head Assemblies and Valve Operating Mechanisms (Mack) (00C6)</td>
<td>363</td>
</tr>
<tr>
<td>Engine Assembly, Part 1 (Mack) (0C12)</td>
<td>363</td>
</tr>
<tr>
<td>Engine Assembly, Part 2 (Mack) (0C13)</td>
<td>363</td>
</tr>
<tr>
<td>Engine Disassembly (Mack) (00C2)</td>
<td>363</td>
</tr>
<tr>
<td>Engine Testing and Run-In (Mack) (0C14)</td>
<td>363</td>
</tr>
<tr>
<td>Fuel Systems, Part 1 (Mack) (00C7)</td>
<td>363</td>
</tr>
<tr>
<td>Fuel Systems, Part 2 (Mack) (00C8)</td>
<td>363</td>
</tr>
<tr>
<td>Mack Diesel Engine Mechanics: Introduction (00C1)</td>
<td>363</td>
</tr>
<tr>
<td>Mack V8 Diesel Engines (0C15)</td>
<td>363</td>
</tr>
<tr>
<td>Roosa Master Fuel Injection System (Mack) (00M6)</td>
<td>365</td>
</tr>
<tr>
<td><strong>Power Shift Transmission Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Power Shift Transmission Systems: Description and Operating Principles (00L1)</td>
<td>353</td>
</tr>
<tr>
<td>Power Shift Transmission Systems: Operating Principles and Troubleshooting (00L2)</td>
<td>353</td>
</tr>
<tr>
<td><strong>Small Engine Repair</strong></td>
<td></td>
</tr>
<tr>
<td>Servicing Outdoor Power Equipment, Part 1 (089029)</td>
<td>357</td>
</tr>
<tr>
<td>Servicing Outdoor Power Equipment, Part 2 (089030)</td>
<td>357</td>
</tr>
<tr>
<td>Small Engine Disassembly (089022)</td>
<td>357</td>
</tr>
<tr>
<td>Small Engine Electrical Systems (089020)</td>
<td>356</td>
</tr>
<tr>
<td>Small Engine Fuel Systems (089021)</td>
<td>356</td>
</tr>
<tr>
<td>Small Engine Ignition Systems (089019)</td>
<td>356</td>
</tr>
<tr>
<td>Small Engine Lubrication and Cooling Systems (089018)</td>
<td>356</td>
</tr>
<tr>
<td>Small Engine Parts and Operation (089017)</td>
<td>356</td>
</tr>
<tr>
<td>Small Engine Reassembly (089025)</td>
<td>357</td>
</tr>
<tr>
<td>Small Engine Rebuild, Part 1 (089023)</td>
<td>357</td>
</tr>
<tr>
<td>Small Engine Rebuild, Part 2 (089024)</td>
<td>357</td>
</tr>
</tbody>
</table>
Recommended Career/Apprentice Curricula

- Automotive Mechanic
- Heavy Duty Equipment (Truck) Mechanic Apprentice/Diesel Engine Mechanic
- Light Duty Equipment (Automotive) Mechanic Apprentice/Gasoline Engine Mechanic
Automotive Mechanic

The Automotive Mechanic program provides trainees with the courseware that enable them to perform the tasks associated with this trade. This print-based curriculum has been developed to meet the subject requirements of an organization’s skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

The Automotive Mechanic curriculum provides comprehensive training in all phases of automobile servicing, both mechanical and electrical. Since the program is developed for the entry level service mechanic, the courses build from a general review of the automobile to more advanced training on electrical systems, automatic transmissions, steering and suspension systems, and computerized engine control systems. The program is also appropriate for the experienced mechanic who needs refresher training.

Upon completion of this program, students will be able to:

- Identify the parts of a gasoline engine.
- Explain how a gasoline engine works.
- Demonstrate safe work practices when using basic tools for servicing gasoline engines.
- Describe the operation, servicing, and maintenance procedures for the air intake and fuel systems.
- Discuss engine cooling, lubrication, and exhaust systems.
- Explain the operation, servicing, and maintenance procedures for an automobile battery, starting system, charging system, and lighting system.
- Discuss how a conventional and electronic ignition system works and how to service these systems.
- Follow the recommended procedures for performing an engine tune-up.
- Differentiate between the functions of the various emission control systems.
- Outline the procedures for the operation, maintenance and repair of clutches, propeller shafts and universal joints.
- List the maintenance, troubleshooting, and repair procedures for automatic transmissions.
- Describe the troubleshooting, servicing, and maintenance procedures for rear axle assemblies, differentials, steering, suspensions, wheels, tires, and front end alignment.
- Explain the operation, servicing, and overhaul of disc and drum brakes.
- List engine disassembly, inspection, and assembly procedures.

**Base Curriculum**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic Automotive Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Introduction to Automotive Repair</td>
<td>004002</td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
</tr>
<tr>
<td>Introduction to Algebra</td>
<td>186013</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>186001</td>
</tr>
<tr>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
</tr>
<tr>
<td>Electrical Safety for the Trades</td>
<td>186005</td>
</tr>
<tr>
<td>Material Handling Safety</td>
<td>186006</td>
</tr>
<tr>
<td><strong>Automotive Electrical Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Ignition System Components and Operation (Automotive)</td>
<td>004007</td>
</tr>
<tr>
<td>Ignition System Maintenance (Automotive)</td>
<td>004008</td>
</tr>
<tr>
<td>Automotive Electrical Systems</td>
<td>004009</td>
</tr>
<tr>
<td><strong>Automotive Engine Performance and Overhaul</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Automotive Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Automotive Engine Parts and Operation</td>
<td>004003</td>
</tr>
<tr>
<td>Automotive Engine Types</td>
<td>004004</td>
</tr>
<tr>
<td>Automotive Lubrication Systems</td>
<td>004005</td>
</tr>
<tr>
<td>Automotive Cooling Systems</td>
<td>004006</td>
</tr>
<tr>
<td>Automotive Fuel Systems, Part 1</td>
<td>004009</td>
</tr>
<tr>
<td>Automotive Fuel Systems, Part 2</td>
<td>004010</td>
</tr>
<tr>
<td><strong>Automotive Steering Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Automotive Steering Systems and Wheel Alignment</td>
<td>004014</td>
</tr>
<tr>
<td><strong>Automotive Braking Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Automotive Braking Systems</td>
<td>004030</td>
</tr>
<tr>
<td>Anti-lock Braking Systems</td>
<td>004031</td>
</tr>
<tr>
<td>Automotive Suspension Systems</td>
<td>004013</td>
</tr>
<tr>
<td>Automotive Steering Systems and Wheel Alignment</td>
<td>004014</td>
</tr>
<tr>
<td><strong>Automotive Engine Operations</strong></td>
<td></td>
</tr>
<tr>
<td>Automotive Engines: Theory and Servicing</td>
<td>AE01</td>
</tr>
<tr>
<td>Automotive Drive Trains: Automatic and Manual</td>
<td>ADT02</td>
</tr>
<tr>
<td><strong>Automotive Computer Control and Additional Systems</strong></td>
<td></td>
</tr>
<tr>
<td>Computerized Engine Controls (Automotive)</td>
<td>004021</td>
</tr>
<tr>
<td>Advanced Automotive Computer Systems</td>
<td>004022</td>
</tr>
<tr>
<td>Automotive Engine Performance/Troubleshooting</td>
<td>004023</td>
</tr>
<tr>
<td>Automotive Heating and Air Conditioning Systems, Part 1</td>
<td>004028</td>
</tr>
<tr>
<td>Automotive Heating and Air Conditioning Systems, Part 1</td>
<td>004029</td>
</tr>
</tbody>
</table>

Estimated Curriculum Duration: 295 hours.
Number of Exams: 40.
The **Heavy Duty Equipment (Truck) Mechanic Apprentice** program provides trainees with the coursework that enable them to perform the tasks associated with the trade of Diesel Engine and Equipment Mechanic. This print-based curriculum has been developed to meet the subject requirements of either an apprenticeship or an organization’s skills’ program. When combined with on-the-job-training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

The **Heavy Duty Equipment (Truck) Mechanic Apprentice** curriculum provides comprehensive training in the service and repair of diesel and gasoline engines used in on-highway trucks and tractors, and off-highway heavy equipment. Courses covering the troubleshooting, servicing, maintaining, and rebuilding of both two- and four-cycle engines manufactured by Cummins, Detroit Diesel, and Mack are included. This program covers the maintenance and repair of driveline components in trucks, tractors, scrapers, graders, and other heavy equipment. These components include clutches, transmissions, axle assemblies, wheels, tires, air brake systems, retarders, and fifth wheels.

Upon completion of this program, students will be able to:

- Explain how a diesel engine operates.
- Demonstrate safe working practices when servicing diesel engines.
- Discuss diesel engine air intake, exhaust, cooling, and lubricating systems.
- Describe operating principles, functions, and maintenance of the various fuel-injection systems.
- Discuss troubleshooting and failure analysis techniques and how to handle maintenance procedures.
- Explain the procedures for performing in-frame engine overhaul.
- Describe the operation, servicing, and maintenance procedures for a diesel engine fuel system.
- Discuss how an ignition system works and how to service this system along with other engine electrical systems.
- Follow the recommended procedures for performing a diesel engine tune-up.
- Explain the operation, servicing, and overhaul of air brake systems.
- Outline the procedures for the operation, maintenance, and repair of clutches, propeller shafts, and universal joints.
- List the maintenance, troubleshooting, and repair procedures for both manual shift and automatic transmissions.
- Describe the troubleshooting, servicing, and maintenance procedures for axle assemblies, steering, suspensions, wheels, tires, and fifth wheels.
- Explain the procedures recommended by Detroit Diesel for rebuilding engines.
- Explain the procedures recommended by Cummins Engine Company for rebuilding engines.
- Discuss hydraulic fundamentals, system components and maintenance.
- Explain the operation, servicing, and repair of Caterpillar D7, D8, and D9 tractors.

### Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diesel Engine Technologies – Basic Applications and Skills</strong></td>
<td></td>
</tr>
<tr>
<td>Introduction to Truck Diesel Mechanics ..................................055002</td>
<td></td>
</tr>
<tr>
<td>Shop and Hand Tools (Diesel) ..................................................0A14</td>
<td></td>
</tr>
<tr>
<td>Arithmetic for Mechanics (Diesel) ..........................................0A15</td>
<td></td>
</tr>
<tr>
<td>Metric System ............................................................................186011</td>
<td></td>
</tr>
<tr>
<td>Drawing and Sketching for the Mechanic (Diesel) .......................0A16</td>
<td></td>
</tr>
<tr>
<td>Computerized Management Systems ..................................086E12</td>
<td></td>
</tr>
<tr>
<td>Troubleshooting Diesel Engines ............................................0A19</td>
<td></td>
</tr>
<tr>
<td>Failure Analysis (Diesel) ..........................................................0A20</td>
<td></td>
</tr>
<tr>
<td>Maintenance of Lubricating and Fuel Systems (Diesel) ..............0A21</td>
<td></td>
</tr>
<tr>
<td>Maintenance of Air Intake, Exhaust, and Cooling Systems (Diesel) ....0A22</td>
<td></td>
</tr>
<tr>
<td>Maintenance of Electrical Systems (Diesel) ............................0A23</td>
<td></td>
</tr>
<tr>
<td>In-Frame Overhaul, Part 1 (Diesel) ........................................0A24</td>
<td></td>
</tr>
<tr>
<td>In-Frame Overhaul, Part 2 (Diesel) ........................................0A25</td>
<td></td>
</tr>
<tr>
<td><strong>Cummins Diesel Engine Mechanic Specialist</strong></td>
<td></td>
</tr>
<tr>
<td>Introduction to Cummins Diesel Engines .................................00H1</td>
<td></td>
</tr>
<tr>
<td>Introduction to Engine Rebuilding (Cummins) ............................00H2</td>
<td></td>
</tr>
<tr>
<td>Rebuild Shop Practices, Part 1 (Cummins) .................................00H3</td>
<td></td>
</tr>
<tr>
<td>Rebuild Shop Practices, Part 2 (Cummins) ................................00H4</td>
<td></td>
</tr>
<tr>
<td>Engine Disassembly (Cummins) ..................................................00H5</td>
<td></td>
</tr>
<tr>
<td>Cylinder Block Group, Part 1 (Cummins) ..................................00H6</td>
<td></td>
</tr>
<tr>
<td>Cylinder Block Group, Part 2 (Cummins) ..................................00H7</td>
<td></td>
</tr>
<tr>
<td>Cylinder Heads, Cam Followers, Tappets, and Rocker Levers (Cummins) ..................................................00H8</td>
<td></td>
</tr>
<tr>
<td>Cummins PT Fuel System ..........................................................00H9</td>
<td></td>
</tr>
<tr>
<td>Lubricating and Cooling Systems (Cummins) .............................0H10</td>
<td></td>
</tr>
<tr>
<td>Drive Units, Intake and Exhaust Systems (Cummins) ..................0H11</td>
<td></td>
</tr>
<tr>
<td>Accessory Equipment and Adaptations (Cummins) .......................0H12</td>
<td></td>
</tr>
<tr>
<td>Engine Assembly (Cummins) ......................................................0H13</td>
<td></td>
</tr>
<tr>
<td>Engine Testing and Run-In (Cummins) ......................................0H14</td>
<td></td>
</tr>
<tr>
<td>Applications and Installation of Cummins Engines ....................0H15</td>
<td></td>
</tr>
<tr>
<td><strong>Detroit Diesel Engine Mechanic Specialist</strong></td>
<td></td>
</tr>
<tr>
<td>Detroit Diesel Engine Mechanics: Introduction .........................00D1</td>
<td></td>
</tr>
<tr>
<td>Engine Disassembly (Detroit Diesel) ..........................................00D2</td>
<td></td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 1 (Detroit Diesel) .............00D3</td>
<td></td>
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<tr>
<td>Cylinder Block and Components, Part 2 (Detroit Diesel) .............00D4</td>
<td></td>
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<tr>
<td>Cylinder Block and Components, Part 3 (Detroit Diesel) ..........00D5</td>
<td></td>
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<tr>
<td>Cylinder Block and Components, Part 4 (Detroit Diesel) ............00D6</td>
<td></td>
</tr>
<tr>
<td>Cylinder Heads, Components, and Valve Operating Mechanisms (Detroit Diesel) ..................................................00D7</td>
<td></td>
</tr>
<tr>
<td>Fuel Systems (Detroit Diesel) ....................................................0D02</td>
<td></td>
</tr>
<tr>
<td>Governors (Detroit Diesel) .........................................................0D03</td>
<td></td>
</tr>
<tr>
<td>Intake Systems, Exhaust Systems (Detroit Diesel) .................0D10</td>
<td></td>
</tr>
<tr>
<td>Cooling and Lubricating Systems (Detroit Diesel) ....................0D11</td>
<td></td>
</tr>
<tr>
<td>Accessory Equipment (Detroit Diesel) ........................................0D12</td>
<td></td>
</tr>
<tr>
<td>Engine Assembly, Part 1 (Detroit Diesel) .................................0D13</td>
<td></td>
</tr>
<tr>
<td>Engine Assembly, Part 2 (Detroit Diesel) ................................0D14</td>
<td></td>
</tr>
<tr>
<td>Engine Tune-Up and Run-In (Detroit Diesel) ............................0D15</td>
<td></td>
</tr>
<tr>
<td>Detroit Diesel V8 and V8-71T Engines ....................................0D16</td>
<td></td>
</tr>
<tr>
<td>92 Series Engines (Detroit Diesel) ...........................................0D17</td>
<td></td>
</tr>
</tbody>
</table>
The Light Duty Equipment (Automotive) Mechanic Apprentice program provides trainees with the courseware that enable them to perform the tasks associated with the trade of Gasoline Engine and Equipment Mechanic. This print-based curriculum has been developed to meet the subject requirements of either an apprenticeship or an organization’s skills program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in this trade area.

The Light Duty Equipment (Automotive) Mechanic Apprentice curriculum provides comprehensive training in the service and repair of gasoline engines used in light-duty trucks and automobiles. The program covers the maintenance and repair of components such as fuel systems, electrical systems, ignition systems, cooling systems, and engine tune-up.

Upon completion of this program, students will be able to:

- Explain how a gasoline engine operates.
- Demonstrate safe work practices when servicing gasoline engines.
- Discuss gasoline engine air intake, exhaust, cooling, and lubricating systems.
- Describe operating principles, functions, and maintenance of various fuel injection systems.
- Discuss troubleshooting and failure analysis techniques and how to handle maintenance procedures.
- Explain the procedures for performing in-frame engine overhaul.
- Describe the operation, servicing, and maintenance procedures for a gasoline engine fuel system.
- Discuss how an ignition system works and how to service this system along with other engine electrical systems.
- Follow the recommended procedures for performing a gasoline engine tune-up.

Base Curriculum

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline Engine Technologies – Basic Applications and Skills</td>
<td></td>
</tr>
<tr>
<td>Introduction to Automotive Repair</td>
<td>004002</td>
</tr>
<tr>
<td>Arithmetic for Mechanics (Gasoline)</td>
<td>0B12</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
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<tr>
<td>Reading Micrometers, Dial Gauges, and Other Measuring Instruments (Gasoline)</td>
<td>0B13</td>
</tr>
<tr>
<td>Shop and Hand Tools, Part 1 (Gasoline)</td>
<td>0B14</td>
</tr>
<tr>
<td>Shop and Hand Tools, Part 2 (Gasoline)</td>
<td>0B15</td>
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<tr>
<td><strong>Caterpillar Tractor Diesel Engine Mechanic Specialist</strong></td>
<td></td>
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<tr>
<td>Introduction to Caterpillar Diesel Engines</td>
<td>00E1</td>
</tr>
<tr>
<td>Engine Disassembly (Caterpillar)</td>
<td>00E2</td>
</tr>
<tr>
<td>Caterpillar D7, D8, and D9 Tractors, Part 1</td>
<td>00P5</td>
</tr>
<tr>
<td>Caterpillar D7, D8, and D9 Tractors, Part 2</td>
<td>00P6</td>
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<tr>
<td>Caterpillar D7, D8, and D9 Tractors, Part 3</td>
<td>00P7</td>
</tr>
<tr>
<td>Caterpillar D7, D8, and D9 Tractors, Part 4</td>
<td>00P8</td>
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</tbody>
</table>

Estimated Curriculum Duration: 1,445 hours.
Number of Exams: 109.
Gasoline Engine Operations and Maintenance Skills

Automotive Engine Parts and Operation .........................................................004003
Automotive Engine Types .................................................................................004004
Automotive Lubrication Systems ...........................................................................004005
Automotive Cooling Systems ....................................................................................004006
Automotive Fuel Systems, Part 1 ..............................................................................004009
Automotive Fuel Systems, Part 2 ..............................................................................004010
Ignition System Components and Operation (Automotive) ......................................004007
Ignition System Maintenance (Automotive) ..............................................................004008
Automotive Electrical Systems ..................................................................................004020
Automotive Braking Systems ......................................................................................004030
Antilock Braking Systems ..........................................................................................004031
Automotive Suspension Systems ..................................................................................004013
Automotive Steering Systems and Wheel Alignment ..................................................004014
Automotive Engines: Theory and Servicing ..............................................................AE01
Automotive Drive Trains: Automatic and Manual ......................................................ADT02
Computerized Engine Controls (Automotive) ...........................................................004021
Advanced Automotive Computer Systems ...............................................................004022
Automotive Engine Performance/Troubleshooting ....................................................004023
Automotive Heating and Air Conditioning Systems, Part 1 ........................................004028
Automotive Heating and Air Conditioning Systems, Part 1 ........................................004029

Estimated Curriculum Duration: 280 hours.
Number of Exams: 33.
004002

Introduction to Automotive Repair

Duration: 10 hours (includes 1 test)

What Students Learn:
Introduction to Automotive Technology; Engine Types; Fuel Systems; Ignition Systems; Safety with respect to Vehicle Maintenance; Understanding of Common Terms; Tools of the Trade.

Special Note:
• This updated course replaces course 3701.

004003

Automotive Engine Components

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Introduction to Automotive Systems (004002)

What Students Learn:
Understanding the Basic Components and their function within an Automotive Engine; Identify and understand individual Internal and External Components; Locate and identify Supporting Systems; Compare and evaluate Two-stroke and Four-stroke Engines.

Special Note:
• This updated course replaces course 3704.

004004

Automotive Engine Overhaul

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Automotive Engine Components (004003)

What Students Learn:
Identification and repair of Engine Types; Recognize major Engine Component groups and their function; Understand and utilize the basic concepts of Torque, Horsepower, Displacement and Compression to evaluate Engine Performance.

Special Note:
• This updated course replaces course 3705.

004005

Automotive Lubrication Systems

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Automotive Engine Overhaul (004004)

What Students Learn:
Understand the principles behind Automotive Lubricants; Recognize damage and wear caused by inadequate or improper Lubrication; Evaluate and diagnose Lubrication Systems and related problems; Locate and repair leaks and damage in Lubricating Systems.

Special Note:
• This updated course replaces course 3706.

004006

Automotive Cooling Systems

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Automotive Engine Components (004003)

What Students Learn:
Understand the function of Automotive Coolant in a Cooling System; Locate and identify Coolant System Components and their function; Understand the role Pressure plays in the Cooling System; Diagnose Cooling System problems.

Special Note:
• This updated course replaces course 3706.

004007

Ignition System Components and Operation (Automotive)

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Automotive Engine Components (004003)

What Students Learn:
Understand the basic concepts of Electricity; How Fuel is Ignited; Identification of Ignition Components; Function of an Ignition System; Understand how Ignition Control systems and direct Fire Ignition systems work.

Special Note:
• This updated course replaces course 3711.
004008

Ignition System Maintenance (Automotive)

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Ignition System Components and Operation (Automotive) (004007)

What Students Learn:
Evaluation procedures and diagnosis of Ignition Systems; Use of modern Test Equipment for troubleshooting Ignition systems; Differentiate between Standard and Electronic Ignition components and operation.

Special Note:
• This updated course replaces course 3711.

004009

Automotive Fuel Systems, Part 1

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Automotive Engine Overhaul (004004)

What Students Learn:
Classify Automotive Fuels and understand their function; Locate and evaluate Fuel System Components; Understand Fuel System delivery and metering components; Differentiate between design and operation of Carburetor and Fuel-injected Systems; Diagnose and evaluate Fuel System problems.

Special Note:
• This updated course replaces course 3707.

004010

Automotive Fuel Systems, Part 2

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Automotive Fuel Systems, Part 1 (004009)

What Students Learn:
Identify and describe Components of Carburetor and Fuel Injection systems; Disassemble, clean and reassemble Fuel System Components; Evaluate the condition of System Components; Diagnose Fuel System problems; Check Fuel System pressure; Locate and identify Exhaust System components and explain their function.

Special Note:
• This updated course replaces course 3707.

004013

Automotive Suspension Systems

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Automotive Engine Components (004003)

What Students Learn:
Locate and identify major components of an Automotive Suspension System; Understand the function of Suspension Components; Identify different types of Suspension Systems; Evaluate Suspension Components for wear and describe repair procedures.

Special Note:
• This updated course replaces course 3703.

004014

Automotive Steering Systems and Wheel Alignment

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Automotive Suspension Systems (004013)

What Students Learn:
Locate and identify Components of a Steering System; Understand the function of Steering System components; Understand the fundamentals of Steering Geometry and its impact on the Steering System; Explain common Wheel Alignment procedures; Diagnose Steering System problems; Explain Steering System repair procedures.

Special Note:
• This updated course replaces course 3703.

004020

Automotive Electrical Systems

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Automotive Engine Components (004003)

What Students Learn:
Understand the basic principles of Electricity and its function in an Automobile; Locate and identify the major components of an Automotive Electrical system; Diagnose problems and explain proper repair procedures.

Special Note:
• This updated course replaces course 3710.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Duration</th>
<th>Course Prerequisite</th>
<th>What Students Learn</th>
<th>Special Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>004021</td>
<td><strong>Computerized Engine Controls</strong> (Automotive)</td>
<td>10 hours</td>
<td>-</td>
<td>Understand the function of a Computer in various Automotive Systems; Locate and identify Automotive Computers and the specific components supporting the Computer Control system; Diagnose problems relating to Computers and Computer Controlled systems; Understand specific Diagnostic Procedures related to Computer systems; Explain the general procedure for using Diagnostic Equipment.</td>
<td>This updated course replaces course 3713.</td>
</tr>
<tr>
<td>004022</td>
<td><strong>Advanced Automotive Computer Systems</strong></td>
<td>10 hours</td>
<td>-</td>
<td>Understand how the Automotive Computer Control System functions; Identify the computer or computers in an Automotive Control system and the specific systems it controls; Understand the use of Self-test Diagnostics in a Control system; Describe the use of Diagnostic Equipment; Evaluate Diagnostic Codes and relate codes to specific problems.</td>
<td>This updated course replaces course 3713.</td>
</tr>
<tr>
<td>004023</td>
<td><strong>Automotive Engine Performance / Troubleshooting</strong></td>
<td>10 hours</td>
<td>-</td>
<td>Identify the tools used for brake system repair. Explain how to safely work on a vehicle’s brake system. Describe how friction is used to slow or stop a vehicle. Describe how the hydraulic system functions and how power boosters operate. Explain the construction and repair of master cylinders. Identify the components of a drum brake system and a disc brake system and explain how these systems operate and are repaired. Discuss the various types of brake lines and valves that are used in automotive and light truck braking systems.</td>
<td>This updated course replaces course 3715.</td>
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<tr>
<td>004028</td>
<td><strong>Automotive Heating and Air Conditioning Systems, Part 1</strong></td>
<td>10 hours</td>
<td>-</td>
<td>Locate and identify the components of an Automotive Heating and Air Conditioning systems; Understand the function of Components within Heating and Air Conditioning systems; Evaluate problems occurring in Heating and Air Conditioning systems; Suggest and implement Repair procedures.</td>
<td>This updated course replaces course 3713.</td>
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<tr>
<td>004029</td>
<td><strong>Automotive Heating and Air Conditioning Systems, Part 2</strong></td>
<td>10 hours</td>
<td>-</td>
<td>Understand the function of Control Systems in Automotive Heating and Air Conditioning systems; Locate and identify components of Computer Controlled Climate systems; Evaluate and diagnose problems relating to advanced Automotive Heating and Air Conditioning systems.</td>
<td>This updated course replaces course 3713.</td>
</tr>
<tr>
<td>004030</td>
<td><strong>Automotive Braking Systems</strong></td>
<td>10 hours</td>
<td>-</td>
<td>Identify the tools used for brake system repair. Explain how to safely work on a vehicle’s brake system. Describe how friction is used to slow or stop a vehicle. Describe how the hydraulic system functions and how power boosters operate. Explain the construction and repair of master cylinders. Identify the components of a drum brake system and a disc brake system and explain how these systems operate and are repaired. Discuss the various types of brake lines and valves that are used in automotive and light truck braking systems.</td>
<td>This updated course replaces course 3713.</td>
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</table>
**004031**

**Antilock Braking Systems**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Automotive Braking Systems (004030)

**What Students Learn:**
- Identify the main components of an antilock braking system and explain their function.
- Discuss how speed information is gathered and how this information is used in an antilock braking system.
- Identify the inputs and outputs of an antilock braking system’s computer controller.
- Describe how the solenoid and motor-driven valves operate in an antilock braking system.
- List the proper steps to use when troubleshooting and servicing a vehicle with antilock brakes.

**00A1**

**Basic Diesel Mechanics: Introduction**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
What a Course in Diesel Mechanics Can Do for You; Getting the Most from Your Course; What is a Diesel Engine; Why is a Diesel Engine So Popular; How a Diesel Engine Operates; Basic Kinds of Diesel Engines; Horsepower.

**00A2**

**Work Habits and Practices, Part 1 (Diesel)**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Self Improvement; The Importance of Teamwork; What Your Job Does for You; What You Can Do for Your Job; Job Location; Order of Performance.

**00B2**

**Work Habits and Practices (Gasoline)**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Self-Improvement; The Importance of Teamwork; Work Practices; Safety; Shop Records; Shop Communications.

**00B3**

**Gasoline Engine Parts, Part 1**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Types of Automotive Gasoline Engines; Similarities of Piston-Type Gasoline Engines; Piston-Type Gasoline Engine Components: Engine Cylinder Block, Oil Pan, Timing Gears, Sprockets and Chains, Crankshaft, Vibration Damper, Flywheel, Main Bearings; Camshaft; Camshaft Bearings.

**00B4**

**Gasoline Engine Parts, Part 2**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Gasoline Engine Parts, Part 1 (00B3)

**What Students Learn:**
Connecting Rods; Connecting Rod Bearings; Pistons; Piston Rings; Cylinder Heads and Components; Valves; Valve Springs; Retainers and Keepers; Valve Oil Seals; Valve Rotators; Valve Operating Mechanisms.

**00B5**

**Fuel Systems, Part 1 (Gasoline)**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Gasoline Engine Parts, Part 2 (00B4)

**What Students Learn:**
Gasoline; The Combustion Process; Carburetors; Multistage and Multi-Barrel Carburetors; Multi-Carburetors; Examples of SWM-Barrel, Two-Barrel, and Four-Barrel Carburetors.
**00B6**

*Fuel Systems, Part 2 (Gasoline)*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Fuel Systems, Part 1 (Gasoline) (00B5)

**What Students Learn:**
Rochester Model 2G Carburetor; Motorcraft Two-Barrel Carburetor; Holley Model 4150 Four-Barrel Carburetor; Electronic Fuel Injection: Functions, Advantages, Types, Description, and Operation.

---

**00B7**

*Fuel Systems, Part 3 (Gasoline)*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Fuel Systems, Part 2 (Gasoline) (00B6)

**What Students Learn:**
Fuel Pumps; Governors; Fuel Tanks; Crankcase Emission Controls; Exhaust Emission Controls; Carburetor Design Changes; Intake Air Heating System; Exhaust Gas Recirculation System; Air Injection System; Evaporation Control System.

---

**00B8**

*Electrical Systems (Gasoline)*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Fuel Systems, Part 3 (Gasoline) (00B7)

**What Students Learn:**
Electricity Defined; Magnets; Electric Circuits; Ohm’s Law; Storage Battery; Generators and Alternators; Regulators; Cranking Motors; Cranking Motor Switches.

---

**00B9**

*Ignition Systems (Gasoline)*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Electrical Systems (Gasoline) (00B8)

**What Students Learn:**
Basic Ignition System; Primary and Secondary Circuits; Ignition Coil; Condenser; Ignition Distributor; Spark Plugs; Spark Plug Cables; Chrysler Transistorized Ignition; Ford Transistorized Ignition; GM Transistorized Ignition.

---

**00J1**

*Hydraulic Fundamentals (Diesel and Automotive)*

**Duration:** 15 hours (includes 1 test)

**Course Prerequisite:**
In-Frame Overhaul, Part 2 (Diesel) (0A25)

**What Students Learn:**
Hydraulics Defined; History of Hydraulics; Explanation of Hydraulic Circuits; Uses for Hydraulic Circuits; Hydraulic Fundamentals: Force, Area, Pressure, Distance, Efficiency.

---

**00J2**

*Hydraulic System Components (Diesel and Automotive)*

**Duration:** 15 hours (includes 1 test)

**Course Prerequisite:**
Hydraulic Fundamentals (Diesel and Automotive) (00J1)

**What Students Learn:**
Hydraulic Oils; Reservoir; Hoses, Piping, and Tubing; Pumps: Gear Pumps, Vane Pumps, Piston Pumps; Valves; Relief or Pressure Control Valves; Check Valves; Control Valves; Cylinders; Hydraulic Oil Filters; Hydraulic Oil Coolers; Hydraulic Symbols.

---

**00J3**

*Hydraulic System Maintenance (Diesel and Automotive)*

**Duration:** 15 hours (includes 1 test)

**Course Prerequisite:**
Hydraulic System Components (Diesel and Automotive) (00J2)

**What Students Learn:**
Importance of Cleanliness; Changing Oil in Hydraulic Systems; Servicing Filters and Strainers; Troubleshooting; Adjustments; Repair; Reservoirs; Gear-Type Pumps; Vane-Type Pumps; Control Valves; Cylinders; Hoses and Tubing.

---

**00K5**

*Refrigeration Systems (Heavy Duty Equipment)*

**Duration:** 15 hours (includes 1 test)

**Course Prerequisite:**
In-Frame Overhaul, Part 2 (Diesel) (0A25)

**What Students Learn:**
History of Refrigeration; Fundamentals of a Refrigeration System; Operation; Maintenance.
00L1

**Power Shift Transmission Systems: Description and Operating Principles**

**Duration:** 15 hours (includes 1 test)

**Course Prerequisite:**
In-Frame Overhaul, Part 2 (Diesel) (0A25)

**What Students Learn:**

00L2

**Power Shift Transmission Systems: Operating Principles and Troubleshooting**

**Duration:** 15 hours (includes 1 test)

**Course Prerequisite:**
Power Shift Transmission Systems: Description and Operating Principles (00L1)

**What Students Learn:**
Allison 6061 Transmission; Power Flow; Clark 16,000 Series Transmission; Gear Train Components; Gear Train Arrangements; Clutches, Hydraulic System Components, Power Flow; Maintenance, Troubleshooting Service.

055002

**Introduction to Truck Diesel Mechanics**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**

**Preview**
The modern vehicle powered by a diesel engine is a complex piece of technology, with its many components working together to safely and reliably haul freight, transport passengers, and serve the construction and farming industries. It takes highly trained, knowledgeable technicians to keep these high-tech vehicles in running order.

**Objectives**
When students complete this study unit, he and she will be able to:

- Name and describe the eight basic operating systems in a vehicle.
- Describe the basic operation of a four cycle diesel internal combustion engine.
- Define the terms: horsepower, displacement, and compression ratio.
- Discuss the employment possibilities that are available in the field of heavy duty vehicle repair.
- List and discuss the steps needed to attain certification in the field of heavy duty vehicle servicing.

086E07

**Today's Technician: Medium / Heavy Duty Truck Electrical and Electronics Systems**

**Duration:** 40 hours (includes 4 tests)

**What Students Learn:**

**Preview**
The technician of today must know the underlying theory of all systems, and be able to service and maintain those systems. They must also know how individual systems interact. This course series covers the mechanical and electrical systems of medium and heavy duty trucks. Each Classroom Manual contains the principles of operation for each system and subsystem. It also discusses the design variations used by different manufacturers. This understanding is necessary to diagnose the complex truck systems.

All of the high priority skills, as identified by the National Institute for Automotive Service Excellence (ASE), are explained in the Shop Manual. It includes step by step instructions for diagnostic and repair procedures. This manual explains the reasons for performing the procedures and when that particular service is appropriate.

**Contents**
Classroom Manual: Safety; Basic Theories; Electrical Components; Wiring Systems and Diagrams; Batteries; Starting Systems; Charging Systems; Truck and Trailer Lighting Systems; Instrumentation and Warning Systems; Truck Electrical Accessories; Ignition Systems; Diesel Computer Systems.

Shop Manual: Safety; Electrical Diagnostic Tools; Basic Electrical Troubleshooting and Service; Wiring Repair Practices and Diagram Reading; Battery Diagnosis and Service; Starting System Diagnosis and Service; Charging System Testing and Service; Lighting Troubleshooting and Repairs; Instrument, Gauges, and Warning System Testing; Truck Electrical Accessories Diagnosis and Repairs; Ignition System Diagnosis and Service; Engine and Vehicle Computer Troubleshooting and Service.

**Special Note:**
- This updated course replaces course 0A23.
Today's Technician: Medium / Heavy Duty Truck Steering and Suspension Systems

Duration: 40 hours (includes 4 tests)

What Students Learn:

Preview
The technician of today must know the underlying theory of all systems, and be able to service and maintain those systems. They must also know how individual systems interact. This course series covers the mechanical and electrical systems of medium and heavy duty trucks.

Each Classroom Manual contains the principles of operation for each system and subsystem. It also discusses the design variations used by different manufacturers. This understanding is necessary to diagnose the complex truck systems.

All of the high priority skills, as identified by the National Institute for Automotive Service Excellence (ASE), are explained in the Shop Manual. It includes step by step instructions for diagnostic and repair procedures. This manual explains the reasons for performing the procedures and when that particular service is appropriate.

Contents
Classroom Manual: Safety Practices; Basic Theories; Wheel Bearings; Steering Columns; Manual Steering Gears, and Steering Linkages; Power Steering Pumps and Power Steering Gears; Frames and Fifth Wheels; Suspension Systems; Air Suspension Systems; Wheel Alignment.

Shop Manual: Safety Practices; Tools and Shop Practices; Wheel, Tire, and Wheel Bearing Service; Steering Column, Manual Steering Gear, and Steering Linkage Diagnosis and Service; Power Steering Pump and Power Steering Gear Diagnosis and Service; Frame and Fifth Wheel Diagnosis and Service; Suspension System Diagnosis and Service; Air Suspension System Diagnosis and Service; Wheel Alignment Procedures.

Special Note:
- This updated course replaces courses 0K12, 0K13, and 0K14.

Heavy Duty Truck Systems – Drivelines

Duration: 40 hours (includes 4 tests)

What Students Learn:

Preview:
Clutches and Standard Transmissions – Transmissions play a critical role in vehicles. A transmission transfers the engine’s power to a vehicle’s driveline and to other powered systems. Many vehicle repair technicians never see the inside of a transmission because specialized shops equipped with specific tooling usually overhaul transmissions. However, the technician must still be able to diagnose a range of transmission-related problems, including servicing the transmission, fluid replacement, filter cleaning, and linkage adjustment.

Objectives:
Describe the operating principles of a clutch; Identify and describe the functions of clutch components; Troubleshoot clutch problems; Outline the procedure for removing, servicing, and replacing clutches; Describe how a manual transmission operates; Explain the function of each major component in a manual transmission; Identify shifting system types and their operating characteristics; Outline the procedure for maintaining and servicing manual transmissions; Troubleshoot a transmission and shift system to identify faults; List the tasks required to overhaul a manual transmission.

Preview:
Automatic Transmissions - While automatic transmissions serve the same purpose as the manual transmissions you studied in Lesson 1, they do so with much less driver interaction. While a driver moves a shift lever to select the gear-meshing configuration of a manual transmission, an automatic transmission changes gear configuration on its own in response to engine load and rotational speed. As you might guess,
the added capabilities of an automatic transmission mean that it’s also a much more complicated device than a manual transmission. In this lesson you’ll learn how an automatic transmission operates as well as how its internal components are removed, serviced, and/or replaced.

Objectives:
Describe the operating principles of a torque converter; Identify and describe the functions of torque-converter components; Troubleshoot torque converter problems; Outline the procedure for removing, servicing, and replacing torque converters; Describe how an automatic transmission operates and how it’s shift points are controlled; Explain the function of each major subsystem of an automatic transmission; Describe how hydraulic retarders operate; Outline the procedure for maintaining and servicing automatic transmissions; Troubleshoot an automatic transmission to identify faults; List the tasks required to overhaul an automatic transmission.

Preview:
Allison Transmissions - Allison is the primary manufacturer of electronically controlled automatic transmissions found in heavy duty vehicle applications. For this reason, your textbook focuses two chapters on two families of Allison automatic transmissions, the CEC and World models.

Objectives:
Describe the operating principles of an Allison CEC transmission, including how electronic signals are converted into hydromechanical ones; Identify and describe the functions of Allison transmission components; Explain how an Allison World transmission operates, including the functions served by its electronic control system; Describe the design differences between Allison CEC and World transmission models; Troubleshoot problems with CEC and Allison World transmissions; Outline the procedure for removing, servicing, and replacing CEC and Allison World transmissions.

Preview:
Drive Shafts and Axles – Transmission is described as being responsible for transferring engine power to the rest of the driveline. In this lesson you’ll study critical components from the rest of the driveline; drive shafts and axle assemblies.

Objectives:
Explain how driveshafts and other driveline components are connected; Outline the procedure for removing, servicing, and replacing drive shafts, universal joints, and other driveline components; Identify different types of drive axles, their operating characteristics, and the function served by each of their major component parts; Describe the operating principles of a differential; Explain how to service and repair problems with driveaxles, differentials, and nondrive axles.

Special Note:
• This updated course replaces course 0K10.

086E11
Heavy Duty Truck Systems – HVAC Systems

Duration: 10 hours (includes 1 test)

What Students Learn:

Preview:
Freight Hauling companies, and others that employ heavy-duty vehicle operators, work hard to find, hire, and train qualified drivers. One of the benefits that make it easier for these companies to retain their drivers is to provide them with comfortable, climate-controlled vehicles. It’s the technician’s job to ensure that the vehicles temperature-control systems (both air conditioning and heating) operate properly. It’s also partially the responsibility of the technician to ensure that the company handles all refrigerants as dictated by state and federal law.

Objectives:
Explain the regulatory system in place to control the handling of A/C system refrigerants and the technician’s role in meeting system guidelines; Describe how an air-conditioning system operates; List general steps to be taken when troubleshooting A/C system complaints; Understand how a vehicles air ventilation system operates; Explain how the heat from engine coolant can be extracted and controlled to heat the vehicles operator compartment.

Special Note:
• This updated course replaces course 0K10.

086E12
Medium / Heavy Duty Truck Engines, Fuel and Computerized Management Systems

Duration: 50 hours (includes 10 tests)

What Students Learn:

Preview
The focus of this course is the truck engine and its hydromechanical and electronic fuel management systems, and electronically managed engines. These systems are presented with a focus on the principles of operation to help technicians understand why and how components and systems function. An overview of general procedures and specifications is presented.

Today’s technician is expected to be computer literate. Computers are used to diagnose engine malfunctions, and to program customer and proprietary data to engine control modules (ECMs). Due to the rapid increase in required noxious emission controls, the commercial highway diesel engine has evolved from hydromechanical management to electronic management. Electronically managed engines last longer, make vehicles easier to drive, require less maintenance, and produce much better fuel mileage.

This course covers engine and fuel management technology for the perspective of the technician in a modern truck service or fleet operation. The emphasis is on diagnosis followed by removal and replacement procedures. A technician capable of properly diagnosing vehicle systems must understand that systems from both the theoretical and practical perspective.
### Contents:

Diesel Engine Fundamentals: Introduction; Hand and Shop Tools, Precision Tools, and Units of Measurement; Personal and Safety Awareness; Engine Basics; History of the Heat Engine; Power; Engine Powertrain Components; Engine Feedback Assembly; Engine Housing Components; Engine Lubrication Systems; Diesel Engine Cooling Systems; Engine Breathing; Engine Retarders; Engine Removal, Disassembly, Cleaning, Inspection, and Reassembly Guidelines; Engine Run-In and Performance Testing.

Hydromechanical Diesel Fuel Injection Systems: Chemistry and Combustion; Diesel Fuel and Alternates; Fuel Subsystems; Overview of Hydromechanical Injection Principles and Objectives; Hydraulic Injector Nozzles; Port Helix Metering Injection Pumps; Detroit Diesel Mechanical Unit Injection Systems; Caterpillar Mechanical Unit Injection; Cummins PT; Governors; Engine and Fuel System Failure Analysis, Troubleshooting, and Diagnoses Strategies.

Computerized Truck and Bus Systems Management: Electricity and Electronics; Digital Computer; Networking and Communications in the Trucking Industry; Vehicle Computer Systems; Electronic Service Tools; Electrical Wiring, Connector, and Terminal Repair; Caterpillar PEEC; Mack Trucks V-MAC 1 and 2; Detroit Diesel Electronic Controls; Caterpillar ADEMS; Cummins CELECT and CELECT Plus; Bosch EUP on DDC Series 55 and V-MAC 3-E-Tech; Caterpillar / Navistar HEUI (Navistar 444E, Ford 7.3 liter, 466E, 530E, and Caterpillar 3126); Cummins HPI and Interact Series Engine Management; Emissions.

Textbook: Medium/Heavy Duty Truck Engines, Fuel, & Computerized Management Systems

Part 1: 055901 Diesel Engine Fundamentals
Part 2: 055902 Hydromechanical Diesel Fuel Injection Systems
Part 3: 055903 Computerized Truck and Bus Systems Management

### Special Note:

- This updated course replaces courses 00A1 through 0A12, and 0A14.

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### 089017

**Small Engine Parts and Operation**

**Duration:** 5 hours (includes 1 test)

**What Students Learn:**

- Explain the basic operating principles of two and four-stroke engines;
- Visually identify the external and internal components of small engines (defined as engines of lower than 25 hp output);
- Describe the basic operation of carburetors, ignition systems and starting systems;
- Understand how transmissions are used to modify the output torque and hp of an engine; Differentiate between the operation of small diesel and gasoline powered engines.

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### 089018

**Small Engine Lubrication and Cooling Systems**

**Duration:** 5 hours (includes 1 test)

**What Students Learn:**

- Identify and describe the various types of small engine lubrication systems and lubricants;
- Explain the role of a properly maintained lubrication system in prolonging engine life and limiting engine noise and omissions;
- Identify and describe the types of small engine cooling systems;
- Explain how to properly maintain cooling systems.

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### 089019

**Small Engine Ignition Systems**

**Duration:** 5 hours (includes 1 test)

**What Students Learn:**

- Explain the electrical operating principles of a starting circuit;
- Identify the components and operating principles of magneto, battery, and electronic ignition systems;
- Explain how safety interlocks are incorporated into ignition systems;
- Describe the procedures required to tune-up and troubleshoot ignition systems.

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### 089020

**Small Engine Electrical Systems**

**Duration:** 5 hours (includes 1 test)

**What Students Learn:**

- Explain how to properly maintain, test and handle batteries;
- Explain the operation of generators, alternators and their circuits;
- Describe how to properly troubleshoot and maintain these components;
- Identify the parts of a starter and describe how to troubleshoot starting system problems;
- Describe how accessory circuits operate and proper troubleshooting procedures for these circuits.

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### 089021

**Small Engine Fuel Systems**

**Duration:** 5 hours (includes 1 test)

**What Students Learn:**

- Describe various types of fuels;
- Explain how carburetors mix fuel and air to control engine speed;
- Identify carburetor components such as venturi, float, needle valve, throttle plate and choke plate;
- Describe the function of other fuel system components;
- Recognize the types of governors and how they operate;
- Explain how to troubleshoot the fuel systems.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Duration</th>
<th>What Students Learn</th>
</tr>
</thead>
<tbody>
<tr>
<td>089022</td>
<td>Small Engine Disassembly</td>
<td>5 hours</td>
<td>Understand the engine numbering systems used by several manufacturers; Explain how to use manufacturer's service manuals; Explain how to remove an engine from a piece of power equipment; List and describe a 20-step disassembly process as it applies to any two or four-stroke engines.</td>
</tr>
<tr>
<td>089023</td>
<td>Small Engine Rebuild, Part 1</td>
<td>5 hours</td>
<td>Interpret and use manufacturer's specifications during rebuild; Use micrometers and calipers to measure engine parts; Use telescoping gages, inside micrometers and bore gages; Explain the proper procedures for inspecting crankshafts and cylinder blocks; Describe steps used to recondition cylinder bores; How to inspect and replace engine bearings.</td>
</tr>
<tr>
<td>089024</td>
<td>Small Engine Rebuild, Part 2</td>
<td>5 hours</td>
<td>Inspect pistons and related parts; Measure and evaluate dimensions and clearances involving pistons, valves, and cylinder bore; Inspecting valve features; Reconditioning valves and valve seats; Repair and replace worn valve guides and seals; Inspect cylinder heads.</td>
</tr>
<tr>
<td>089025</td>
<td>Small Engine Reassembly</td>
<td>5 hours</td>
<td>Explain the role and proper installation techniques for gaskets and seals; Work with torque specifications; Identify the basic steps used to reassemble any two or four-stroke engine; Explain how to properly install piston rings; Check assembly control features such as bearing clearance, piston ring end gap, crankshaft end play, ignition system air gap, and valve timing; Identify post assembly troubleshooting procedures.</td>
</tr>
<tr>
<td>089029</td>
<td>Servicing Outdoor Power Equipment, Part 1</td>
<td>5 hours</td>
<td>Explain why engines overheat and describe ways to correct overheating; Describe basic diesel fuel systems and how to maintain them; Describe the procedure for troubleshooting OPE for electrical failure; Explain how to select engine oil and other maintenance products; Differentiate between types of fuel.</td>
</tr>
<tr>
<td>089030</td>
<td>Servicing Outdoor Power Equipment, Part 2</td>
<td>5 hours</td>
<td>Recognize the importance of selecting the right hardware for OPE repair; Identify situations where torque wrenches are necessary for making repairs; Explain how to service drive belts, pulleys, and chains; Describe the working components of a wide selection of OPE; Identify major service problems experienced by OPE technicians; Understand the importance of proper maintenance and servicing.</td>
</tr>
<tr>
<td>ADT02</td>
<td>Automotive Drive Trains: Automatic and Manual</td>
<td>35 hours</td>
<td>Describe the function of a drive train. Understand the differences between manual and automatic transmission and transaxle drive trains. Describe, diagnose, and replace front wheel drive axles and CV joints. Explain and service drive shafts and universal joints. Understand differentials and drive axles. Describe the operating principles of a clutch. Diagnose and service clutch assemblies. Describe the functions and operating principles of manual transmissions and transaxles. Diagnose, remove, and replace manual transmissions and transaxles. Describe the operating principles of automatic transmissions and transaxles. Explain conventional and lockup torque converters. Understand the function of planetary gear systems, multiple disc clutches, bands and servos. Explain automatic shifting. Diagnose and identify automatic transmission and transaxle problems. Repair and replace automatic transmissions and transaxles. Describe the operation of four wheel drive systems. Explain the function of the viscous coupling, the center differential, and the transfer case.</td>
</tr>
<tr>
<td>004003</td>
<td>Automotive Engine Parts and Operation</td>
<td>35 hours</td>
<td>Course Prerequisite: Automotive Engine Parts and Operation (004003)</td>
</tr>
</tbody>
</table>
• Understand how to diagnose four wheel drive system problems.
• Differentiate between planetary, nonplanetary, and continuously variable transmissions (CVT)

Special Note:
• This course consists of the Today’s Technician: Automatic Transmissions & Transaxles, textbook series the Today’s Technician: Manual Transmissions & Transaxles textbook series, and two study guides.

AE01

Automotive Engines: Theory and Servicing

Duration: 25 hours (includes 5 tests)
Course Prerequisite: Automotive Engine Parts and Operation (004003)

What Students Learn:
• Safely use tools to install and remove fasteners.
• Understand how to measure engine power and classify engine sizes.
• Understand how oil is used to lubricate an engine.
• Safely test and install a battery.
• Understand how engine operation is effected by ignition systems.
• Understand gasoline and its properties.
• Understand how a cooling system works.
• Identify problems in the cooling system.
• Diagnose problems in the engine.
• Diagnose the engine’s condition.
• Remove and disassemble the engine.
• Clean an engine after disassembly.
• Detect and repair cracks in the engine.
• Measure the engine components.
• Describe the intake and exhaust manifolds.
• Understand how combustion chambers work.
• Describe how to recondition a cylinder head.
• Understand the types of valves and the purpose and operation of each.
• Understand how to correctly reface and install valves.
• Describe how the camshaft works.
• Explain how to service a valve train.
• Identify the different types of engine blocks and describe how to machine them.
• Describe the functions of pistons and rods.
• Understand what to look for during an inspection of pistons, rings, and rods.
• Understand the difference between a scat and forged crankshaft.
• Explain the function of engine balance shafts.
• Describe the general steps of assembling an engine.
• Test for proper oil pressure after assembly.
• Explain how to properly install an engine.
• Describe how to break in a newly rebuilt engine.

Special Note:
• This new course consists of Automotive Engines: Theory and Servicing textbook (stock number TB0340) and two study guides (stock numbers 004906 and 004907).

0A13

Welding (Diesel)

Duration: 10 hours (includes 1 test)
Course Prerequisite: Diesel Engine Parts, Part 2 (00A5)

What Students Learn:
Metallurgy of Welding; Heat Treatment of Metals; Electric Arc Welding; Electric Arc Welding Procedures; The Carbon Arc; The Gas Shield Arc; Oxyacetylene Welding; Techniques Used in Welding; Soldering; High Brazing and Bronze Welding.

0A15

Arithmetic for Mechanics (Diesel)

Duration: 10 hours (includes 1 test)
Course Prerequisite: Work Habits and Practices, Part 2 (Diesel) (00A3)

What Students Learn:
Numbers and Symbols: Numbers and Position; Addition; Subtraction; Multiplication; Division; Fractions; Decimals; Practice Problems in Basic Arithmetic; Percentage and its Application; Equations and Formulas; Ratio and Proportion; Graphs; The Metric System of Measurement; Fundamental Ideas in Geometry.

0A16

Drawing and Sketching for the Mechanic (Diesel)

Duration: 10 hours (includes 1 test)
Course Prerequisite: Diesel Engine Parts, Part 2 (00A5)

What Students Learn:
The Language of Drawing; Drawing Methods; Drawing Materials and Tools; Standard Drawing Practices; Kinds of Drawings; Blueprint Reading; Shop Photography.

0A18

Engine and Allied Equipment Service Manuals (Diesel)

Duration: 10 hours (includes 1 test)
Course Prerequisite: Diesel Engine Operations, Part 2 (0A12)

What Students Learn:
Engine Specifications and Tolerances; Recommended Overhaul and Rebuild Procedures; Recommended Maintenance Procedures; Use of Specification and Tolerance Tables.
0A19

Troubleshooting Diesel Engines

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Engine and Allied Equipment Service Manuals (Diesel) (0A18)

What Students Learn:
Principles of Troubleshooting; Troubleshooting Procedure; Troubleshooting with a Chassis Dynamometer; Checking Compression Pressure; Fuel Flow; Restriction of Intake Air and Exhaust Back Pressure; Checking Causes of Vibration.

0A20

Failure Analysis (Diesel)

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Troubleshooting Diesel Engines (0A19)

What Students Learn:
Definition of Failure Analysis; Failure Analysis Procedure; Failure Analysis Charts: Cylinder Block, Camshaft and Camshaft Bearings, Crankshaft, Main and Connecting Rod Bearings, Pistons and Piston Rings, Gear Trains, Cylinder Heads and Cylinder Head Gaskets, Valves, Guides, Springs and Crossheads, Blowers and Superchargers, Turbochargers.

0A22

Maintenance of Air Intake, Exhaust, and Cooling Systems (Diesel)

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Maintenance of Lubricating and Fuel Systems (Diesel) (0A21)

What Students Learn:
Turbochargers; Superchargers and Blowers; Exhaust Systems; Cleaning the Cooling Systems; Servicing Cooling System Filters; Adjusting Fan Belts; Servicing Shutters; Antifreeze Solutions.

0A24

In-Frame Overhaul, Part 1 (Diesel)

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Maintenance of Electrical Systems (Diesel) (0A23)

What Students Learn:
Symptoms Indicating a Need for In-Frame Overhaul; Transmission Removal; Clutch Removal; Disassembly of Engine; Inspection of Piston, Connecting Rod, and Cylinder Liner Assemblies; Inspection of Crankshaft, Main Bearings, and Connecting Rod Bearings; Inspection of Cylinder Block; Inspection of Cylinder Liners.

0A25

In-Frame Overhaul, Part 2 (Diesel)

Duration: 10 hours (includes 1 test)

Course Prerequisite:
In-Frame Overhaul, Part 1 (Diesel) (0A24)

What Students Learn:
Service of Cylinder Liner, Piston, and Connecting Rod Assemblies; Service of Cylinder Head Assemblies; Reassembly of Engine Following In-Frame Overhaul; Adjusting Injectors and Valves; Helpful Tips on Parts Replacement.

0B10

Lubricating Systems (Gasoline Engine Mechanics)

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Gasoline Engine Parts, Part 2 (00B4)

What Students Learn:
Lubricating Oil Functions; Lubrication Oil Properties; Processing Lubricating Oils; Lubricating Oil Classifications; Gear Lubricants; Gear Lubricant Classification; Greases; Grease Classification; Automatic Transmission Fluid; Typical Gasoline Engine Lubricating System; Lubricating Oil Pump; Lubricating Oil Filters; Bearing Lubrication.
0B11  
**Cooling, Air Intake, and Exhaust Systems (Gasoline)**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Gasoline Engine Parts, Part 2 (00B4)

**What Students Learn:**
Function of the Cooling System; Thermostat; Radiator Shutters Fans and Fan Drive Hub Assemblies; Radiators; Radiator Cap; Water Pumps; Antifreeze Solutions; Air-Cooled Engines; Air Intake System; Air Cleaners; Air Restriction; Exhaust Systems; Mufflers.

0B12  
**Arithmetic for Mechanics (Gasoline)**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Work Habits and Practices (Gasoline) (00B2)

**What Students Learn:**
Numbers and Symbols; Numbers and Position; Addition; Subtraction; Multiplication; Division; Fractions; Decimals; Practice Problems in Basic Arithmetic: Percentage and its Application; Equations and Formulas; Ratio and Proportion; Graphs; The Metric System of Measurement; Fundamental Ideas in Geometry.

0B13  
**Reading Micrometers, Dial Gauges, and Other Measuring Instruments (Gasoline)**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Gasoline Engine Parts, Part 2 (00B4)

**What Students Learn:**
Simple Measurements; Precision Measuring Techniques; Feeler or Thickness Gauges; Radius Gauges; Telescoping Gauges; Small Bore Gauges; Micrometers; Dial Gauges; Pressure Gauges; Vacuum Gauges; Manometers; Tachometers.

0B14  
**Shop and Hand Tools, Part 1 (Gasoline)**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Work Habits and Practices (Gasoline) (00B2)

**What Students Learn:**
Using Tools Safely; Lifting Tools and Equipment; Cleaning; Inspection Equipment; Engine Dynamometer; Grinding Machines; Drill Presses; Honing Machines; Boring Machines.

0B15  
**Shop and Hand Tools, Part 2 (Gasoline)**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Shop and Hand Tools, Part 1 (Gasoline) (0B14)

**What Students Learn:**
Engine Lathe; Pressing Tools and Operations; Power Hacksaws; Impact Wrenches; Welding and Soldering Equipment; Hand Tools.

0B16  
**Tune-Up of Gasoline Engines (Diagnostics), Part 1**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Shop and Hand Tools, Part 2 (Gasoline) (0B15)

**What Students Learn:**
Principles of Troubleshooting and Testing; Troubleshooting without Testing Equipment; Preliminary Tune-Up Check; Procedures for Using Testing Instruments and Equipment for Engine Tune-Ups.

0B17  
**Tune-Up of Gasoline Engines (Diagnostics), Part 2**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Tune-Up of Gasoline Engines (Diagnostics), Part 1 (0B16)

**What Students Learn:**
Using Engine Testing and Troubleshooting Instruments and Equipment; Checking Transistorized Ignition Systems; Testing and Servicing Emission Controls.
0B18  
**Failure Analysis (Gasoline)**
Duration: 10 hours (includes 1 test)  
Course Prerequisite: Tune-Up of Gasoline Engines (Diagnostics), Part 2 (0B17)  
What Students Learn: Making a Preliminary Inspection; Locating the Failure; Example of Failure Analysis; Failure Analysis Reference Guide: Cylinder Block, Camshaft and Camshaft Bearings, Crankshaft, Main and Connecting Rod Bearings, Pistons and Piston Rings; Timing Gears, Sprockets and Chains; Cylinder Head Assemblies.

0B19  
**Engine Maintenance: Lubricating, Air Intake, Exhaust, and Cooling Systems (Gasoline)**
Duration: 10 hours (includes 1 test)  
Course Prerequisite: Failure Analysis (Gasoline) (0B18)  
What Students Learn: Lubricating System Maintenance; Checking Engine Oil; Changing Engine Oil; Servicing Lubricating Oil Filters; Oil Coolers; Air Intake System Maintenance; Servicing Air Cleaners; Thermostatically Controlled Air Cleaner; Exhaust System Maintenance; Cooling System Maintenance; Checking Engine Coolant; Checking Thermal Controls; Pressure-Testing the Cooling System.

0B20  
**Engine Maintenance: Fuel System Maintenance and Overhaul (Gasoline)**
Duration: 10 hours (includes 1 test)  
Course Prerequisite: Engine Maintenance: Lubricating, Air Intake, Exhaust, and Cooling Systems (Gasoline) (0B19)  

0B21  
**Engine Maintenance: Ignition System Components Maintenance and Overhaul (Gasoline)**
Duration: 10 hours (includes 1 test)  
Course Prerequisite: Engine Maintenance: Fuel System Maintenance and Overhaul (Gasoline) (0B20)  
What Students Learn: Battery; Ignition Switch; Distributor Cap and Rotor; Breaker Points; Condenser; Coil; Dwell Adjustment; Distributor Overhaul; Transistorized Ignition System Distributor.

0B22  
**Engine Maintenance: Electrical Systems (Gasoline)**
Duration: 10 hours (includes 1 test)  
Course Prerequisite: Engine Maintenance: Ignition System Components Maintenance and Overhaul (Gasoline) (0B21)  
What Students Learn: Periodic Inspection: Battery, Wiring, Cranking Motor, Alternator or Generator, Regulator; Testing: Battery Cells, Cables, Generators, Alternators, Regulators, Cranking Motors; Servicing and Overhauling Electric Units.

0B23  
**Engine Overhaul, Part 1 (Gasoline)**
Duration: 10 hours (includes 1 test)  
Course Prerequisite: Engine Maintenance: Electrical Systems (Gasoline) (0B22)  
0B24

*Engine Overhaul, Part 2 (Gasoline)*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Engine Overhaul, Part 1 (Gasoline) (0B23)

**What Students Learn:**
Cylinder Block; Crankshaft; Main and Connecting Rod Bearings; Pistons and Rings; Connecting Rods; Camshaft; Timing Gear or Timing Chain Cover; Hydraulic Valve Lifters; Flywheel Ring Gear; Assembly of Cylinder Block Components.

0B25

*Engine Overhaul, Part 3 (Gasoline)*

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Engine Overhaul, Part 2 (Gasoline) (0B24)

**What Students Learn:**
Cylinder Heads; Rocker Arm Assembly; Pushrods; Engine Assembly; Engine Installation; Connecting Exhaust Pipes; Installing Wiring, Tubing, Hoses, and Linkages; Engine Starting and Run-In.

0KK4

*Retarders and Oil Seals (Heavy Duty Equipment)*

**Duration:** 15 hours (includes 1 test)

**Course Prerequisite:**
In-Frame Overhaul, Part 2 (Diesel) (0A25)

**What Students Learn:**
Introduction; Jacobs Engine Brake; Exhaust Brakes; Caterpillar Brake Saver; Jacobs Electric Retarder; Oil Seals.
For information about the following courses, please contact your Training Consultant or Customer Service.

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>00A3</td>
<td>Work Habits and Practices, Part 2 (Diesel)</td>
<td>10 hours (1 test)</td>
</tr>
<tr>
<td>00A4</td>
<td>Diesel Engine Parts, Part 1</td>
<td>10 hours (1 test)</td>
</tr>
<tr>
<td>00A5</td>
<td>Diesel Engine Parts, Part 2</td>
<td>10 hours (1 test)</td>
</tr>
<tr>
<td>00A6</td>
<td>Fuel Systems, Part 1 (Diesel)</td>
<td>10 hours (1 test)</td>
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<tr>
<td>00A7</td>
<td>Fuel Systems, Part 2 (Diesel)</td>
<td>10 hours (1 test)</td>
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<tr>
<td>00A8</td>
<td>Lubricating Systems (Diesel)</td>
<td>10 hours (1 test)</td>
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<tr>
<td>00A9</td>
<td>Cooling, Air Intake, and Exhaust Systems (Diesel)</td>
<td>10 hours (1 test)</td>
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<tr>
<td>00A10</td>
<td>Electrical Systems (Basic Diesel Mechanics)</td>
<td>10 hours (1 test)</td>
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<tr>
<td>00A11</td>
<td>Diesel Engine Operations, Part 1 (Diesel)</td>
<td>10 hours (1 test)</td>
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<td>00A12</td>
<td>Diesel Engine Operations, Part 1 (Diesel)</td>
<td>10 hours (1 test)</td>
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<tr>
<td>00A14</td>
<td>Shop and Hand Tools (Diesel)</td>
<td>10 hours (1 test)</td>
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<tr>
<td>00A17</td>
<td>Reading Micrometers, Dial Gauges, and Other Measuring Instruments (Diesel)</td>
<td>10 hours (1 test)</td>
</tr>
<tr>
<td>00A21</td>
<td>Maintenance of Lubricating and Fuel Systems (Diesel)</td>
<td>10 hours (1 test)</td>
</tr>
<tr>
<td>00A23</td>
<td>Maintenance of Electrical Systems (Diesel)</td>
<td>10 hours (1 test)</td>
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<tr>
<td>00C1</td>
<td>Mack Diesel Engine Mechanics: Introduction</td>
<td>15 hours (1 test)</td>
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<tr>
<td>00C2</td>
<td>Engine Disassembly (Mack)</td>
<td>15 hours (1 test)</td>
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<tr>
<td>00C3</td>
<td>Cylinder Block and Components, Part 1 (Mack)</td>
<td>15 hours (1 test)</td>
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<tr>
<td>00C4</td>
<td>Cylinder Block and Components, Part 2 (Mack)</td>
<td>15 hours (1 test)</td>
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<tr>
<td>00C5</td>
<td>Cylinder Block and Components, Part 3 (Mack)</td>
<td>15 hours (1 test)</td>
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<tr>
<td>00C6</td>
<td>Cylinder Head Assemblies and Valve Operating Mechanisms (Mack)</td>
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<td>00C7</td>
<td>Fuel Systems, Part 1 (Mack)</td>
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<td>Accessory Equipment (Mack)</td>
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<td>Engine Assembly, Part 2 (Mack)</td>
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<td>0C14</td>
<td>Engine Testing and Run-In (Mack)</td>
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<td>0C15</td>
<td>Mack V8 Diesel Engines</td>
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<tr>
<td>00D1</td>
<td>Detroit Diesel Engine Mechanics: Introduction</td>
<td>15 hours (1 test)</td>
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<td>00D2</td>
<td>Engine Disassembly (Detroit Diesel)</td>
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<tr>
<td>00D3</td>
<td>Cylinder Block and Components, Part 1 (Detroit Diesel)</td>
<td>15 hours (1 test)</td>
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<td>Cylinder Block and Components, Part 2 (Detroit Diesel)</td>
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<td>Governors (Detroit Diesel)</td>
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<td>Intake Systems, Exhaust Systems (Detroit Diesel)</td>
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<td></td>
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<td>Cooling and Lubricating Systems (Detroit Diesel)</td>
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<td>0D13</td>
<td>Engine Assembly, Part 1 (Detroit Diesel)</td>
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<td>Engine Assembly, Part 2 (Detroit Diesel)</td>
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<td>0KK5</td>
<td>Clutches and Driveshaft Assemblies</td>
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<tr>
<td>0KK6</td>
<td>Rebuilding Transmissions and Controls</td>
<td>15 hours</td>
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<td><em>(Heavy Duty Equipment)</em></td>
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<tr>
<td>0KK7</td>
<td>Rebuilding Manual Transmissions</td>
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<td><em>(Heavy Duty Equipment)</em></td>
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<td>0KK8</td>
<td>Rebuilding Automatic Transmissions</td>
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<td>Cab Air Conditioning Systems</td>
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<td>Maintenance and Repair of Drive Axles</td>
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<td>0K13</td>
<td>Front Axles, Steering, and Suspensions</td>
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<td><em>(Heavy Duty Equipment)</em></td>
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<td>00M6</td>
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</tbody>
</table>
Accounting
Business Law
Business Management Foundation Skills
Computers in Business
Marketing and Sales
Personnel Management
Supervisory Skills for First-Level Managers
## Business Management Practices

### Subject Index

#### Business Management Foundation Skills
- Elements of Business Success (060001) .................................................. 371
- Fundamentals of Business (060002) .......................................................... 371
- Introduction to Marketing (060006) ............................................................ 371
- Principles of Business Finance (060005) ................................................. 371
- The Role of Management in Business (060003) ......................................... 371
- Tools and Trends of the Managerial Trade (060004) .................................. 371

#### Accounting
- Accounting (0610XX, 02-14) .................................................................. 272
- Advanced Partnership Accounting (5970) ............................................... 376
- Consignment and Installment Sales (5972) ............................................... 376
- Funds Accounting (5971) ....................................................................... 376
- Intermediate Accounting (6656A-K) ....................................................... 377
- Introduction to Accounting (061001) ....................................................... 372
- Introduction to Business Finance (5074A-B) ........................................... 376
- Inventory Control (6235A-C) ................................................................. 377
- Managing Physical Distribution (6536A-B) ............................................ 377
- Materials Management and Inventory Control (386E03) ....................... 320

#### Business Law
- Business Law: The Law of Business Organization (5080A-B) ................. 376
- Business Law: The Law of Business Transactions (5081A-C) ............... 376

#### Computers in Business
- Introduction to Computer Concepts (06400X, 3-7) .................................. 374

#### Marketing and Sales
- Marketing Research (5055A-D) ............................................................... 375
- Principles of Marketing (5057A-B) ........................................................... 375
- Public Relations (5058A-C) ................................................................... 375
- Sales Management (5060A-C) ................................................................. 375
- Sales Records and Reports (5998) ......................................................... 377
- Selling Your Ideas (6219) ....................................................................... 377

#### Personnel Management
- Personnel Management (5065A-C) ......................................................... 376

#### Supervisory Skills for First-Level Managers
- Basic Supervision Skills:
  - Cost Control and Work Simplification (060012) .................................. 372
  - Basic Supervision Skills: Employee Relations (060010) ....................... 372
  - Basic Supervision Skills:
    - How to Plan, Organize and Control (060008) .................................. 371
    - Basic Supervision Skills: Management Concepts (060007) ............... 371
    - Basic Supervision Skills: The Process of Motivation (060009) ........... 372
    - Basic Supervision Skills:
      - Training, Communication and Coordination (060011) .................. 372
      - Introduction to ISO 9000: ISO for the Supervisor (186038) ............ 45
      - Jobs, Companies, and the Economy: Basic Concepts for Employees (186034) .......................................................... 45
      - Learning Strategies (147008) ........................................................... 45
      - Organizational Behavior (060935) .................................................. 372
      - Quality Concepts: Terminology for Management (186035) .............. 45
      - Problem Solving and Troubleshooting (186073) ............................ 46
Recommended Career Curricula

- Business Management
- Industrial Supervisor
Business Management

The Business Management program provides trainees with the study materials that enable them to perform the functions associated within this professional area. This print based curriculum has been developed to meet the subject requirements of an organization’s educational development program. When combined with on-the-job training, this program will provide trainees with the comprehensive skills and knowledge they will need to perform in the primary business disciplines.

The Business Management curriculum provides comprehensive training in these fields of study: Introduction to Business Principles, First-Level Supervisory Management concepts and skills, Accounting, Business Law, Personnel Management, Marketing and Sales Skills, and an introduction to the use and applications of computers.

This curriculum is appropriate for people who require the technical proficiency of: a Business generalist in a supervisory or managerial position in a manufacturing or service organization, an entry level Accountant, a Marketing or Sales trainee, and for people who need an introduction to computers as part of their job and skill set.

Upon completion of this program, students will be able to:

- Discuss the concepts and skills that a first-level supervisor would use in their daily responsibilities including: managerial concepts, how to plan, organize and control, the process of motivation, employee relations; training, communication, and coordination, and cost control and work simplification.
- Maintain and understand accounting methods, preparing financial statements and balance sheets, accounting journals including accounts receivables and payables, inventory, sales, purchases, and payroll.
- Understand the various principles of business finance.
- Plan marketing strategy, focusing on product, pricing, promotion, and distribution.
- Describe the principal requirements of sales management, including the recruiting, selecting, and training of sales people, prospecting for clients, planning, and developing a sales strategy.
- Understand the capabilities, functions and operations of personal computers and how they are used in business today.

Special Note:
Optional courses covering Personal Computing Software Applications are listed in Resource 1, Career Development.

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Management Foundation Skills</td>
<td></td>
</tr>
<tr>
<td>Elements of Business Success</td>
<td>060001</td>
</tr>
<tr>
<td>Fundamentals of Business</td>
<td>060002</td>
</tr>
<tr>
<td>The Role of Management in Business</td>
<td>060003</td>
</tr>
<tr>
<td>Tools and Trends of the Managerial Trade</td>
<td>060004</td>
</tr>
<tr>
<td>Principles of Business Finance</td>
<td>060005</td>
</tr>
<tr>
<td>Introduction to Marketing</td>
<td>060006</td>
</tr>
<tr>
<td>Business Mathematics</td>
<td>5565A-B</td>
</tr>
<tr>
<td>Report Writing</td>
<td>05001-24</td>
</tr>
<tr>
<td>Supervisory Concepts and Skills</td>
<td></td>
</tr>
<tr>
<td>Basic Supervision Skills: Management Concepts</td>
<td>060007</td>
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<tr>
<td>Basic Supervision Skills: How to Plan, Organize, and Control</td>
<td>060008</td>
</tr>
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<td>Basic Supervision Skills: The Process of Motivation</td>
<td>060009</td>
</tr>
<tr>
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<td>060010</td>
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<tr>
<td>Basic Supervision Skills: Training, Communication, and Coordination</td>
<td>060011</td>
</tr>
<tr>
<td>Basic Supervision Skills: Cost Control and Work Simplification</td>
<td>060012</td>
</tr>
<tr>
<td>Problem Solving and Troubleshooting</td>
<td>186073</td>
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<tr>
<td>Accounting and Finance</td>
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<td>Introduction to Accounting</td>
<td>061001</td>
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<tr>
<td>Accounting: Financial Statement Reporting</td>
<td>061002</td>
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<td>Accounting: Use of Accounts</td>
<td>061003</td>
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<td>Accounting: Journal Entries</td>
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<td>Accounting: The Work Sheet</td>
<td>061005</td>
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<td>061007</td>
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<td>Accounting: Cash Accounting</td>
<td>061008</td>
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<td>Accounting: Investment and Inventory Accounting</td>
<td>061009</td>
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<td>Accounting: Depreciation of Fixed Assets</td>
<td>061010</td>
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<tr>
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<td>061011</td>
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<tr>
<td>Accounting: Partnerships</td>
<td>061012</td>
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<tr>
<td>Accounting: Corporations</td>
<td>061013</td>
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<tr>
<td>Accounting: Comprehensive Review</td>
<td>061014</td>
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<td>Introduction to Business Finance</td>
<td>5074A-B</td>
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Industrial Supervisor

The Industrial Supervisor curricula provides targeted education and skills development for the newly promoted foreman or supervisor in a manufacturing plant. It also covers subjects that would be beneficial as refresher training for the experienced supervisor as part of an organizational quality improvement initiative.

The program covers many of the knowledge and skills used on a daily basis by supervisors: proven managerial concepts; effective verbal and written communications; employee development techniques; and several aspects relating to plant operations. Emphasis is placed on the principles and applications of quality, continuous improvement, and on statistical process control. It is strongly encouraged that all manufacturing professionals become computer literate and develop their proficiency with software applications such as word processing, spreadsheets, databases, and project management.

Upon completion of this program, students will be able to:

- Discuss the concepts and skills that a first-level supervisor uses in their daily responsibilities including: managerial concepts, how to plan, organize, and control; the process of motivation; employee relations; training, communication, and coordination; cost control and work simplification.
- Sharpen their verbal communication skills.
- Write effective letters, reports, and proposals.
- Be a contributing leader/member of an organizations quality improvement team, by understanding and communicating the accepted concepts and techniques.
- Learn and implement the principles of statistical process control within their organization.
- Learn and understand the use of quality measurement tools and measurement inspection methods.

Estimated Curriculum Duration: 615 hours.
Number of Exams: 65.

Computers in Business

Introduction to Computer Concepts ..............................................050924

Optional: Advanced Accounting/Communication Skills

Intermediate Accounting .................................................................6656A-K
Consignment and Installment Sales ..................................................5972
Advanced Partnership Accounting ..................................................5970
Funds Accounting .........................................................................5971
Practical English and the Command of Words ..................................ELIM07

Estimated Duration: 176 hours.
Number of Exams: 18.

Marketing and Sales

Principles of Marketing .................................................................5057A-B
Managing Physical Distribution .......................................................6536A-B
Marketing Research .......................................................................5055A-D
Sales Management .......................................................................5060A-C
Sales Records and Reports .............................................................5998
Public Relations ...........................................................................5058A-C
Selling Your Ideas .........................................................................6219

Estimated Curriculum Duration: 615 hours.
Number of Exams: 65.

Special Note:
Optional courses covering Personal Computing Software Applications are listed in Resource 1, Career Development.

Base Curriculum

<table>
<thead>
<tr>
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<tbody>
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<td>Principles of Supervision</td>
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</table>
| Trades Safety: Getting Started ..............................................186001
| Working Safely with Chemicals ...............................................186002
| Fire Safety ...............................................................................186003
| Material Handling Safety .......................................................186006
| Basic Supervision Skills: Management Concepts .........................060007
| Basic Supervision Skills: How to Plan, Organize, and Control ..........060008
| Basic Supervision Skills: The Process of Motivation ......................060009
| Basic Supervision Skills: Employee Relations ................................060010
| Basic Supervision Skills: Training, Communication, and Coordination ..............................................................................060011
| Basic Supervision Skills: Cost Control and Work Simplification ..........060012
| Problem Solving and Troubleshooting .........................................186073

Operations/Communications Enhancement

Plant Layout ..................................................................................2555A-B
Operation Analysis .........................................................................2552A-B
Maintenance and Troubleshooting ..................................................Block 27
Preventive Maintenance ...................................................................286085
Preventive Maintenance Techniques ..................................................286086
Predictive Maintenance ....................................................................286087
Predictive Maintenance: Vibration Analysis ......................................286088
Predictive Maintenance: Advanced Topics ......................................286089
Practical English and the Command of Words ..................................ELIM07
Report Writing ...............................................................................05001-24
Time Study, Part 1 ..........................................................................066016
Time Study, Part 2 ..........................................................................066017
Selling Your Ideas ..........................................................................6219
Material Management and Inventory Control ..................................386E03

Quality Improvement Concepts and Statistical Process Control

Quality Concepts: Terminology for Management ................................186035
Quality Control of Manufactured Products ......................................2590
Quality Control for the Technician ..................................................386E02

Estimated Curriculum Duration: 376 hours.
Number of Exams: 46.

060001
Elements of Business Success
<table>
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<th>Course Title</th>
<th>Duration</th>
<th>Course Prerequisite</th>
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<tr>
<td>060002</td>
<td>Fundamentals of Business</td>
<td>5 hours (includes 1 test)</td>
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<td>Your Place in Business; Attitude; Productivity; Outcomes and Processes; Relationships; Excellence; Personal Management.</td>
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<tr>
<td>060003</td>
<td>The Role of Management in Business</td>
<td>5 hours (includes 1 test)</td>
<td>Fundamentals of Business (060002)</td>
<td>The Origins and Development of Business; The Principles of Business; Managing the Business System; Winning in Business.</td>
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<tr>
<td>060004</td>
<td>Tools and Trends of the Managerial Trade</td>
<td>5 hours (includes 1 test)</td>
<td>The Role of Management in Business (060003)</td>
<td>Planning; Problem Solving; Useful Managerial Control Tools; New Directions for Today's Managers.</td>
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<tr>
<td>060005</td>
<td>Principles of Business Finance</td>
<td>5 hours (includes 1 test)</td>
<td>Fundamentals of Business (060002)</td>
<td>Concepts of Business Finance; Forms of Business Organization; Financing a Business; Business Accounting.</td>
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<tr>
<td>060006</td>
<td>Introduction to Marketing</td>
<td>5 hours (includes 1 test)</td>
<td>Fundamentals of Business (060002)</td>
<td>Marketing Functions; Four Critical Marketing Factors; Understanding Consumers; The Purchase Process; The Product Life Cycle; Market Research.</td>
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<td>060007</td>
<td>Basic Supervision Skills: Management Concepts</td>
<td>10 hours (includes 1 test)</td>
<td>Fundamentals of Business (060002)</td>
<td>Management Concepts Study Unit: Historical Development of the Management Concept; Nature and Role of Management: Responsibilities, Functions, Authority, Delegation; Leadership Styles and Abilities; Discipline.</td>
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<td>060008</td>
<td>Basic Supervision Skills: How to Plan, Organize, and Control</td>
<td>10 hours (includes 1 test)</td>
<td>The Role of Management in Business (060003)</td>
<td>How to Plan, Organize, and Control Study Unit: The Nature of Planning; The Meaning of Organization; The Need for Formal Organization Structures; A Six Step Procedure for Reorganization; Aspects of Controlling.</td>
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060009  
**Basic Supervision Skills: The Process of Motivation**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
The Process of Motivation Study Unit: Concepts and Theories of Motivational Management; Managerial Responsibility for Motivation; The Power to Understand Individual Needs: A Bi-Relational Concern; On-The-Job Assessment of Workers' Needs; The New Worker and New Motivation; Participative Management as a Means to Motivational Management; The Good Morale Enterprise: A By-Product of Motivational Management.

060010  
**Basic Supervision Skills: Employee Relations**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Employee Relations Study Unit: From Labor Unions to Unionism; The Manager's Role in Employee Relations; The Manager's Role in Employee Selection; The Manager's Role in Employee Development.

060011  
**Basic Supervision Skills: Training, Communication, and Coordination**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Training, Communication, and Coordination Study Unit: Employee Training; The Training Process; The Manager as Trainee; Communication in Modern Organizations; Communication and Coordination.

060012  
**Basic Supervision Skills: Cost Control and Work Simplification**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Cost Control and Work Simplification Study Unit: Cost Control; The Language of Cost Control; Work Simplification; The Process of Work Simplification: Select the Problem; Record the Details; Challenge the Details; Develop an Improvement; Install the Improvement.

060935  
**Organizational Behavior**

**Duration:** 36 hours (includes 6 tests)

**What Students Learn:**
Management Approaches; Human Decision Making; Conflict Management; Communication in Groups; Power and Influence; Organizational Environment; Structure and Design; Fundamental Forces of Change.

**Special Note:**
- This course consists of a textbook and a supplemental study guide.

061001  
**Introduction to Accounting**

**Duration:** 10 hours (includes 1 test)

**What Students Learn:**
Fields of Accounting; Career Specialization Opportunities; Business and the Need for Accounting; Nature and Purpose of Accounting; Accounting Principles; The Balance Sheet; Accounting Equations.

061002  
**Accounting: Financial Statement Reporting**

**Course Prerequisite:** Introduction to Accounting (061001)

**What Students Learn:**

061003  
**Accounting: Use of Accounts**

**Course Prerequisite:** Introduction to Accounting (061001)

**What Students Learn:**
Recording Transactions: Use of Accounts; Debits and Credits; Balance Sheet Accounts; Revenue and Expense Accounts; Debit and Credit Summary; Recording Business Transactions; The Trial Balance; Journal Entries and Posting; The Journal; The General Journal; Journalizing; Recording Business Transactions in a Journal; Posting to Ledger Accounts; Classification of Accounts; Procedures in the Accounting Sequence.
061004
**Accounting: Journal Entries**

*Duration:* 10 hours (includes 1 test)

*Course Prerequisite:* Introduction to Accounting (061001)

*What Students Learn:* Periodic Adjustments: Historical Entries; Cash versus Accrual Method of Accounting; The Matching Concept; The Need for Adjusting Accounts; Types of Adjusting Entries; Recording Periodic Adjusting Entries; Adjusting Entries and the Accounting Cycle; Closing the Accounts; Procedures in the Closing Process; Closing Entries; Balancing and Ruling Accounts; Post-Closing Trial Balance.

061007
**Accounting: Accounting Journals**

*Duration:* 10 hours (includes 1 test)

*Course Prerequisite:* Introduction to Accounting (061001)


061005
**Accounting: The Work Sheet**

*Duration:* 10 hours (includes 1 test)

*Course Prerequisite:* Introduction to Accounting (061001)

*What Students Learn:* The Work Sheet: Purpose of the Work Sheet; Preparing the Work Sheet; Using the Work Sheet; The Accounting Cycle; A Comprehensive Review of the Accounting Cycle for a Service Business.

061008
**Accounting: Cash Accounting**

*Duration:* 10 hours (includes 1 test)

*Course Prerequisite:* Introduction to Accounting (061001)

*What Students Learn:* Accounting for Cash: The Bank Checking Account; Accounting for Receivables: Classification, Sales on Credit, Accounting for Uncollectible Receivables; Notes Receivable: Definition, Determining Maturity and Interest, Accounting.

061006
**Accounting: Merchandising Business Procedures**

*Duration:* 10 hours (includes 1 test)

*Course Prerequisite:* Introduction to Accounting (061001)

*What Students Learn:* Accounts and Procedures for a Merchandising Business: The Sales Account; The Sales Invoice; The Purchase Account; The Purchase Order; The Merchandise Inventory Account; The Sales Returns and Allowances Account; The Credit Memorandum; The Debit Memorandum; The Purchases Returns and Allowances Account; The Transportation-In Account; Trade Discounts; Sales Discounts; Purchase Discounts; Uncollectible Accounts; Estimating the Uncollectible Accounts Expense; The Income Statement; A Detailed Illustration; The Work Sheet for a Merchandising Business; The Financial Statement: Closing Entries.

061009
**Accounting: Investment and Inventory Accounting**

*Duration:* 10 hours (includes 1 test)

*Course Prerequisite:* Introduction to Accounting (061001)

*What Students Learn:* Accounting for Short-Term Investments: Nature of Investments – Stocks and Bonds; Importance of Inventory Accounting; Inventory Valuation Methods; Periodic and Perpetual Inventory Accounting; Markups and Markdowns.
061010  
**Accounting: Depreciation of Fixed Assets**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Introduction to Accounting (061001)

**What Students Learn:**
Accounting for the Acquisition and Depreciation of Property, Plant, and Equipment; Nature of Fixed Assets; Methods of Computing Depreciation; Disposal of Fixed Assets; Accounting for Natural Resources and Long-Lived Intangible Assets; Accounting for Long-Term Investments.

061011  
**Accounting: Liabilities**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Introduction to Accounting (061001)

**What Students Learn:**
Accounting for Current Liabilities: Current Ratio; Accounting for Long-Term Liabilities; Sinking Funds; Accounting Principles and Concepts.

061012  
**Accounting: Partnerships**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Introduction to Accounting (061001)

**What Students Learn:**
Accounting for Partnerships: Forms of Business Organizations; Methods of Dividing Partnership Income and Losses; Terminating a Partnership.

061013  
**Accounting: Corporations**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Introduction to Accounting (061001)

**What Students Learn:**
Accounting for Corporations: Types of Business Organizations; Corporate Ownership and Management; Classes of Capital Stock; Dividend Distribution; Treasury Stock; Retained Earnings; Dividend Accounting; Consolidated Accounting Methods and Financial Statement Preparation.

061014  
**Accounting: Comprehensive Review**

**Duration:** 10 hours (includes 1 test)

**Course Prerequisite:**
Introduction to Accounting (061001)

**What Students Learn:**
Comprehensive Review of the Accounting Cycle for a Firm Operating as a Corporate Entity: Instructions for Handling Accounting Transactions.

050924  
**Introduction to Computer Concepts**

**Duration:** 10 hours (includes 2 test)

**What Students Learn:**
Describe what computers do and how they work; Explain the hardware components and their functions; Identify the two general types of software; Describe the principles of telecommunication; Discuss the Internet and the World Wide Web; Describe the characteristics of a software suite; Identify the steps of the systems development life cycle (SDLC); List some ways databases are used on the World Wide Web (WWW); Discuss the considerations taken into account when selecting a computer system; Access the impact of computers on everyday life.
5055A-D
Marketing Research

Duration: 40 hours (includes 4 tests)

Course Prerequisite: Principles of Marketing (5057A-B)

What Students Learn:
Part 1 (5055A), Marketing Environment; Decision Process; Tri-Plan System; Marketing Orientation; Buying and Selling Motives; Consumerism; Nature and Scope of Marketing Research; Methods of Marketing Research.
Part 2 (5055B), Introduction to Sampling; Defining the Universe; Sample Design; Probability versus Nonprobability Sampling; Normal Curve; Standard Deviation; Sampling Error; Confidence Limits; Size of the Sample; Sampling Methods; Overview of a Marketing Research Project; Planning the Research Project; Formulating the Problem; Decision Process Determining the Research Objective; Determining the Sources of Information.
Part 3 (5055C), Secondary Data; Advantages of Secondary Data; Limitations of Secondary Data; Selecting Sources of Secondary Data; Types of Secondary Data; Primary Data Sources; Preparing the Primary Data Program; Preparing the Questionnaire; Varieties of Questionnaire Scales; Activating the Research Project; Organizing Field Operations; Data Analysis Developing Summary Statistics.
Part 4 (5055D), Preparing Data for Analysis; Rules of Editing; Validating the Sample; Tabulation; Bias; Correlation Analysis; Reliability Tests; Chi-square Tests; Analysis of Variance; Nonparametric Tests; Methods of Statistical Presentations; Forecasting.

5055A-D
Marketing Research

5057A-B
Principles of Marketing

Duration: 20 hours (includes 2 tests)

What Students Learn:
Part 1 (5057A), The New Marketing Concept; Functions of the Marketing Manager; Planning Marketing Strategy; Market Segmentation Analysis; The Marketing Environment - Economic, Ecological, Technological, and Cultural; Political and Legal Constraints on Marketing; Consumerism, Market Analysis, Cultural and Social Determinants, and Consumer Behavior; Problem Solving Models of Consumer and Industrial Buying Behavior; Value Analysis; Marketing Research and Forecasting.
Part 2 (5057B), The Product Concept; Product Planning and Development; Product Branding and Packaging; Promotion and Promotional Policies; Managing the Sales Force; Selection, Training, and Compensation; Channels of Distribution; Developing a Channel Strategy; Price Determination and Pricing Policy; Government Regulation.

5058A-C
Public Relations

Duration: 30 hours (includes 3 tests)

Course Prerequisite: Principles of Marketing (5057A-B)

What Students Learn:
Part 1 (5058A), What is Public Relations; Evolution of Public Relations; Public Relations Responsibility and Functions; The Public Relations Agency; Public Opinion; Theory of Cognitive Dissonance; Laws of Public Opinion; Research and Communication Theory.
Part 2 (5058B), Dealing with the Press; Art of Publicity; Public Relations in Government; Corporate Government Relations; Community Relations; Public Affairs; Financial Relations; Disclosure and the S.E.C.; Employee Public; Consumer Public; Youth, Women, and Other Special Publics.
Part 3 (5058C), Techniques of Public Relations Writing; Effective Speech Writing; Public Relations and Marketing; Uses in Advertising; Public Relations Abroad; Support Activities and the Future.

5060A-C
Sales Management

Duration: 30 hours (includes 3 tests)

What Students Learn:
Part 1 (5060A), The Field Sales Management; Careers in Selling; Organization of the Sales Force; Sales Organization "Danger Signals;" Leadership Qualities; Relation of Sales Department to Internal Organization and External Community; The Art of Sales Management.
Part 3 (5060C), The Role of the Sales Manager; Sales Operations Strategy; Managing Sales Representatives Performance; Managing Distribution; Management of Information.

5065A-C
Personnel Management

Duration: 30 hours (includes 3 tests)

What Students Learn:
Part 1 (5065A), Personnel Management Defined; Duties and Qualifications of the Personnel Manager; Line and Staff Relationships; Employee Selection; Orientation and Training; Wage and Salary Administration; Employee Health and Safety; Discipline, Promotions, and Transfers; Union-Management Relations; Fringe Benefits; The Employment Process.
Part 2 (5065B), Determination of Training Needs; Types of Training Methods; Evaluating Training Programs; Employee Appraisal Techniques; Job Analysis and Evaluation; Salary Surveys; Methods of Compensation.
Part 3 (5065C), Unions and the Personnel Management Function; Collective Bargaining Procedures; Who, Where, and When of Negotiating; Employee Benefits and Services.
5074A-B
Introduction to Business Finance

Duration: 20 hours (includes 2 tests)

What Students Learn:
Part 1 (5074A). The Role of Finance; Forms of Business Organization; Managing Business Firms; Financial Control; Capital Budgeting; Sources of Funds; Retained Earnings; Dividend Policies.
Part 2 (5074B). Marketing Primary Securities; Secondary Market for Securities; Stock Exchanges; Sources of Funds; Long Term Debt; Capital Structure; Financial Planning; Changing the Capital Structure; Growth of the Business Firm; Financing Foreign Expansion and Trade; Reorganization or Liquidation of the Business Firm.

5080A-B
Business Law: The Law of Business Organization

Duration: 20 hours (includes 2 tests)

What Students Learn:
Part 1 (5080A). Nature and Creation of an Agency; Rights, Duties, and Obligations in a Partnership; Purchase and Sale of Real Property.
Part 2 (5080B). Corporate Form of Business Organization; General Corporate Powers; Board of Directors; Liability of Officers; Issuance and Sale of Shares; Classes of Stock; Shareholder's Rights; Voting Rights; Dividends; Preemptive Rights; Dissolution and Liquidation.

5081A-C
Business Law: The Law of Business Transactions

Duration: 30 hours (includes 3 tests)

What Students Learn:
Part 2 (5081B). Contractual Capacity; Parol Evidence Rule; Interpretation of Contracts; Introduction to Assignments; Third-Party Beneficiary Contracts; Conditions and Discharge of Contracts; The Repair Doctrine; Secured Transactions; Suretyship; Statue of Frauds; Usury.
Part 3 (5081C). Contractual Remedies; Obligations of Sellers; Obligations of Buyers: Expressed and Implied Warranties; Seller’s Remedies; Buyer’s Remedies; Bankruptcy; Commercial Paper; Transfer of Commercial Paper; Endorsements; Holder in Due Course; Real Defenses; Liability of Parties.

5970
Advanced Partnership Accounting

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Intermediate Accounting (6656A-K)

What Students Learn:
Organization and Profit Sharing; Changes in Ownership Interest; Liquidation of a Partnership; Incorporation of a Partnership; Joint Ventures.

5971
Funds Accounting

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Accounting (0610XX)

What Students Learn:
Governmental Accounting Principles; Accounting for Governmental Funds; Accounting for Other Funds.

5972
Consignment and Installment Sales

Duration: 10 hours (includes 1 test)

Course Prerequisite:
Accounting (0610XX)

What Students Learn:
Introduction to Consignment Sales; Accounting Methods of the Consignee; Accounting Methods of the Consignor; Accounting for Installment Sales.

5998
Sales Records and Reports

Duration: 10 hours (includes 1 test)

What Students Learn:
Purpose of Records and Reports; Customers’ Records; Chronological Records; Importance of Reports to Management; Proper Market Research; Graph-A-Matic Computing Charts; Control of Salesman’s Performance; Types of Reports; Weekly Work Plan.

6219
Selling Your Ideas

Duration: 10 hours (includes 1 test)

What Students Learn:
The Qualities Which Employers Look For; How to Make Others Understand; How to Achieve Good Self-Expression; Putting Over Ideas Through Persuasion; The Relationship between Advancement and the
Selling of Ideas; The Cultivation of a Positive Attitude; Speaking Up, Using Words as Tools, Questioning, and Listening; Working with Associates; Admitting Mistakes; Seeking Participation.

6235A-C
Inventory Control

Duration: 30 hours (includes 3 tests)

What Students Learn:
Part 1 (6235A). Purpose of Inventory Control; Types of Inventory; Inventory Forms and Records; Record Maintenance; Physical Location; Maintaining Proper Inventory Balances; Interpretation of the Material Record; Total Requirements and Total Coverage; Statement of Inventory Policy; Planning Controls; Shortages; Receiving; Location and Layout, Responsibilities, and Personnel.
Part 2 (6235B). Stores Department: Location, Identification of Materials, Operation Policies, and Personnel; Shipping Department: Location, Layout, and Documentation; Rejections: Rule of Inspection and Rejection Points; Physical Inventory: Purpose, Kinds, Reconciliation, and Sequence of Transactions; Advanced Inventory Control: Variable Costs, Costs of Having Inventory, Cost of Getting Inventory, Economic Order Quantity (EOQ) Tables, Analyzing EOQ Formula, Unit Formula for Fixed Costs and Quantity Discounts.
Part 3 (6235C). The Effect of Errors in the Economic Order Quantity (EOQ) Formula; Improving Order Quantity Without Cost Studies; Reducing Inventory Costs; The “When to Order” Action: Costs Affecting Reorder Point, Reorder Point Practices, Balanced Protection, Defining Lead Time, Probable Variation in Usage and Normal Curve; Working and Safety Stocks; Selective Treatments of Inventory: Need for Inventory Classification and Classification by Value; Making an Inventory Study; Order Tables, Stockout Frequency, and the Summary Report; Measuring Inventory Efficiency; Total Cost Turnover; Problems of “Selling” Advanced Inventory Control to Operating Personnel and Management.

6536A-B
Managing Physical Distribution

Duration: 20 hours (includes 2 tests)

What Students Learn:
Part 1 (6536A). Historical Development of Physical Distribution; Cost of Physical Distribution; Importance of Physical Distribution; Functional Areas of Physical Distribution; Distribution System Analysis; The Systems Concept; The Physical Distribution System; Establishment of Distribution Objectives; Selection of Alternative Systems; Constructing and Testing Models; Total Cost Analysis; Comparative Statistics; Multiple Analysis.
Part 2 (6536B). Location Analysis; Production Plant Location; Retail Location; Distribution Warehouse Location; Single Facility Location; Multiple Facility Location; Transportation and Traffic; Legal Forms of Transportation; Coordinated Transportation Systems; Special Transportation Agencies; Transportation Rates; Special Transportation Services; Transportation Documentation; Traffic Distribution Planning; Organization and Performance Measurement; Centralized Concept of Formal Organization.

6656A-K
Intermediate Accounting

Duration: 110 hours (includes 11 tests)

Course Prerequisite:
Accounting (0610XX)

What Students Learn:
Part 2 (6656B). Compound Interest, Present Value, and Annuities; Cash and Temporary Investments; Receivables.
Part 3 (6656C). Inventory Basic Cost Methods; Inventory Valuation Methods; Estimating Techniques.
Part 4 (6656D). Fixed Assets; Depreciation; Depletion.
Part 5 (6656E). Intangible Assets; Long-Term Investments in Securities; Other Long-Term Investments.
Part 6 (6656F). Current Liabilities; Bonds Payable.
Part 7 (6656G). Corporations; Retained Earnings and Dividends.
Part 8 (6656H). Treasury Stock; Book Value; Earnings per Share; Long-Term Leases and Pensions.
Part 9 (6656I). Accounting for Income Taxes; Accounting Changes; Correction of Errors; Statements from Incomplete Records.
Part 11 (6656K). Interpretation of Financial Statements; Price-Level Accounting.
**Alphabetical/Subject Index**

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Course Number</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Motor Repair</td>
<td>6631A-B</td>
<td>149</td>
</tr>
<tr>
<td>AC, Motors, Generators, and Rectifiers</td>
<td>6669E</td>
<td>149</td>
</tr>
<tr>
<td>AC Principles</td>
<td>Block A22</td>
<td>152</td>
</tr>
<tr>
<td>Accessory Equipment (Detroit Diesel)</td>
<td>0D12</td>
<td>364</td>
</tr>
<tr>
<td>Accessory Equipment (Mack)</td>
<td>0C11</td>
<td>363</td>
</tr>
<tr>
<td>Accessory Equipment and Adaptations (Cummins)</td>
<td>0H12</td>
<td>364</td>
</tr>
<tr>
<td>Accident Investigation (K000AIN9EM)</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>Accident Investigation (K000AIN9EM)</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>Accident Investigation (V000AIN9EM)</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>Accident Prevention (K000SHK9EM)</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>Accident Prevention (K000SHK9EM)</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Accident Release Measures &amp; Spill Cleanup Procedures</td>
<td>V000ACC9EW</td>
<td>91</td>
</tr>
<tr>
<td>Accounting</td>
<td>0610XX, 02-14</td>
<td>272</td>
</tr>
<tr>
<td>Addition and Subtraction</td>
<td>186008</td>
<td>56</td>
</tr>
<tr>
<td>Advanced Automotive Computer Systems</td>
<td>004022</td>
<td>350</td>
</tr>
<tr>
<td>Advanced Mechanical Drawing</td>
<td>5773A-B</td>
<td>333</td>
</tr>
<tr>
<td>Advanced Partnership Accounting</td>
<td>5970</td>
<td>376</td>
</tr>
<tr>
<td>Advanced Solid State Circuits</td>
<td>2008A-B</td>
<td>140</td>
</tr>
<tr>
<td>Advanced Troubleshooting Techniques (Block B16)</td>
<td>167</td>
<td></td>
</tr>
<tr>
<td>Air Brake Systems, Part 1</td>
<td>0KK2</td>
<td>365</td>
</tr>
<tr>
<td>Air Brake Systems, Part 2</td>
<td>0KK3</td>
<td>365</td>
</tr>
<tr>
<td>Air Compressors, Part 1</td>
<td>286096</td>
<td>204</td>
</tr>
<tr>
<td>Air Compressors, Part 2</td>
<td>286097</td>
<td>204</td>
</tr>
<tr>
<td>Air Conditioning Systems</td>
<td>6080A-B</td>
<td>207</td>
</tr>
<tr>
<td>Air Intake and Exhaust Systems (Mack)</td>
<td>00C9</td>
<td>363</td>
</tr>
<tr>
<td>Algebra</td>
<td>2469A-E</td>
<td>49</td>
</tr>
<tr>
<td>Alternating Current</td>
<td>086007</td>
<td>152</td>
</tr>
<tr>
<td>Alternating Current Circuits</td>
<td>086008</td>
<td>152</td>
</tr>
<tr>
<td>Alternating Current Motors</td>
<td>4032</td>
<td>144</td>
</tr>
<tr>
<td>Alternators</td>
<td>4031</td>
<td>144</td>
</tr>
<tr>
<td>Amplifiers</td>
<td>086012</td>
<td>153</td>
</tr>
<tr>
<td>Analog Circuit Measurement</td>
<td>Block A23</td>
<td>153</td>
</tr>
<tr>
<td>Analog Electronic Components</td>
<td>Block B23</td>
<td>169</td>
</tr>
<tr>
<td>Analog Systems</td>
<td>2133</td>
<td>141</td>
</tr>
<tr>
<td>Analytic Geometry</td>
<td>6561A-B</td>
<td>51</td>
</tr>
<tr>
<td>ANSI MSDS</td>
<td>K000MAS9EM</td>
<td>82</td>
</tr>
<tr>
<td>ANSI MSDS</td>
<td>V000MAL9EW</td>
<td>95</td>
</tr>
<tr>
<td>ANSI MSDS</td>
<td>V000MAT9EL</td>
<td>84</td>
</tr>
<tr>
<td>Antilock Braking Systems</td>
<td>004031</td>
<td>351</td>
</tr>
<tr>
<td>Applications and Installation of Cummins Engines</td>
<td>0H15</td>
<td>364</td>
</tr>
<tr>
<td>Applications and Troubleshooting of Resonant Circuits</td>
<td>086039</td>
<td>168</td>
</tr>
<tr>
<td>Arc Welding Equipment, Part 1</td>
<td>286032</td>
<td>233</td>
</tr>
<tr>
<td>Arc Welding Equipment, Part 2</td>
<td>286033</td>
<td>233</td>
</tr>
<tr>
<td>Arc Welding Equipment, Part 3</td>
<td>286053</td>
<td>233</td>
</tr>
<tr>
<td>Arc Welding of Alloy Steels and Iron</td>
<td>5250</td>
<td>243</td>
</tr>
<tr>
<td>Arc Welding of Low Carbon Steel</td>
<td>5249A-B</td>
<td>242</td>
</tr>
<tr>
<td>Arc Welding of Nonferrous Metals and Overlaying</td>
<td>5251</td>
<td>243</td>
</tr>
<tr>
<td>Architectural Drawing</td>
<td>5637A-B</td>
<td>332</td>
</tr>
<tr>
<td>Arithmetic for Mechanics (Diesel)</td>
<td>0A15</td>
<td>358</td>
</tr>
<tr>
<td>Arithmetic for Mechanics (Gasoline)</td>
<td>0B12</td>
<td>360</td>
</tr>
<tr>
<td>Asbestos Awareness</td>
<td>K000ASBVEO</td>
<td>97</td>
</tr>
<tr>
<td>Asbestos Awareness (V000ASB9EO)</td>
<td>87, 102</td>
<td></td>
</tr>
<tr>
<td>Audio and RF Circuits</td>
<td>086046</td>
<td>172</td>
</tr>
<tr>
<td>Automatic Combustion Control</td>
<td>2596A-C</td>
<td>267</td>
</tr>
<tr>
<td>Automatic Process Control Valves</td>
<td>6307</td>
<td>207</td>
</tr>
<tr>
<td>Automatic Screw Machines</td>
<td>3530A-B</td>
<td>235</td>
</tr>
<tr>
<td>Automotive Braking Systems</td>
<td>004030</td>
<td>350</td>
</tr>
<tr>
<td>Automotive Cooling Systems</td>
<td>004006</td>
<td>348</td>
</tr>
<tr>
<td>Automotive Drive Trains: Automatic and Manual</td>
<td>ADT02</td>
<td>357</td>
</tr>
<tr>
<td>Automotive Electrical Systems</td>
<td>004020</td>
<td>349</td>
</tr>
<tr>
<td>Automotive Engine Components</td>
<td>004003</td>
<td>348</td>
</tr>
<tr>
<td>Automotive Engine Overhaul</td>
<td>004004</td>
<td>348</td>
</tr>
<tr>
<td>Automotive Engine Performance/Troubleshooting</td>
<td>004023</td>
<td>350</td>
</tr>
<tr>
<td>Automotive Engines: Theory and Servicing</td>
<td>AE01</td>
<td>358</td>
</tr>
<tr>
<td>Automotive Fuel Systems, Part 1</td>
<td>004009</td>
<td>349</td>
</tr>
<tr>
<td>Automotive Fuel Systems, Part 2</td>
<td>004010</td>
<td>349</td>
</tr>
<tr>
<td>Automotive Heating and Air Conditioning</td>
<td>004028</td>
<td>350</td>
</tr>
<tr>
<td>Automotive Heating and Air Conditioning Systems</td>
<td>004029</td>
<td>350</td>
</tr>
<tr>
<td>Automotive Lubrication Systems</td>
<td>004005</td>
<td>348</td>
</tr>
<tr>
<td>Automotive Steering Systems and Wheel Alignment</td>
<td>004014</td>
<td>349</td>
</tr>
<tr>
<td>Automotive Suspension Systems</td>
<td>004013</td>
<td>349</td>
</tr>
<tr>
<td>Back Safety</td>
<td>V0000439EM</td>
<td>73</td>
</tr>
<tr>
<td>Back Safety</td>
<td>K0000439EM</td>
<td>80</td>
</tr>
<tr>
<td>Back Safety</td>
<td>K000043VEM</td>
<td>78</td>
</tr>
<tr>
<td>Basic Electronic Circuits</td>
<td>Block B24</td>
<td>170</td>
</tr>
<tr>
<td>Basic Electronic Components and Schematic Symbols</td>
<td>2020</td>
<td>140</td>
</tr>
<tr>
<td>Basic Industrial Computer Systems</td>
<td>Block B10</td>
<td>162</td>
</tr>
<tr>
<td>Basic Industrial Electronic System</td>
<td>Block B15</td>
<td>166</td>
</tr>
<tr>
<td>Basic Industrial Math</td>
<td>Block X21</td>
<td>56</td>
</tr>
<tr>
<td>Basic Machining Skills</td>
<td>Block X08</td>
<td>248</td>
</tr>
<tr>
<td>Basic Organic Chemistry</td>
<td>5017A-B</td>
<td>324</td>
</tr>
<tr>
<td>Basic Semiconductor Components: Diodes</td>
<td>086019</td>
<td>169</td>
</tr>
<tr>
<td>Basic Semiconductor Components: Transistors</td>
<td>086020</td>
<td>169</td>
</tr>
<tr>
<td>Basic Supervision Skills: Cost Control and Work Simplification</td>
<td>060012</td>
<td>372</td>
</tr>
<tr>
<td>Basic Supervision Skills: Employee Relations</td>
<td>060010</td>
<td>372</td>
</tr>
<tr>
<td>Basic Supervision Skills: How to Plan, Organize, and Control</td>
<td>060008</td>
<td>371</td>
</tr>
</tbody>
</table>
# Alphabetic/Subject Index

## Course Title Number Number Page

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Number</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Supervision Skills:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management Concepts</td>
<td>060007</td>
<td>371</td>
</tr>
<tr>
<td>Basic Supervision Skills: The Process of Motivation</td>
<td>060009</td>
<td>372</td>
</tr>
<tr>
<td>Basic Supervision Skills Training, Communication, and Coordination</td>
<td>060011</td>
<td>372</td>
</tr>
<tr>
<td>Basic Test Equipment</td>
<td>086025</td>
<td>153</td>
</tr>
<tr>
<td>Batteries and Electronic Power Supplies</td>
<td>6598</td>
<td>148</td>
</tr>
<tr>
<td>Bearings and Seals, Part 1</td>
<td>286093</td>
<td>203</td>
</tr>
<tr>
<td>Bearings and Seals, Part 2</td>
<td>286094</td>
<td>203</td>
</tr>
<tr>
<td>Belt Power Transmission</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bench Work</td>
<td>5004A-C</td>
<td>241</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>K000B219EO</td>
<td>102</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>K000B2P9ER</td>
<td>102</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>K000B2Y9EO</td>
<td>102</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>V000B219EO</td>
<td>87</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>K000B2Y9EO</td>
<td>87</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>K000B2P9ER</td>
<td>87</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>V000B219EO</td>
<td>87</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>V000B2Y9EO</td>
<td>87</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>V000B2P9ER</td>
<td>87</td>
</tr>
<tr>
<td>Bloodborne Pathogens</td>
<td>V000B319EO</td>
<td>88</td>
</tr>
<tr>
<td>Boring Mills</td>
<td>5636A-A</td>
<td>243</td>
</tr>
<tr>
<td>Broaching</td>
<td>6091</td>
<td>243</td>
</tr>
<tr>
<td>Builder's Hardware</td>
<td>6421A-B</td>
<td>271</td>
</tr>
<tr>
<td>Building Drawings</td>
<td>186043</td>
<td>60</td>
</tr>
<tr>
<td>Building Unit Construction</td>
<td>2185</td>
<td>266</td>
</tr>
<tr>
<td>Bulk Measurement</td>
<td>186022</td>
<td>57</td>
</tr>
<tr>
<td>Business Mathematics</td>
<td>5565A-B</td>
<td>50</td>
</tr>
<tr>
<td>Cab Air Conditioning Systems</td>
<td>0K10</td>
<td>365</td>
</tr>
<tr>
<td>Cable: Introduction to Transmission and Measurement</td>
<td>786001</td>
<td>150</td>
</tr>
<tr>
<td>Cable: Performance Characteristics</td>
<td>786002</td>
<td>150</td>
</tr>
<tr>
<td>Calculus: Function and Use</td>
<td>6618A-D</td>
<td>51</td>
</tr>
<tr>
<td>Cams</td>
<td>2605</td>
<td>198</td>
</tr>
<tr>
<td>Capacitors and Inductors</td>
<td>086003</td>
<td>151</td>
</tr>
<tr>
<td>Capacitors in AC Circuits</td>
<td>086010</td>
<td>153</td>
</tr>
<tr>
<td>Carpenter</td>
<td>986M01</td>
<td>270</td>
</tr>
<tr>
<td>Carpentry</td>
<td>5602A-F</td>
<td>270</td>
</tr>
<tr>
<td>Caterpillar D7, D8, and D9 Tractors, Part 1</td>
<td>00P5</td>
<td>365</td>
</tr>
<tr>
<td>Caterpillar D7, D8, and D9 Tractors, Part 2</td>
<td>00P6</td>
<td>36</td>
</tr>
<tr>
<td>Caterpillar D7, D8, and D9 Tractors, Part 3</td>
<td>00P7</td>
<td>365</td>
</tr>
<tr>
<td>Caterpillar D7, D8, and D9 Tractors, Part 4</td>
<td>00P8</td>
<td>365</td>
</tr>
<tr>
<td>Chemistry</td>
<td>007094</td>
<td>318</td>
</tr>
<tr>
<td>Circuit Analysis and Ohms Law</td>
<td>086002</td>
<td>151</td>
</tr>
<tr>
<td>City Surveying</td>
<td>6818A-C</td>
<td>338</td>
</tr>
<tr>
<td>Clutches and Driveshaft Assemblies</td>
<td>0KK5</td>
<td>365</td>
</tr>
<tr>
<td>CNC Milling</td>
<td>386042</td>
<td>239</td>
</tr>
<tr>
<td>CNC Technology and Programming</td>
<td>66903</td>
<td>230</td>
</tr>
<tr>
<td>CNC Turning</td>
<td>386041</td>
<td>238</td>
</tr>
<tr>
<td>Cold Water Supply</td>
<td>5384</td>
<td>206</td>
</tr>
<tr>
<td>Combustion Turbines, Part 1</td>
<td>786013</td>
<td>293</td>
</tr>
<tr>
<td>Combustion Turbines, Part 2</td>
<td>786014</td>
<td>293</td>
</tr>
<tr>
<td>Combustion Turbines, Part 3</td>
<td>786015</td>
<td>293</td>
</tr>
<tr>
<td>Common Brickwork</td>
<td>6290</td>
<td>271</td>
</tr>
<tr>
<td>Common Hand Tools, Part 1</td>
<td>186052</td>
<td>58</td>
</tr>
<tr>
<td>Common Hand Tools, Part 2</td>
<td>186053</td>
<td>58</td>
</tr>
<tr>
<td>Common Thermal Cutting Processes</td>
<td>286028</td>
<td>232</td>
</tr>
<tr>
<td>Component Testers</td>
<td>086062</td>
<td>134</td>
</tr>
<tr>
<td>Compressed Gas Cylinders</td>
<td>K000CG9EM</td>
<td>81</td>
</tr>
<tr>
<td>Compressed Gas Cylinders</td>
<td>V000CG9EM</td>
<td>86</td>
</tr>
<tr>
<td>Compressed Gas Cylinders</td>
<td>K000CGCVEM</td>
<td>77</td>
</tr>
<tr>
<td>Compressed Gas Cylinders</td>
<td>V000CGC9M</td>
<td>74</td>
</tr>
<tr>
<td>Computer Aided Drafting and Design</td>
<td>066091</td>
<td>316</td>
</tr>
<tr>
<td>Computer Workstation Safety</td>
<td>K0000219EM</td>
<td>81</td>
</tr>
<tr>
<td>Computer Workstation Safety</td>
<td>K0000219EM</td>
<td>80</td>
</tr>
<tr>
<td>Computer Workstation Safety</td>
<td>V0000219EM</td>
<td>73</td>
</tr>
<tr>
<td>Computerized Engine Controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Automotive)</td>
<td>004021</td>
<td>350</td>
</tr>
<tr>
<td>Concrete Construction</td>
<td>4512A-B</td>
<td>269</td>
</tr>
<tr>
<td>Condensers</td>
<td>6553</td>
<td>209</td>
</tr>
<tr>
<td>Conductors</td>
<td>006014</td>
<td>129</td>
</tr>
<tr>
<td>Conductors, Insulators, and Batteries</td>
<td>86005</td>
<td>151</td>
</tr>
<tr>
<td>Confined Entry Space</td>
<td>K000CFSVER</td>
<td>100</td>
</tr>
<tr>
<td>Confined Space Entry</td>
<td>K000CFS9ER</td>
<td>88</td>
</tr>
<tr>
<td>Confined Space Entry</td>
<td>K000CSE9EC</td>
<td>103</td>
</tr>
<tr>
<td>Confined Space Entry</td>
<td>V000CSE9EC</td>
<td>88</td>
</tr>
<tr>
<td>Confined Space Entry</td>
<td>K000CSEVEC</td>
<td>98</td>
</tr>
<tr>
<td>Confined Space Entry</td>
<td>V000CSE9EC</td>
<td>103</td>
</tr>
<tr>
<td>Confined Space Entry</td>
<td>V000CSE9EW</td>
<td>92</td>
</tr>
<tr>
<td>Consignment and Installment Sales</td>
<td>5972</td>
<td>376</td>
</tr>
<tr>
<td>Construction Safety</td>
<td>6487</td>
<td>70</td>
</tr>
<tr>
<td>Contracts, Specifications, and Design Drawings</td>
<td>3410</td>
<td>320</td>
</tr>
<tr>
<td>Control of Materials</td>
<td>2600</td>
<td>319</td>
</tr>
<tr>
<td>Controlling Industrial Motors</td>
<td>086053</td>
<td>134</td>
</tr>
<tr>
<td>Controls for Air Conditioning</td>
<td>006035</td>
<td>197</td>
</tr>
<tr>
<td>Conveyor Systems</td>
<td>786027</td>
<td>295</td>
</tr>
<tr>
<td>Cooling and Lubricating Systems (Detroit Diesel)</td>
<td>0D11</td>
<td>364</td>
</tr>
<tr>
<td>Cooling and Lubricating Systems (Mack)</td>
<td>0C10</td>
<td>363</td>
</tr>
<tr>
<td>Cooling, Air Intake, and Exhaust Systems (Diesel)</td>
<td>00A9</td>
<td>363</td>
</tr>
<tr>
<td>Cooling, Air Intake, and Exhaust Systems (Gasoline)</td>
<td>0B11</td>
<td>360</td>
</tr>
</tbody>
</table>
## Alphabetical/Subject Index

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Page Number</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crane Safety</td>
<td>00D1</td>
<td>363</td>
</tr>
<tr>
<td>Diesel Engine Operations, Part 1</td>
<td>0A11</td>
<td>363</td>
</tr>
<tr>
<td>Diesel Engine Parts, Part 1</td>
<td>00A4</td>
<td>363</td>
</tr>
<tr>
<td>Diesel Engine Parts, Part 2</td>
<td>00A5</td>
<td>363</td>
</tr>
<tr>
<td>Digital Electronics</td>
<td>086E18</td>
<td>139</td>
</tr>
<tr>
<td>Digital Methods and Components</td>
<td>2131A-B</td>
<td>141</td>
</tr>
<tr>
<td>Digital Test Equipment</td>
<td>086063</td>
<td>135</td>
</tr>
<tr>
<td>Digital Trainer</td>
<td>XK-200</td>
<td>174</td>
</tr>
<tr>
<td>Dimensioning and Tolerancing</td>
<td>186082</td>
<td>59</td>
</tr>
<tr>
<td>Distillation</td>
<td>06041</td>
<td>334</td>
</tr>
<tr>
<td>Distributed Control Systems, Part 1</td>
<td>086084</td>
<td>135,284</td>
</tr>
<tr>
<td>Distributed Control Systems, Part 2</td>
<td>086085</td>
<td>135,284</td>
</tr>
<tr>
<td>Distributed Control Systems, Part 3</td>
<td>086086</td>
<td>135,284</td>
</tr>
<tr>
<td>Distribution and Power Transformers</td>
<td>4042</td>
<td>145</td>
</tr>
<tr>
<td>Domestic and Institutional Water Supply</td>
<td>5390</td>
<td>270</td>
</tr>
<tr>
<td>DOT_General Awareness</td>
<td>K000033VEX</td>
<td>98</td>
</tr>
<tr>
<td>DOT_General Awareness</td>
<td>K0000339EX</td>
<td>105</td>
</tr>
<tr>
<td>DOT_General Awareness</td>
<td>V0000339EX</td>
<td>86</td>
</tr>
<tr>
<td>DOT In-Depth Security</td>
<td>K0000339EX</td>
<td>106</td>
</tr>
<tr>
<td>DOT Safety Training</td>
<td>V0000359EX</td>
<td>86,106</td>
</tr>
<tr>
<td>DOT_Safety Training</td>
<td>K000035VEX</td>
<td>98</td>
</tr>
<tr>
<td>DOT Security Awareness</td>
<td>K000037VEX</td>
<td>106</td>
</tr>
<tr>
<td>DOT Security Awareness</td>
<td>V0000379EX</td>
<td>86,106</td>
</tr>
<tr>
<td>Drafting Kit</td>
<td>1200M</td>
<td>317</td>
</tr>
<tr>
<td>Drainage Systems</td>
<td>4502</td>
<td>268</td>
</tr>
<tr>
<td>Drawing and Sketching for the Mechanic (Diesel)</td>
<td>0A16</td>
<td>358</td>
</tr>
<tr>
<td>Drawings for Welded Parts</td>
<td>5645</td>
<td>332</td>
</tr>
<tr>
<td>Drilling</td>
<td>3521A-B</td>
<td>235</td>
</tr>
<tr>
<td>Drive Units, Intake and Exhaust</td>
<td>0H11</td>
<td>364</td>
</tr>
<tr>
<td>Systems (Cummins)</td>
<td>K000DRV9EM</td>
<td>81</td>
</tr>
<tr>
<td>Driving Safety</td>
<td>K000DRV9EM</td>
<td>78</td>
</tr>
<tr>
<td>Driving Safety</td>
<td>V000DRV9EM</td>
<td>74</td>
</tr>
<tr>
<td>Drying</td>
<td>5370</td>
<td>328</td>
</tr>
<tr>
<td>Duct and Piping Design for Air Conditioning</td>
<td>2945</td>
<td>206</td>
</tr>
<tr>
<td>Earthwork</td>
<td>5468</td>
<td>330</td>
</tr>
<tr>
<td>Effective Training</td>
<td>8932TB</td>
<td>53</td>
</tr>
<tr>
<td>Efficiency Tests</td>
<td>4342</td>
<td>146</td>
</tr>
<tr>
<td>Electric Drilling and Grinding Tools</td>
<td>186054</td>
<td>58</td>
</tr>
<tr>
<td>Electric Furnaces</td>
<td>4420A-B</td>
<td>146</td>
</tr>
<tr>
<td>Electric Heating</td>
<td>006034</td>
<td>133</td>
</tr>
<tr>
<td>Electric Lamps, Part 1</td>
<td>006031</td>
<td>132</td>
</tr>
<tr>
<td>Electric Lamps, Part 2</td>
<td>006032</td>
<td>133</td>
</tr>
<tr>
<td>Duct and Piping Design for Air Conditioning</td>
<td>2945</td>
<td>206</td>
</tr>
<tr>
<td>Earthwork</td>
<td>5468</td>
<td>330</td>
</tr>
<tr>
<td>Effective Training</td>
<td>8932TB</td>
<td>53</td>
</tr>
<tr>
<td>Efficiency Tests</td>
<td>4342</td>
<td>146</td>
</tr>
<tr>
<td>Electric Drilling and Grinding Tools</td>
<td>186054</td>
<td>58</td>
</tr>
<tr>
<td>Electric Furnaces</td>
<td>4420A-B</td>
<td>146</td>
</tr>
<tr>
<td>Electric Heating</td>
<td>006034</td>
<td>133</td>
</tr>
<tr>
<td>Electric Lamps, Part 1</td>
<td>006031</td>
<td>132</td>
</tr>
<tr>
<td>Electric Lamps, Part 2</td>
<td>006032</td>
<td>133</td>
</tr>
<tr>
<td>Duct and Piping Design for Air Conditioning</td>
<td>2945</td>
<td>206</td>
</tr>
<tr>
<td>Earthwork</td>
<td>5468</td>
<td>330</td>
</tr>
<tr>
<td>Effective Training</td>
<td>8932TB</td>
<td>53</td>
</tr>
<tr>
<td>Efficiency Tests</td>
<td>4342</td>
<td>146</td>
</tr>
<tr>
<td>Electric Drilling and Grinding Tools</td>
<td>186054</td>
<td>58</td>
</tr>
<tr>
<td>Electric Furnaces</td>
<td>4420A-B</td>
<td>146</td>
</tr>
<tr>
<td>Electric Heating</td>
<td>006034</td>
<td>133</td>
</tr>
<tr>
<td>Electric Lamps, Part 1</td>
<td>006031</td>
<td>132</td>
</tr>
<tr>
<td>Electric Lamps, Part 2</td>
<td>006032</td>
<td>133</td>
</tr>
<tr>
<td>Duct and Piping Design for Air Conditioning</td>
<td>2945</td>
<td>206</td>
</tr>
<tr>
<td>Earthwork</td>
<td>5468</td>
<td>330</td>
</tr>
<tr>
<td>Effective Training</td>
<td>8932TB</td>
<td>53</td>
</tr>
<tr>
<td>Efficiency Tests</td>
<td>4342</td>
<td>146</td>
</tr>
<tr>
<td>Electric Drilling and Grinding Tools</td>
<td>186054</td>
<td>58</td>
</tr>
<tr>
<td>Electric Furnaces</td>
<td>4420A-B</td>
<td>146</td>
</tr>
<tr>
<td>Electric Heating</td>
<td>006034</td>
<td>133</td>
</tr>
<tr>
<td>Electric Lamps, Part 1</td>
<td>006031</td>
<td>132</td>
</tr>
<tr>
<td>Electric Lamps, Part 2</td>
<td>006032</td>
<td>133</td>
</tr>
<tr>
<td>Diesel Engine Operations, Part 1</td>
<td>0A11</td>
<td>363</td>
</tr>
<tr>
<td>Diesel Engine V8 and V8-7IT Engines</td>
<td>0D16</td>
<td>364</td>
</tr>
<tr>
<td>Development of Surfaces</td>
<td>5399</td>
<td>328</td>
</tr>
<tr>
<td>Dies and Die Making</td>
<td>5101A-B</td>
<td>242</td>
</tr>
<tr>
<td>Dies and Die Making, Part 3</td>
<td>386048</td>
<td>239</td>
</tr>
<tr>
<td>Diesel Engine Operations, Part 1</td>
<td>0A11</td>
<td>363</td>
</tr>
<tr>
<td>Diesel Engine V8 and V8-7IT Engines</td>
<td>0D16</td>
<td>364</td>
</tr>
<tr>
<td>Development of Surfaces</td>
<td>5399</td>
<td>328</td>
</tr>
<tr>
<td>Dies and Die Making</td>
<td>5101A-B</td>
<td>242</td>
</tr>
<tr>
<td>Dies and Die Making, Part 3</td>
<td>386048</td>
<td>239</td>
</tr>
</tbody>
</table>

### Alphabetical Index

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crane Safety</td>
<td>K000CSTVEM</td>
</tr>
<tr>
<td>Crane Safety</td>
<td>K000CST9EM</td>
</tr>
<tr>
<td>Crane Safety</td>
<td>V000CST9EM</td>
</tr>
<tr>
<td>Creating an Informal Proposal</td>
<td>050024</td>
</tr>
<tr>
<td>Cummins PT Fuel System</td>
<td>00F9</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 1 (Detroit Diesel)</td>
<td>00D3</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 1 (Mack)</td>
<td>00C3</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 2 (Detroit Diesel)</td>
<td>00D4</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 2 (Mack)</td>
<td>00C4</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 3 (Detroit Diesel)</td>
<td>00D5</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 3 (Mack)</td>
<td>00C5</td>
</tr>
<tr>
<td>Cylinder Block and Components, Part 4 (Detroit Diesel)</td>
<td>00D6</td>
</tr>
<tr>
<td>Cylinder Block Group, Part 1 (Cummins)</td>
<td>00H6</td>
</tr>
<tr>
<td>Cylinder Block Group, Part 2 (Cummins)</td>
<td>00H7</td>
</tr>
<tr>
<td>Cylinder Head Assemblies and Valve Operating Mechanisms (Mack)</td>
<td>00C6</td>
</tr>
<tr>
<td>Cylinder Heads, Cam Followers, Tappets, and Rocker Levers (Cummins)</td>
<td>00H8</td>
</tr>
<tr>
<td>Cylindrical Grinding, Part 1</td>
<td>386010</td>
</tr>
<tr>
<td>Cylindrical Grinding, Part 2</td>
<td>386011</td>
</tr>
<tr>
<td>Data, Voice, and Video Cabling</td>
<td>086E16</td>
</tr>
<tr>
<td>DC Generators and Motors</td>
<td>6687</td>
</tr>
<tr>
<td>DC Machines</td>
<td>4030A-B</td>
</tr>
<tr>
<td>DC Machines</td>
<td>4030A-B</td>
</tr>
<tr>
<td>DC Generators and Generator Theory</td>
<td>086006</td>
</tr>
<tr>
<td>DC Principles</td>
<td>Block A21</td>
</tr>
<tr>
<td>Decimals</td>
<td>007015</td>
</tr>
<tr>
<td>Decontamination Procedures</td>
<td>V000DEC9EW</td>
</tr>
<tr>
<td>Design of Alternating Current Machines</td>
<td>2720A-B</td>
</tr>
<tr>
<td>Design of Alternating Current Machines</td>
<td>2720A-B</td>
</tr>
<tr>
<td>Design of Prestressed Concrete</td>
<td>6582</td>
</tr>
<tr>
<td>Design of Retaining Walls</td>
<td>5272A-B</td>
</tr>
<tr>
<td>Design of Spread Footings</td>
<td>5290</td>
</tr>
<tr>
<td>Design of Steel Building Frames</td>
<td>5440A-C</td>
</tr>
<tr>
<td>Design of Transformers</td>
<td>4415</td>
</tr>
<tr>
<td>Determination of True Meridian</td>
<td>5465</td>
</tr>
<tr>
<td>Detroit Diesel Engine Mechanics:</td>
<td></td>
</tr>
<tr>
<td>Introduction</td>
<td>00D1</td>
</tr>
<tr>
<td>Detroit Diesel V8 and V8-7IT Engines</td>
<td>0D16</td>
</tr>
<tr>
<td>Development of Surfaces</td>
<td>5399</td>
</tr>
<tr>
<td>Dies and Die Making</td>
<td>5101A-B</td>
</tr>
<tr>
<td>Dies and Die Making, Part 3</td>
<td>386048</td>
</tr>
<tr>
<td>Diesel Engine Operations, Part 1</td>
<td>0A11</td>
</tr>
</tbody>
</table>
### Alphabetical/Subject Index

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Page Number</th>
<th>Course Title</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Energy Distribution</td>
<td>86013</td>
<td>Energy, Force, and Power</td>
<td>186024</td>
</tr>
<tr>
<td>Electrical Equipment</td>
<td>Block A24</td>
<td>Engine and Allied Equipment</td>
<td>0A18</td>
</tr>
<tr>
<td>Electronic Test Instruments</td>
<td>4146A-C</td>
<td>Service Manuals (Diesel)</td>
<td>0A18</td>
</tr>
<tr>
<td>Electronic Systems</td>
<td>Block B25</td>
<td>Engine Assembly (Cummins)</td>
<td>0H13</td>
</tr>
<tr>
<td>Electronic Sensors</td>
<td>086022</td>
<td>Engine Assembly, Part 1 (Detroit Diesel)</td>
<td>0D13</td>
</tr>
<tr>
<td>Electronic for the Trades</td>
<td>186005</td>
<td>Engine Assembly, Part 1 (Mack)</td>
<td>0C12</td>
</tr>
<tr>
<td>Electricity and Electronics</td>
<td>K000ELC9EM</td>
<td>Engine Assembly, Part 2 (Detroit Diesel)</td>
<td>0D14</td>
</tr>
<tr>
<td>Electronic Control Circuits</td>
<td>086065</td>
<td>Engine Assembly, Part 2 (Mack)</td>
<td>0C13</td>
</tr>
<tr>
<td>Electrical Devices and Amplification</td>
<td>086045</td>
<td>Engine Disassembly (Caterpillar)</td>
<td>00E2</td>
</tr>
<tr>
<td>Electronic Control Circuits</td>
<td>186045</td>
<td>Engine Disassembly (Cummins)</td>
<td>00H5</td>
</tr>
<tr>
<td>Electronic Control Circuits and Applications</td>
<td>6526</td>
<td>Engine Disassembly (Detroit Diesel)</td>
<td>00D2</td>
</tr>
<tr>
<td>Electronic Devices and Amplification</td>
<td>086045</td>
<td>Engine Disassembly (Mack)</td>
<td>00C2</td>
</tr>
<tr>
<td>Electrical Wiring Practices</td>
<td>086E02</td>
<td>Engine Maintenance: Electrical</td>
<td>00E2</td>
</tr>
<tr>
<td>Electrician's Tools</td>
<td>006026</td>
<td>Engine Maintenance: Ignition System</td>
<td>00B21</td>
</tr>
<tr>
<td>Electricity</td>
<td>4210A-C</td>
<td>Engine Maintenance: Lubricating, Air Intake,</td>
<td>0B21</td>
</tr>
<tr>
<td>Electricity and Electronics</td>
<td>007096</td>
<td>Exhaust, and Cooling Systems (Gasoline)</td>
<td>0B21</td>
</tr>
<tr>
<td>Electricity and Magnetism</td>
<td>4010A-C</td>
<td>Engine Overhaul, Part 1 (Gasoline)</td>
<td>0B23</td>
</tr>
<tr>
<td>Electronic Control Circuits and Circuits</td>
<td>6580</td>
<td>Engine Overhaul, Part 2 (Gasoline)</td>
<td>0B24</td>
</tr>
<tr>
<td>Electronic Devices and Amplification</td>
<td></td>
<td>Engine Overhaul, Part 3 (Gasoline)</td>
<td>0B25</td>
</tr>
<tr>
<td>Electronic Instrumentation and Control</td>
<td>Block B13</td>
<td>Engine Testing and Run-In (Cummins)</td>
<td>0H14</td>
</tr>
<tr>
<td>Electronic Instrumentation Methods</td>
<td>6526</td>
<td>Engine Testing and Run-In (Mack)</td>
<td>0C14</td>
</tr>
<tr>
<td>Electronic Test Instruments</td>
<td>186045</td>
<td>Engine Tune-Up and Run-In (Detroit Diesel)</td>
<td>0D15</td>
</tr>
<tr>
<td>Electronic Troubleshooting of Industrial</td>
<td>086065</td>
<td>Engineering Chemistry</td>
<td>5012</td>
</tr>
<tr>
<td>Motor Controllers</td>
<td></td>
<td>Engineering Chemistry</td>
<td>5012</td>
</tr>
<tr>
<td>Electronics</td>
<td>2002A-D</td>
<td>Engineering Economy</td>
<td>2549</td>
</tr>
<tr>
<td>Electronics for Numerical Control</td>
<td>2148A-B</td>
<td>Engineering Materials</td>
<td>2536A-C</td>
</tr>
<tr>
<td>Electronics Hardware</td>
<td>086040</td>
<td>Engineering Mechanics, Part 1</td>
<td>286036</td>
</tr>
<tr>
<td>Electronics Workbench</td>
<td>086800</td>
<td>Engineering Mechanics, Part 2</td>
<td>286037</td>
</tr>
<tr>
<td>Elementary Architectural Drawings</td>
<td>5893A-C</td>
<td>Engineering Mechanics, Part 3</td>
<td>286038</td>
</tr>
<tr>
<td>Elementary Mechanical Drawing</td>
<td>5434</td>
<td>Engineering Mechanics, Part 4</td>
<td>286039</td>
</tr>
<tr>
<td>Elements of Business Success</td>
<td>060001</td>
<td>Engineering Technology</td>
<td>062004</td>
</tr>
<tr>
<td>Elements of Chemistry</td>
<td>5011</td>
<td>Orientation, Part 1</td>
<td>062002</td>
</tr>
<tr>
<td>Elements of Photographmetry</td>
<td>6513A-D</td>
<td>Orientation, Part 2</td>
<td>062003</td>
</tr>
<tr>
<td>Elements of Print Reading</td>
<td>6719A-B</td>
<td>Erecting</td>
<td>2246A-B</td>
</tr>
<tr>
<td>Elements of Projection Drawing</td>
<td>5649</td>
<td>Erection of Steel Building Frames</td>
<td>5261</td>
</tr>
<tr>
<td>Emergency Planning</td>
<td>K000EPL9EX</td>
<td>Evaporation and Crystallization</td>
<td>6048</td>
</tr>
<tr>
<td>Emergency Planning</td>
<td>K000EPL9EX</td>
<td>Excavations and Foundations</td>
<td>4544</td>
</tr>
<tr>
<td>Emergency Planning</td>
<td>V000EJ9EX</td>
<td>Experiments in Electrical Measurements</td>
<td>086089</td>
</tr>
<tr>
<td>Emergency Planning</td>
<td>V000EJ9EX</td>
<td>lab Manual</td>
<td>086089</td>
</tr>
<tr>
<td>Emergency Response</td>
<td>V000EMR9EW</td>
<td>Experiments with Basic AC Theory</td>
<td>086088</td>
</tr>
<tr>
<td>Exposure Monitoring &amp;</td>
<td></td>
<td>Experiments with Basic DC Theory</td>
<td>086087</td>
</tr>
<tr>
<td>Experiments with Resonant Circuits</td>
<td>lab Manual</td>
<td>Experiments with Resonant Circuits</td>
<td>086090</td>
</tr>
<tr>
<td>Experiments with Basic AC Theory</td>
<td>062002</td>
<td>Exposure Monitoring &amp;</td>
<td>086089</td>
</tr>
<tr>
<td>Course Title</td>
<td>Number</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>----------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Medical Surveillance</td>
<td>V000EMM9EW</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td>Eye Safety</td>
<td>K000EYE9EM</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>Fabrication of Pipe by Welding</td>
<td>6278A-B</td>
<td>245</td>
<td></td>
</tr>
<tr>
<td>Failure Analysis (Diesel)</td>
<td>0A20</td>
<td>359</td>
<td></td>
</tr>
<tr>
<td>Failure Analysis (Gasoline)</td>
<td>0B18</td>
<td>361</td>
<td></td>
</tr>
<tr>
<td>Fall Protection</td>
<td>K000FALVEM</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>Fall Protection</td>
<td>K000FAL9EM</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>Fall Protection</td>
<td>V000FAL9EM</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Fasteners</td>
<td>286095</td>
<td>267</td>
<td></td>
</tr>
<tr>
<td>Feedwater Treatment and Equipment</td>
<td>6727</td>
<td>338</td>
<td></td>
</tr>
<tr>
<td>Fiber Optics</td>
<td>086E03</td>
<td>137</td>
<td></td>
</tr>
<tr>
<td>Fiber Optics Training Kit</td>
<td>086803</td>
<td>136</td>
<td></td>
</tr>
<tr>
<td>Field Methods in Concrete Construction</td>
<td>6330A-B</td>
<td>335</td>
<td></td>
</tr>
<tr>
<td>Field Sketching</td>
<td>5810</td>
<td>333</td>
<td></td>
</tr>
<tr>
<td>Fifth Wheels, Wheels, and Tires</td>
<td>0K14</td>
<td>365</td>
<td></td>
</tr>
<tr>
<td>Filteration</td>
<td>5878</td>
<td>333</td>
<td></td>
</tr>
<tr>
<td>Fire Prevention &amp; Safety</td>
<td>K0000459EM</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>Fire Prevention &amp; Safety</td>
<td>V0000319EM</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>Fire Prevention &amp; Safety</td>
<td>V0000329EM</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>Fire Prevention &amp; Safety</td>
<td>V0000459EM</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Fire Prevention &amp; Safety</td>
<td>V0000469EM</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Fire Prevention &amp; Safety</td>
<td>K0000329EM</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Fire Prevention &amp; Safety</td>
<td>K000032VEM</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Fire Prevention &amp; Safety</td>
<td>K0000459EM</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>Fire Prevention &amp; Safety</td>
<td>V000FP9EW</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>Fire Safety</td>
<td>186003</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Fireproofing of Buildings</td>
<td>5891</td>
<td>334</td>
<td></td>
</tr>
<tr>
<td>Fitness &amp; Wellness</td>
<td>K000FTW9EM</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>Fitness &amp; Wellness</td>
<td>K000FTW9EM</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>Fitness &amp; Wellness</td>
<td>V000FTW9EM</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>Hammers &amp; Explosives</td>
<td>V000FEX9EL</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Flat Slab Design</td>
<td>5289</td>
<td>326</td>
<td></td>
</tr>
<tr>
<td>Flue Gas Analysis</td>
<td>6810</td>
<td>289</td>
<td></td>
</tr>
<tr>
<td>Fluid Flow</td>
<td>5019</td>
<td>324</td>
<td></td>
</tr>
<tr>
<td>Fluid Flow Measuring and Control Instruments</td>
<td>6508A-B</td>
<td>208</td>
<td></td>
</tr>
<tr>
<td>Fluid Measurement</td>
<td>186025</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Fluid Mechanics, Part 1</td>
<td>286010</td>
<td>199</td>
<td></td>
</tr>
<tr>
<td>Fluid Mechanics, Part 2</td>
<td>286011</td>
<td>199</td>
<td></td>
</tr>
<tr>
<td>Fluid Mechanics, Part 3</td>
<td>286012</td>
<td>199</td>
<td></td>
</tr>
<tr>
<td>Forging Dies</td>
<td>3199</td>
<td>234</td>
<td></td>
</tr>
<tr>
<td>Forklift/Powered Industrial Truck Safety</td>
<td>V000K259EO</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>Forklift/Powered Industrial Truck Safety</td>
<td>V000K259EO</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td>Forklift/Powered Industrial Truck Safety</td>
<td>K000K25VEO</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Formaldehyde Standard</td>
<td>V000FOR9EL</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Forms and Centering</td>
<td>2756A-B</td>
<td>267</td>
<td></td>
</tr>
<tr>
<td>Formulas</td>
<td>186012</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>Formulas</td>
<td>2468</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Foundations and Piling</td>
<td>5523</td>
<td>331</td>
<td></td>
</tr>
<tr>
<td>Fractional Horsepower Motors</td>
<td>4033</td>
<td>144</td>
<td></td>
</tr>
<tr>
<td>Fractions</td>
<td>007014</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>186010</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>Front Axles, Steering, and Suspensions</td>
<td>0K13</td>
<td>365</td>
<td></td>
</tr>
<tr>
<td>Fuel Systems (Detroit Diesel)</td>
<td>00D8</td>
<td>364</td>
<td></td>
</tr>
<tr>
<td>Fuel Systems, Part 1 (Diesel)</td>
<td>00A6</td>
<td>363</td>
<td></td>
</tr>
<tr>
<td>Fuel Systems, Part 1 (Gasoline)</td>
<td>00B5</td>
<td>351</td>
<td></td>
</tr>
<tr>
<td>Fuel Systems, Part 1 (Mack)</td>
<td>00C7</td>
<td>363</td>
<td></td>
</tr>
<tr>
<td>Fuel Systems, Part 2 (Diesel)</td>
<td>00A7</td>
<td>363</td>
<td></td>
</tr>
<tr>
<td>Fuel Systems, Part 2 (Gasoline)</td>
<td>00B6</td>
<td>352</td>
<td></td>
</tr>
<tr>
<td>Fuel Systems, Part 2 (Mack)</td>
<td>00C8</td>
<td>363</td>
<td></td>
</tr>
<tr>
<td>Fuel Systems, Part 3 (Gasoline)</td>
<td>00B7</td>
<td>352</td>
<td></td>
</tr>
<tr>
<td>Fuels</td>
<td>5340</td>
<td>287</td>
<td></td>
</tr>
<tr>
<td>Full Function Digital Multimeter Kit</td>
<td>086801</td>
<td>157</td>
<td></td>
</tr>
<tr>
<td>Fundamental Principles of Rigging Technology</td>
<td>286016</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Fundamental Principles of Rigging Technology</td>
<td>286016</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Braking Systems</td>
<td>0KK1</td>
<td>365</td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Business</td>
<td>060002</td>
<td>371</td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Electronic Instrumentation and Control</td>
<td>6525</td>
<td>147</td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Grinding</td>
<td>386016</td>
<td>236</td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Law for Surveyors</td>
<td>5463</td>
<td>330</td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Linework</td>
<td>786016</td>
<td>293</td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Metal Cutting</td>
<td>386030</td>
<td>237</td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Power</td>
<td>786005</td>
<td>291</td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Power Plant</td>
<td>786006</td>
<td>292</td>
<td></td>
</tr>
<tr>
<td>Operation, Part 2</td>
<td>786007</td>
<td>292</td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Power Plant</td>
<td>786007</td>
<td>292</td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Tool Design</td>
<td>386E04</td>
<td>235</td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Welding, Part 1</td>
<td>286025</td>
<td>232</td>
<td></td>
</tr>
<tr>
<td>Fundamentals of Welding, Part 2</td>
<td>286066</td>
<td>234</td>
<td></td>
</tr>
<tr>
<td>Funds Accounting</td>
<td>5971</td>
<td>376</td>
<td></td>
</tr>
<tr>
<td>Gage Making</td>
<td>5098</td>
<td>241</td>
<td></td>
</tr>
<tr>
<td>Gas Cutting</td>
<td>6275A-B</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>Gas Metal Arc Welding</td>
<td>286059</td>
<td>234</td>
<td></td>
</tr>
<tr>
<td>Gas Tungsten Arc Welding</td>
<td>286035</td>
<td>231</td>
<td></td>
</tr>
<tr>
<td>Gas Welding Equipment</td>
<td>6727A-B</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>Gas Welding Techniques</td>
<td>6727A-C</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>Gasoline Engine Mechanics: Introduction</td>
<td>00B1</td>
<td>351</td>
<td></td>
</tr>
<tr>
<td>Gasoline Engine Parts, Part 1</td>
<td>00B3</td>
<td>351</td>
<td></td>
</tr>
<tr>
<td>Gasoline Engine Parts, Part 2</td>
<td>00B4</td>
<td>351</td>
<td></td>
</tr>
<tr>
<td>Gating and Counting Circuits</td>
<td>086056</td>
<td>171</td>
<td></td>
</tr>
<tr>
<td>Gear Calculations</td>
<td>2243</td>
<td>197</td>
<td></td>
</tr>
<tr>
<td>Gear Making</td>
<td>5532A-B</td>
<td>243</td>
<td></td>
</tr>
<tr>
<td>Gear Trains</td>
<td>2604</td>
<td>198</td>
<td></td>
</tr>
<tr>
<td>Gearing</td>
<td>2446</td>
<td>243</td>
<td></td>
</tr>
<tr>
<td>General Review (of Math)</td>
<td>007018</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Geometric Dimensioning and Tolerancing</td>
<td>386EO1</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>Geometrical Drawing</td>
<td>5544A-B</td>
<td>331</td>
<td></td>
</tr>
</tbody>
</table>
### Index

#### Course Title Number

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting Started as an Electrician</td>
<td>6025</td>
</tr>
<tr>
<td>Going Metric</td>
<td>2443</td>
</tr>
<tr>
<td>Governors (Detroit Diesel)</td>
<td>00D9</td>
</tr>
<tr>
<td>Hand &amp; Power Tool Safety</td>
<td>K0000449EM</td>
</tr>
<tr>
<td>Hand &amp; Power Tool Safety</td>
<td>V0000449EM</td>
</tr>
<tr>
<td>Hand &amp; Power Tool Safety</td>
<td>V0000499EM</td>
</tr>
<tr>
<td>Hand and Power Tools</td>
<td>Block X24</td>
</tr>
<tr>
<td>Hand, Wrist, &amp; Finger Safety</td>
<td>K000HWF9EM</td>
</tr>
<tr>
<td>Hand, Wrist, &amp; Finger Safety</td>
<td>V000HWF9EM</td>
</tr>
<tr>
<td>Hand, Wrist, &amp; Finger Safety</td>
<td>V000HWF9EM</td>
</tr>
<tr>
<td>Handling Hazardous Materials</td>
<td>V000MH9EW</td>
</tr>
<tr>
<td>Hard Pavements</td>
<td>2773A-B</td>
</tr>
<tr>
<td>Hardening and Tempering</td>
<td>3195</td>
</tr>
<tr>
<td>Hazardous Labeling</td>
<td>K0000139EM</td>
</tr>
<tr>
<td>Hazardous Labeling</td>
<td>V0000139EM</td>
</tr>
<tr>
<td>Hazardous Labeling</td>
<td>V0000139EM</td>
</tr>
<tr>
<td>Hazardous Labeling</td>
<td>K000HWF9EM</td>
</tr>
<tr>
<td>HAZMAT Labeling</td>
<td>V000HAL9EW</td>
</tr>
<tr>
<td>HAZWOPER 8 hour Annual</td>
<td>V000HZI9EW</td>
</tr>
<tr>
<td>HAZWOPER all 23 Programs</td>
<td>V000HZ49EW</td>
</tr>
<tr>
<td>HAZWOPER Complete 40 hour</td>
<td>V000HZ39EW</td>
</tr>
<tr>
<td>HAZWOPER Emergency Response</td>
<td>V000HMS9EW</td>
</tr>
<tr>
<td>HAZMAT Labeling</td>
<td>V000HVS9EW</td>
</tr>
<tr>
<td>HAZMAT Labeling</td>
<td>V000HVS9EW</td>
</tr>
<tr>
<td>HAZMAT Labeling</td>
<td>K000HVS9EO</td>
</tr>
<tr>
<td>HAZMAT Labeling</td>
<td>K000HVS9EO</td>
</tr>
<tr>
<td>Heat</td>
<td>007092</td>
</tr>
<tr>
<td>Heat Stress</td>
<td>K000HST9EM</td>
</tr>
<tr>
<td>Heat Stress</td>
<td>K000HST9EM</td>
</tr>
<tr>
<td>Heat Stress</td>
<td>V000HST9EM</td>
</tr>
<tr>
<td>Heat Stress</td>
<td>V000HST9EM</td>
</tr>
<tr>
<td>Heat Transfer</td>
<td>2545</td>
</tr>
<tr>
<td>Heat Transmission through Buildings</td>
<td>5207</td>
</tr>
<tr>
<td>Heat Treatment</td>
<td>3541A-D</td>
</tr>
<tr>
<td>Heat Treatment</td>
<td>2897</td>
</tr>
<tr>
<td>Heat, Part 1</td>
<td>686001</td>
</tr>
<tr>
<td>Heat, Part 2</td>
<td>686002</td>
</tr>
<tr>
<td>Heavy Duty Truck</td>
<td>355</td>
</tr>
<tr>
<td>Systems - HVAC Systems</td>
<td>086E11</td>
</tr>
<tr>
<td>High Pressure Pipelining</td>
<td>2452</td>
</tr>
<tr>
<td>Highways Curves</td>
<td>6812A-B</td>
</tr>
<tr>
<td>Highway Drainage</td>
<td>5374</td>
</tr>
<tr>
<td>Highway Embankments and Subgrades</td>
<td>5359</td>
</tr>
<tr>
<td>Highway Location and Design</td>
<td>5353A-C</td>
</tr>
<tr>
<td>Hot Water Heating</td>
<td>4503</td>
</tr>
<tr>
<td>Hot Water Supply</td>
<td>5385</td>
</tr>
<tr>
<td>How to Solder and Desolder</td>
<td>SLD1</td>
</tr>
<tr>
<td>Hydraulic and Pneumatic Drawings</td>
<td>186046</td>
</tr>
<tr>
<td>Hydraulic and Pneumatic</td>
<td>174</td>
</tr>
<tr>
<td>Hydraulic and Pneumatic</td>
<td>60</td>
</tr>
<tr>
<td>Power Transmission</td>
<td>2539A-E</td>
</tr>
<tr>
<td>Hydraulic Components: Actuators, Pumps and Motors</td>
<td>286061</td>
</tr>
<tr>
<td>Hydraulic Components: Conductors, Conditioners and Fluids</td>
<td>286062</td>
</tr>
<tr>
<td>Hydraulic Fundamentals</td>
<td>352</td>
</tr>
<tr>
<td>Hydraulic Turbines</td>
<td>6718A-C</td>
</tr>
<tr>
<td>Hydrographic Surveying</td>
<td>5751</td>
</tr>
<tr>
<td>I-C Engine Fuels and Combustion</td>
<td>2526</td>
</tr>
<tr>
<td>I-C Engine Testing</td>
<td>2527</td>
</tr>
<tr>
<td>Ignition System Components and Operation</td>
<td>004007</td>
</tr>
<tr>
<td>Ignition System Maintenance (Automotive)</td>
<td>004008</td>
</tr>
<tr>
<td>Ignition Systems (Gasoline)</td>
<td>00B9</td>
</tr>
<tr>
<td>Illumination Principles</td>
<td>6646</td>
</tr>
<tr>
<td>In-Frame Overhaul, Part 1 (Diesel)</td>
<td>0A24</td>
</tr>
<tr>
<td>In-Frame Overhaul, Part 2 (Diesel)</td>
<td>0A25</td>
</tr>
<tr>
<td>Indoor Air Quality</td>
<td>K000AQ9EO</td>
</tr>
<tr>
<td>Indoor Air Quality</td>
<td>V000AQ9EO</td>
</tr>
<tr>
<td>Inductance and Capacitance</td>
<td>6617</td>
</tr>
<tr>
<td>Inductors in AC Circuits</td>
<td>086009</td>
</tr>
<tr>
<td>Industrial AC Motors</td>
<td>086052</td>
</tr>
<tr>
<td>Industrial Amplification Systems</td>
<td>086058</td>
</tr>
<tr>
<td>Industrial Computer Networks</td>
<td>086069</td>
</tr>
<tr>
<td>Industrial DC Motors</td>
<td>086051</td>
</tr>
<tr>
<td>Industrial Electron Tubes</td>
<td>2080</td>
</tr>
<tr>
<td>Industrial Electronic Circuit Applications</td>
<td>Block B14</td>
</tr>
<tr>
<td>Industrial Electronic Troubleshooting</td>
<td>086064</td>
</tr>
<tr>
<td>Industrial Ergonomics</td>
<td>K000ERG9EM</td>
</tr>
<tr>
<td>Industrial Ergonomics</td>
<td>K000ERGVEM</td>
</tr>
<tr>
<td>Industrial Ergonomics</td>
<td>V000ERG9EM</td>
</tr>
<tr>
<td>Industrial Materials and Components</td>
<td>Block X06</td>
</tr>
<tr>
<td>Industrial Microprocessors</td>
<td>086E05</td>
</tr>
<tr>
<td>Industrial Motor Applications</td>
<td>4341</td>
</tr>
<tr>
<td>Industrial Motor Control</td>
<td>6699A-C</td>
</tr>
<tr>
<td>Industrial Motor Control (for Programmable Logic Controllers) Part 1</td>
<td>006011</td>
</tr>
<tr>
<td>Industrial Motor Control (for Programmable Logic Controllers) Part 2</td>
<td>006012</td>
</tr>
<tr>
<td>Course Title</td>
<td>Number</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Laboratory Safety</td>
<td>V000EOS9EL</td>
</tr>
<tr>
<td>Laboratory Safety Orientation</td>
<td>V000OLS9EL</td>
</tr>
<tr>
<td>Laboratory Standard</td>
<td>K000L9AS9EO</td>
</tr>
<tr>
<td>Laboratory Standard</td>
<td>K000LASVEO</td>
</tr>
<tr>
<td>Laboratory Standard</td>
<td>K000LSDVER</td>
</tr>
<tr>
<td>Laboratory Standard</td>
<td>V000LSD9ER</td>
</tr>
<tr>
<td>Laboratory Standard</td>
<td>V000L9AS9EO</td>
</tr>
<tr>
<td>Ladder Safety</td>
<td>K000LAD9EM</td>
</tr>
<tr>
<td>Ladder Safety</td>
<td>K000LAD9EM</td>
</tr>
<tr>
<td>Ladder Safety</td>
<td>V000LAD9EM</td>
</tr>
<tr>
<td>Lathes, Part 1</td>
<td>386036</td>
</tr>
<tr>
<td>Lathes, Part 2</td>
<td>386037</td>
</tr>
<tr>
<td>Lathes, Part 3</td>
<td>386038</td>
</tr>
<tr>
<td>Lathes, Part 4</td>
<td>386039</td>
</tr>
<tr>
<td>Lathes, Part 5</td>
<td>386040</td>
</tr>
<tr>
<td>Layout</td>
<td>3501</td>
</tr>
<tr>
<td>Lead Standard</td>
<td>K000LDSVEO</td>
</tr>
<tr>
<td>Lead Standard</td>
<td>V000LDS9EO</td>
</tr>
<tr>
<td>Lead Standard</td>
<td>K000LDSVEO</td>
</tr>
<tr>
<td>Learning Strategies</td>
<td>147008</td>
</tr>
<tr>
<td>Leveling</td>
<td>6671</td>
</tr>
<tr>
<td>Light</td>
<td>007095</td>
</tr>
<tr>
<td>Light</td>
<td>6255A-B</td>
</tr>
<tr>
<td>Lighting Control</td>
<td>006033</td>
</tr>
<tr>
<td>Limes, Cements, and Mortars</td>
<td>1830</td>
</tr>
<tr>
<td>Linear and Digital Integrated Circuits</td>
<td>Block B09</td>
</tr>
<tr>
<td>Linear and Distance Measurement</td>
<td>186021</td>
</tr>
<tr>
<td>Linear Surveying</td>
<td>6670</td>
</tr>
<tr>
<td>Linewreker's Tools</td>
<td>786017</td>
</tr>
<tr>
<td>Link Mechanisms</td>
<td>2603</td>
</tr>
<tr>
<td>Liquid Level Measuring and Control Instruments</td>
<td>6338A-B</td>
</tr>
<tr>
<td>Lithium Bromide Absorption System</td>
<td>014005</td>
</tr>
<tr>
<td>Loads in Buildings</td>
<td>2766</td>
</tr>
<tr>
<td>Local Distribution of Electric Power</td>
<td>006038</td>
</tr>
<tr>
<td>Lock-Out/Tag-Out</td>
<td>K000LTR9EO</td>
</tr>
<tr>
<td>Lock-Out/Tag-Out</td>
<td>K000LTR9ER</td>
</tr>
<tr>
<td>Lock-Out/Tag-Out</td>
<td>K000LTRVEO</td>
</tr>
<tr>
<td>Lock-Out/Tag-Out</td>
<td>K000LTRVER</td>
</tr>
<tr>
<td>Lock-Out/Tag-Out</td>
<td>V000LTR9EO</td>
</tr>
<tr>
<td>Lock-Out/Tag-Out</td>
<td>V000LTR9ER</td>
</tr>
<tr>
<td>Logarithms</td>
<td>5254</td>
</tr>
<tr>
<td>Logic Circuits</td>
<td>086055</td>
</tr>
<tr>
<td>Logic Circuits</td>
<td>Block B08</td>
</tr>
<tr>
<td>Low Cost Road Surfaces</td>
<td>6403A-B</td>
</tr>
<tr>
<td>Lubricating and Cooling</td>
<td></td>
</tr>
<tr>
<td>Systems (Cummins)</td>
<td>0H10</td>
</tr>
<tr>
<td>Lubricating Systems (Diesel)</td>
<td>00A8</td>
</tr>
<tr>
<td>Lubricating Systems</td>
<td></td>
</tr>
<tr>
<td>(Gasoline Engine Mechanics)</td>
<td>0B10</td>
</tr>
<tr>
<td>Lubrication, Part 1</td>
<td>286091</td>
</tr>
<tr>
<td>Lubrication, Part 2</td>
<td>286092</td>
</tr>
<tr>
<td>Course Title</td>
<td>Number</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Machine Guard Safety</td>
<td>K000MGD9EM</td>
</tr>
<tr>
<td>Machine Guard Safety</td>
<td>K000MGD9EM</td>
</tr>
<tr>
<td>Machine Guard Safety</td>
<td>V000MGD9EM</td>
</tr>
<tr>
<td>Machine Shop Safety</td>
<td>186007</td>
</tr>
<tr>
<td>Machine Sketching</td>
<td>5807</td>
</tr>
<tr>
<td>Mack Diesel Engine</td>
<td>00C1</td>
</tr>
<tr>
<td>Mack V8 Diesel Engine</td>
<td>0C15</td>
</tr>
<tr>
<td>Magnetism and Electromagnetism</td>
<td>086004</td>
</tr>
<tr>
<td>Maintenance and Repair of Drive Axles</td>
<td>OK12</td>
</tr>
<tr>
<td>Maintenance and Troubleshooting</td>
<td>Block X07</td>
</tr>
<tr>
<td>Maintenance and Troubleshooting</td>
<td>Block X27</td>
</tr>
<tr>
<td>Maintenance of Air Intake, Exhaust, and Cooling Systems (Diesel)</td>
<td>0A22</td>
</tr>
<tr>
<td>Maintenance of Electrical Systems (Diesel)</td>
<td>0A23</td>
</tr>
<tr>
<td>Fuel Systems (Diesel)</td>
<td>0A21</td>
</tr>
<tr>
<td>Making Forging Dies</td>
<td>3197</td>
</tr>
<tr>
<td>Managing Physical Distribution</td>
<td>6536A-B</td>
</tr>
<tr>
<td>Manufacturing Processes</td>
<td>186075-186078</td>
</tr>
<tr>
<td>Manufacturing Processes, Part 1</td>
<td>186075</td>
</tr>
<tr>
<td>Manufacturing Processes, Part 2</td>
<td>186076</td>
</tr>
<tr>
<td>Manufacturing Processes, Part 3</td>
<td>186077</td>
</tr>
<tr>
<td>Manufacturing Processes, Part 4</td>
<td>186078</td>
</tr>
<tr>
<td>Mapping</td>
<td>5462A-B</td>
</tr>
<tr>
<td>Marketing Research</td>
<td>5055A-D</td>
</tr>
<tr>
<td>Material and Energy Balances</td>
<td>5018</td>
</tr>
<tr>
<td>Material Handling Safety</td>
<td>186006</td>
</tr>
<tr>
<td>Material Management and Inventory Control</td>
<td>386E03</td>
</tr>
<tr>
<td>Materials Handling</td>
<td>2512</td>
</tr>
<tr>
<td>Materials Handling Safety</td>
<td>K000MHS9EM</td>
</tr>
<tr>
<td>Materials Handling Safety</td>
<td>K000MHSVEM</td>
</tr>
<tr>
<td>Materials Handling Safety</td>
<td>V000MHS9EM</td>
</tr>
<tr>
<td>Materials Management &amp; Inventory Control</td>
<td>386E03</td>
</tr>
<tr>
<td>Measurement</td>
<td>007016</td>
</tr>
<tr>
<td>Measurements Trainer</td>
<td>XK-100</td>
</tr>
<tr>
<td>Mechanical Calculations</td>
<td>5608</td>
</tr>
<tr>
<td>Mechanical Design</td>
<td>186E01</td>
</tr>
<tr>
<td>Mechanical Drawing</td>
<td>5739</td>
</tr>
<tr>
<td>Mechanical Power Transmission Part 1</td>
<td>286101</td>
</tr>
<tr>
<td>Mechanical Power Transmission Part 2</td>
<td>286102</td>
</tr>
<tr>
<td>Mechanical Power Transmission Part 3</td>
<td>286103</td>
</tr>
<tr>
<td>Mechanical Testing of Materials</td>
<td>2608A-B</td>
</tr>
<tr>
<td>Mechanics</td>
<td>7091</td>
</tr>
<tr>
<td>Mechanics of Materials</td>
<td>5282A-C</td>
</tr>
<tr>
<td>Medical Surveillance Programs</td>
<td>V000MED9EW</td>
</tr>
<tr>
<td>Medium/Heavy Duty Truck Engines, Fuel and Computerized Management Systems</td>
<td>086E12</td>
</tr>
<tr>
<td>Metallography</td>
<td>5338A-B</td>
</tr>
<tr>
<td>Metallurgy of Iron</td>
<td>5110</td>
</tr>
<tr>
<td>Metallurgy of Nonferrous Metals</td>
<td>5337</td>
</tr>
<tr>
<td>Metallurgy of Steel</td>
<td>5111</td>
</tr>
<tr>
<td>Metric System</td>
<td>186011</td>
</tr>
<tr>
<td>Microchemical Analysis</td>
<td>5006</td>
</tr>
<tr>
<td>Microprocessor Trainer</td>
<td>086802</td>
</tr>
<tr>
<td>Milling Machine Cutting Tools</td>
<td>386032</td>
</tr>
<tr>
<td>Milling Machine Fundamentals</td>
<td>386031</td>
</tr>
<tr>
<td>Milling Machine Indexing and Spiral Work</td>
<td>386035</td>
</tr>
<tr>
<td>Milling Machine Practice and</td>
<td>386033</td>
</tr>
<tr>
<td>Operation, Part 1</td>
<td>386033</td>
</tr>
<tr>
<td>Milling Machine Practice and</td>
<td>386034</td>
</tr>
<tr>
<td>Operation, Part 2</td>
<td>386034</td>
</tr>
<tr>
<td>Millwork</td>
<td>2179</td>
</tr>
<tr>
<td>Mixing</td>
<td>6209</td>
</tr>
<tr>
<td>Modern Refrigeration and Air Conditioning</td>
<td>G14003</td>
</tr>
<tr>
<td>Modulation and Detection Circuits</td>
<td>086044</td>
</tr>
<tr>
<td>Monitoring Procedures &amp; Equipment</td>
<td>V000MON9EW</td>
</tr>
<tr>
<td>Motor Control Fundamentals (for Programmable Logic Controllers)</td>
<td>006010</td>
</tr>
<tr>
<td>Multiplication and Division</td>
<td>186009</td>
</tr>
<tr>
<td>National Building Code</td>
<td>4501A-C</td>
</tr>
<tr>
<td>National Electrical Code</td>
<td>5177EM</td>
</tr>
<tr>
<td>National Fuel Gas Code</td>
<td>6593</td>
</tr>
<tr>
<td>National Standard Plumbing Code</td>
<td>286M06</td>
</tr>
<tr>
<td>Nature of Electricity</td>
<td>086001</td>
</tr>
<tr>
<td>Nondestructive Testing of Castings</td>
<td>5961</td>
</tr>
<tr>
<td>Nontraditional Machine Technologies</td>
<td>386029</td>
</tr>
<tr>
<td>Number Systems and Logic</td>
<td>2130A-B</td>
</tr>
<tr>
<td>Numerical Control for Machining</td>
<td>5041</td>
</tr>
<tr>
<td>Numerical Control Milling and Drilling</td>
<td>5042</td>
</tr>
<tr>
<td>Numerical Control Turning</td>
<td>5043</td>
</tr>
<tr>
<td>Office Ergonomics</td>
<td>K0000199EM</td>
</tr>
<tr>
<td>Office Ergonomics</td>
<td>K0000199EM</td>
</tr>
<tr>
<td>Office Ergonomics</td>
<td>V0000199EM</td>
</tr>
<tr>
<td>Office Safety</td>
<td>K0000209EM</td>
</tr>
<tr>
<td>Office Safety</td>
<td>K0000209EM</td>
</tr>
<tr>
<td>Office Safety</td>
<td>V0000209EM</td>
</tr>
<tr>
<td>Oil and Gas Firing for Steam Generation</td>
<td>2592</td>
</tr>
<tr>
<td>Operation Analysis</td>
<td>2552A-B</td>
</tr>
<tr>
<td>Operation of Wastewater Treatment Plants</td>
<td>5046A-C</td>
</tr>
<tr>
<td>Operation of Water Treatment Plants</td>
<td>5302A-D</td>
</tr>
<tr>
<td>Operations Preliminary to Building</td>
<td>2190</td>
</tr>
<tr>
<td>Optoelectronic and Fiber Optic Components</td>
<td>086024</td>
</tr>
<tr>
<td>Organic Chemistry</td>
<td>5814A-G</td>
</tr>
<tr>
<td>Organization of Digital Computers</td>
<td>2132</td>
</tr>
<tr>
<td>Organizational Behavior</td>
<td>060935</td>
</tr>
<tr>
<td>Organizing, Researching, and</td>
<td>050022</td>
</tr>
<tr>
<td>Illustrating Your Material</td>
<td>086043</td>
</tr>
<tr>
<td>Oscillators</td>
<td>086043</td>
</tr>
</tbody>
</table>
## Alphabetical/Subject Index

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>Page Number</th>
<th>Course</th>
<th>Course Title</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSCILLATORS, FEEDBACK, AND WAVEFORMS</td>
<td>086047</td>
<td>172</td>
<td>OSHA RECORDKEEPING</td>
<td>K0000159EO</td>
<td>101</td>
</tr>
<tr>
<td>OSHA RECORDKEEPING</td>
<td>K0000159EO</td>
<td>101</td>
<td>OSHA RECORDKEEPING</td>
<td>K0000179EO</td>
<td>87</td>
</tr>
<tr>
<td>OSHA RECORDKEEPING</td>
<td>V0000189EO</td>
<td>87</td>
<td>OSHA RECORDKEEPING</td>
<td>K0000189EO</td>
<td>100</td>
</tr>
<tr>
<td>OSHA RECORDKEEPING</td>
<td>V0000179EO</td>
<td>87</td>
<td>PLUMBING AND PIPEFITTING TOOLS</td>
<td>286042</td>
<td>58</td>
</tr>
<tr>
<td>PLUMBING AND PIPEFITTING TOOLS</td>
<td>286042</td>
<td>58</td>
<td>PERSONNEL PROTECTIVE EQUIPMENT</td>
<td>V000PPS9EO</td>
<td>104</td>
</tr>
<tr>
<td>PERSONNEL PROTECTIVE EQUIPMENT</td>
<td>286042</td>
<td>104</td>
<td>PERSONNEL PROTECTIVE EQUIPMENT</td>
<td>V000CPE9EW</td>
<td>91</td>
</tr>
<tr>
<td>PERSONNEL PROTECTIVE EQUIPMENT</td>
<td>V000CPE9EW</td>
<td>91</td>
<td>PHYSICAL CHEMISTRY</td>
<td>5013A-D</td>
<td>323</td>
</tr>
<tr>
<td>PHYSICS, Part 1</td>
<td>686003</td>
<td>339</td>
<td>PHYSICS, Part 2</td>
<td>686004</td>
<td>339</td>
</tr>
<tr>
<td>PIPEFITTING PRACTICE</td>
<td>5581</td>
<td>206</td>
<td>Pipes and Fittings</td>
<td>5886</td>
<td>207</td>
</tr>
<tr>
<td>PIPES, FITTINGS, AND VALVES</td>
<td>286041</td>
<td>210</td>
<td>PIPEWORK</td>
<td>5586</td>
<td>206</td>
</tr>
<tr>
<td>PIPING: DRAWINGS, MATERIALS, AND PARTS</td>
<td>186047</td>
<td>60</td>
<td>PLANE GEOMETRY</td>
<td>2310A-F</td>
<td>47</td>
</tr>
<tr>
<td>PLANE TRIGONOMETRY</td>
<td>2309A-B</td>
<td>47</td>
<td>PLANE TRIGONOMETRY</td>
<td>6232A-E</td>
<td>51</td>
</tr>
<tr>
<td>PLANE TRIGONOMETRY</td>
<td>6232A-E</td>
<td>51</td>
<td>PLANERS</td>
<td>6118</td>
<td>271</td>
</tr>
<tr>
<td>PLANNING THE RIGGING OPERATION</td>
<td>286017</td>
<td>200</td>
<td>PLANT LAYOUT</td>
<td>2555A-B</td>
<td>319</td>
</tr>
<tr>
<td>PLASTERING</td>
<td>2019</td>
<td>266</td>
<td>PLASTIC ADHESIVES AND COATINGS</td>
<td>5001</td>
<td>240</td>
</tr>
<tr>
<td>PLASTICS: FILMS, SHEETS, FOAMS, and LAMINATES</td>
<td>5002</td>
<td>240</td>
<td>PLATE GIRDERS FOR STEEL BUILDINGS</td>
<td>5481</td>
<td>331</td>
</tr>
<tr>
<td>PLUMBING AND PIPEFITTING TOOLS</td>
<td>6463</td>
<td>209</td>
<td>PLUMBING AND PIPEFITTING TOOLS</td>
<td>286042</td>
<td>58</td>
</tr>
<tr>
<td>PLUMBING DRAWING</td>
<td>6211</td>
<td>335</td>
<td>PLUMBING FIXTURES AND APPLIANCES</td>
<td>286045</td>
<td>210</td>
</tr>
<tr>
<td>PLUMBING PLANS, SPECIFICATIONS, and INSPECTION</td>
<td>4516</td>
<td>269</td>
<td>PNEUMATIC HAND TOOLS</td>
<td>186056</td>
<td>58</td>
</tr>
<tr>
<td>PNEUMATIC INSTRUMENTATION for the Technician</td>
<td>286041</td>
<td>205</td>
<td>PNEUMATICS</td>
<td>286098, 286099, 286010, 286100</td>
<td>204</td>
</tr>
<tr>
<td>POWER CUTTING TOOLS</td>
<td>186055</td>
<td>58</td>
<td>POWER LINE CALCULATIONS</td>
<td>6256</td>
<td>288</td>
</tr>
<tr>
<td>POWER PLANT AUXILIARY EQUIPMENT</td>
<td>786024</td>
<td>294</td>
<td>POWER PLANT BOILERS AND RELATED EQUIPMENT</td>
<td>786026</td>
<td>295</td>
</tr>
<tr>
<td>POWER PLANT ECONOMY</td>
<td>2514</td>
<td>285</td>
<td>POWER PLANT FUEL FLOW PATHS, Part 1</td>
<td>786018</td>
<td>293</td>
</tr>
<tr>
<td>POWER PLANT FUEL FLOW PATHS, Part 2</td>
<td>786019</td>
<td>294</td>
<td>POWER PLANT FUEL FLOW PATHS, Part 3</td>
<td>786020</td>
<td>294</td>
</tr>
<tr>
<td>POWER PLANT INSTRUMENTATION SYSTEMS</td>
<td>786025</td>
<td>295</td>
<td>POWER PLANT STEAM FLOW PATHS, Part 1</td>
<td>786021</td>
<td>294</td>
</tr>
<tr>
<td>POWER PLANT STEAM FLOW PATHS, Part 2</td>
<td>786022</td>
<td>294</td>
<td>POWER PLANT STEAM FLOW PATHS, Part 3</td>
<td>786023</td>
<td>294</td>
</tr>
<tr>
<td>POWER PLANT WATER TREATMENT, Part 1</td>
<td>786008</td>
<td>292</td>
<td>POWER PLANT WATER TREATMENT, Part 2</td>
<td>786009</td>
<td>292</td>
</tr>
<tr>
<td>POWER PLANT WATER TREATMENT, Part 3</td>
<td>786010</td>
<td>292</td>
<td>POWER SHIFT TRANSMISSION SYSTEMS: DEDESCRIPTION AND OPERATING PRINCIPLES</td>
<td>00L1</td>
<td>353</td>
</tr>
<tr>
<td>POWER SHIFT TRANSMISSION SYSTEMS: OPERATING PRINCIPLES AND TROUBLESHOOTING</td>
<td>00L2</td>
<td>353</td>
<td>PPE &amp; DECONTAMINATION PROCEDURES</td>
<td>V000PED09EW</td>
<td>96</td>
</tr>
<tr>
<td>PRACTICAL ENGLISH AND THE COMMAND OF WORDS</td>
<td>ELIM07</td>
<td>62</td>
<td>PRACTICAL GEOMETRY</td>
<td>5983A-B</td>
<td>51</td>
</tr>
<tr>
<td>PRACTICAL GEOMETRY AND TRIGONOMETRY</td>
<td>5567</td>
<td>50</td>
<td>PRACTICAL MEASUREMENTS</td>
<td>Block X22</td>
<td>57</td>
</tr>
<tr>
<td>PRACTICAL MECHANICS, Part 1</td>
<td>286007</td>
<td>199</td>
<td>PRACTICAL MECHANICS, Advanced Topics</td>
<td>286089</td>
<td>62</td>
</tr>
<tr>
<td>PRACTICAL MECHANICS, Advanced Topics</td>
<td>286089</td>
<td>62</td>
<td>PRACTICAL MECHANICS: VIBRATION ANALYSIS</td>
<td>286088</td>
<td>62</td>
</tr>
<tr>
<td>PRESSURE PARTS FOR STEAM GENERATORS</td>
<td>2588</td>
<td>286</td>
<td>PREVENTING CONTAMINATION</td>
<td>V000PCN9EL</td>
<td>84</td>
</tr>
<tr>
<td>PRESSURE VESSEL AND TANK PRINT READING</td>
<td>6691</td>
<td>209</td>
<td>PREVENTIVE MAINTENANCE</td>
<td>286085</td>
<td>61</td>
</tr>
<tr>
<td>PREVENTIVE MAINTENANCE TECHNIQUES</td>
<td>286086</td>
<td>61</td>
<td>PRINCIPLES AND USES OF NUCLEAR ENERGY</td>
<td>6683</td>
<td>289</td>
</tr>
<tr>
<td>PRINCIPLES OF AC CIRCUITS</td>
<td>4018A-D</td>
<td>143</td>
<td>PRINCIPLES OF AUTOMATIC PROCESS</td>
<td>Control Instruments</td>
<td>6305A-B</td>
</tr>
<tr>
<td>PRINCIPLES OF BUSINESS FINANCE</td>
<td>.060005</td>
<td>371</td>
<td>PRINCIPLES OF HEATING, VENTILATING, and AIR CONDITIONING</td>
<td>.6447A-B</td>
<td>208</td>
</tr>
<tr>
<td>PRINCIPLES OF MARKETING</td>
<td>5057A-B</td>
<td>375</td>
<td>PRINCIPLES OF MECHANICS, Part 1</td>
<td>286007</td>
<td>199</td>
</tr>
<tr>
<td>PRINCIPLES OF MECHANICS, Part 2</td>
<td>286008</td>
<td>199</td>
<td>PRINCIPLES OF REFRIGERATION</td>
<td>5127C</td>
<td>206</td>
</tr>
<tr>
<td>PRINCIPLES OF THE I-C ENGINE</td>
<td>2525</td>
<td>285</td>
<td>PRINT READING APPLICATIONS</td>
<td>186083</td>
<td>60</td>
</tr>
<tr>
<td>PRINT READING SYMBOLS AND ABBREVIATIONS</td>
<td>186081</td>
<td>59</td>
<td>PROBLEM SOLVING AND TROUBLESHOOTING</td>
<td>186073</td>
<td>46</td>
</tr>
<tr>
<td>PROCESS PRESSURE MEASURING and CONTROL INSTRUMENTS</td>
<td>6309A-B</td>
<td>208</td>
<td>PRODUCTION OF CONCRETE</td>
<td>5469A-C</td>
<td>270</td>
</tr>
<tr>
<td>PRODUCTION PLANNING AND CONTROL</td>
<td>2580</td>
<td>319</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Alphabetical/Subject Index

### Course Title and Number Page

**Productivity Engineering and Management**
- Course Number: 066904
- Page Number: 316

**Programmable Controllers and Microprocessors**
- Course Number: 086061
- Page Number: 172

**Properties of Materials**
- Course Number: 686005
- Page Number: 339

**Proposals and Special Projects**
- Course Number: 050018
- Page Number: 52

**Protective Relaying**
- Course Number: 6538A-B
- Page Number: 148

**Public Relations**
- Course Number: 5058A-C
- Page Number: 375

**Pulp and Paper Manufacture, Volume 1**
- Course Number: 5007A-L
- Page Number: 321

**Pulp and Paper Manufacture, Volume 2**
- Course Number: 5009A-I
- Page Number: 322

**Pulse and Digital Circuits**
- Course Number: 086057
- Page Number: 171

**Pulse and Logic Circuits**
- Course Number: 086060
- Page Number: 172

**Pumps, Part 1**
- Course Number: 286001
- Page Number: 199

**Pumps, Part 2**
- Course Number: 286002
- Page Number: 199

**Pumps, Part 3**
- Course Number: 286003
- Page Number: 199

**Purification of Water**
- Course Number: 5301A-B
- Page Number: 326

**Qualitative Analysis**
- Laboratory Manual: 6710A-D
- Page Number: 337

**Quality Concepts: Terminology for Management**
- Course Number: 186035
- Page Number: 45

**Quality Concepts: Tools and Applications**
- Course Number: 186036
- Page Number: 45

**Quality Control for the Technician**
- Course Number: 386E02
- Page Number: 232

**Quality Control of Manufactured Products**
- Course Number: 2590
- Page Number: 232

**Quantitative Analysis**
- Course Number: 545A-H
- Page Number: 329

**Quantitative Analysis Laboratory Manual**
- Course Number: 5456
- Page Number: 329

**Radiators, Convector, and Unit Heaters**
- Course Number: 6465
- Page Number: 272

**Radio Frequency Circuits**
- Course Number: 6515
- Page Number: 146

**Ratio, Proportion, and Percent**
- Course Number: 007017
- Page Number: 50

**Reactance and Impedance**
- Course Number: 086037
- Page Number: 168

**Reactive Circuits**
- Course Number: Block B22
- Page Number: 168

**Reading Architect's Blueprints**
- Course Number: 1842A-C
- Page Number: 266

**Reading Construction Prints**
- Course Number: 6705
- Page Number: 272

**Reading Electrical Schematic Diagrams**
- Course Number: 006022
- Page Number: 131

**Reading Highway Blueprints**
- Course Number: 6688A-B
- Page Number: 337

**Reading Improvement**
- Course Number: 2400A-H
- Page Number: 47

**Reading Micrometers, Dial Gauges, and Other Measuring Instruments (Diesel)**
- Course Number: 0A17
- Page Number: 363

**Reading Micrometers, Dial Gauges, and Other Measuring Instruments (Gasoline)**
- Course Number: 0B13
- Page Number: 360

**Reading Piping Prints**
- Course Number: 0732
- Page Number: 209

**Reading Prints and Schematics**
- Course Number: Block X25
- Page Number: 59

**Reading Shop Prints**
- Course Number: 386043, 386044
- Page Number: 239

**Reading Shop Prints, Part 1**
- Course Number: 386043
- Page Number: 239

**Reading Shop Prints, Part 2**
- Course Number: 386044
- Page Number: 239

**Reading Structural Steel Drawings**
- Course Number: 547A1-B
- Page Number: 331

**Real Life Math and the Power of Numbers**
- Course Number: MTHM07
- Page Number: 63

**Rebuild Shop Practices, Part 1 (Cummins)**
- Course Number: 00H4
- Page Number: 364

**Rebuild Shop Practices, Part 2 (Cummins)**
- Course Number: 00H4
- Page Number: 364

**Rebuilding Automatic Transmissions**
- Course Number: 0KK8
- Page Number: 365

**Rebuilding Manual Transmissions**
- Course Number: 0KK7
- Page Number: 365

**Rebuilding Transmissions and Controls**
- Course Number: 0KK6
- Page Number: 365

**Reconnecting Induction Motors**
- Course Number: 6585
- Page Number: 148

**Rectification and Basic Electronic Devices**
- Course Number: 086014
- Page Number: 153

**Rectifiers and Power Supplies**
- Course Number: 086041
- Page Number: 170

**Refrigeration in Air Conditioning**
- Course Number: 5383
- Page Number: 206

**Refrigeration Systems**
- Course Number: 00K5
- Page Number: 352

**Reinforced Concrete Design**
- Course Number: 5450A-C
- Page Number: 328

**Repairing DC Motors and Generators**
- Course Number: 4220A-B
- Page Number: 145

**Repairing Fractional/Horsepower Motors**
- Course Number: 4034
- Page Number: 144

**Resonant Circuits**
- Course Number: 3306
- Page Number: 142

**Resonant Circuits**
- Course Number: 086038
- Page Number: 168

**Respiratory Safety**
- Course Number: V000RS9EW
- Page Number: 96

**Retarders and Oil Seals**
- Course Number: 0KK4
- Page Number: 362

**Rigging for Lineworkers**
- Course Number: 786E04
- Page Number: 291

**Rigging Safety**
- Course Number: V000RGC9EM
- Page Number: 75

**Rigging Safety**
- Course Number: K000RGG9EM
- Page Number: 78

**Rigging, Lifting Equipment**
- Course Number: 286020
- Page Number: 201

**Right-To-Know**
- V000CHM9ER
- Page Number: 103

**Right-To-Know**
- V000CHMVER
- Page Number: 100

**Right-To-Know**
- K000FOD9EO
- Page Number: 88, 103

**Right-To-Know**
- K000FODVEO
- Page Number: 99

**Right-To-Know**
- K000RBLVEO
- Page Number: 99

**Right-To-Know**
- K000RCMVEO
- Page Number: 99

**Right-To-Know**
- K000RHCVEO
- Page Number: 99

**Right-To-Know**
- K000RHSVEO
- Page Number: 99

**Right-To-Know**
- V000RA69EO
- Page Number: 90

**Right-To-Know**
- V000RBL9EO
- Page Number: 90

**Right-To-Know**
- V000RCC9EO
- Page Number: 90

**Right-To-Know**
- V000RCH9EO
- Page Number: 90

**Right-To-Know**
- V000RIN9EO
- Page Number: 91

**Right-To-Know**
- K000RA69EO
- Page Number: 104

**Right-To-Know**
- K000RBL9EO
- Page Number: 104

**Right-To-Know**
- K000RCM9EO
- Page Number: 104

**Right-To-Know**
- K000RHC9EO
- Page Number: 105

**Right-To-Know**
- K000RHS9EO
- Page Number: 105

**Right-To-Know**
- K000RIN9EO
- Page Number: 105

**Right-To-Know**
- K000RIVE9EO
- Page Number: 99

**Right-To-Know**
- V000RA69ER
- Page Number: 88

**Right-To-Know**
- V000FOD9EO
- Page Number: 90

**Right-To-Know**
- V000RHS9EO
- Page Number: 90

**Roofing**
- Course Number: 3074A-B
- Page Number: 268

**Roofing Master Fuel Injection System (Mack)**
- Course Number: 00M6
- Page Number: 365

**Routers, Power Planers and Sanders**
- Course Number: 186059
- Page Number: 59

**Safe Handling of Pressurized Gases and Welding**
- Course Number: 186044
- Page Number: 71

**Safety Audits**
- Course Number: K000SAU9EM
- Page Number: 80

**Safety Audits**
- Course Number: V000SAU9EM
- Page Number: 75

**Safety Audits**
- Course Number: K000SAU9EM
- Page Number: 78

**Safety for Lineworkers**
- Course Number: 786E02
- Page Number: 290
<table>
<thead>
<tr>
<th>Course Title</th>
<th>Number</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety in Welding and Cutting</td>
<td>6154</td>
<td>244</td>
</tr>
<tr>
<td>Safety Orientation</td>
<td>V000SA9EW</td>
<td>96</td>
</tr>
<tr>
<td>Safety Showers &amp; Eye Washes</td>
<td>K000SS9EM</td>
<td>83</td>
</tr>
<tr>
<td>Safety Showers &amp; Eye Washes</td>
<td>V000SS9EM</td>
<td>84</td>
</tr>
<tr>
<td>Safety Showers &amp; Eye Washes</td>
<td>V000SS9EM</td>
<td>75</td>
</tr>
<tr>
<td>Sales Management</td>
<td>5060A-C</td>
<td>375</td>
</tr>
<tr>
<td>Sales Records and Reports</td>
<td>5998</td>
<td>377</td>
</tr>
<tr>
<td>Sanitary Bacteriology</td>
<td>3048</td>
<td>320</td>
</tr>
<tr>
<td>Sanitary Chemistry</td>
<td>5501</td>
<td>331</td>
</tr>
<tr>
<td>Sanitary Plumbing Fixtures</td>
<td>4515A-B</td>
<td>269</td>
</tr>
<tr>
<td>Selling Your Ideas</td>
<td>6219</td>
<td>377</td>
</tr>
<tr>
<td>Sentence Skills</td>
<td>007074</td>
<td>48</td>
</tr>
<tr>
<td>Servicing Gas Appliances</td>
<td>4500B</td>
<td>268</td>
</tr>
<tr>
<td>Servicing Outdoor Power Equipment, Part 1</td>
<td>089029</td>
<td>357</td>
</tr>
<tr>
<td>Servicing Outdoor Power Equipment, Part 2</td>
<td>089030</td>
<td>267</td>
</tr>
<tr>
<td>Servo and Control Systems</td>
<td>086059</td>
<td>172</td>
</tr>
<tr>
<td>Servomechanisms</td>
<td>2028A-B</td>
<td>197</td>
</tr>
<tr>
<td>Sewage Treatment</td>
<td>5294A-D</td>
<td>326</td>
</tr>
<tr>
<td>Sewage</td>
<td>6794A-C</td>
<td>338</td>
</tr>
<tr>
<td>Sexual Harassment</td>
<td>K0000489EM</td>
<td>77</td>
</tr>
<tr>
<td>Sexual Harassment</td>
<td>V0000489EM</td>
<td>72</td>
</tr>
<tr>
<td>Sexual Harassment</td>
<td>V0000519EM</td>
<td>72</td>
</tr>
<tr>
<td>Sexual Harassment</td>
<td>K0000479EM</td>
<td>76</td>
</tr>
<tr>
<td>Sexual Harassment</td>
<td>K0000519EM</td>
<td>76</td>
</tr>
<tr>
<td>Sexual Harassment</td>
<td>V0000479EM</td>
<td>72</td>
</tr>
<tr>
<td>Sexual Harassment</td>
<td>V0000499EM</td>
<td>72</td>
</tr>
<tr>
<td>Shapers, Slotters, and Keyseaters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheet Metal Basics</td>
<td>166049</td>
<td>61</td>
</tr>
<tr>
<td>Sheet Metal Drafting</td>
<td>5551A-B</td>
<td>331</td>
</tr>
<tr>
<td>Sheet Metal Hand Processes</td>
<td>6712A-B</td>
<td>245</td>
</tr>
<tr>
<td>Sheet Metal Machine Processes</td>
<td>6716</td>
<td>245</td>
</tr>
<tr>
<td>Sheet Metal Work</td>
<td>2176</td>
<td>231</td>
</tr>
<tr>
<td>Shielded Metal Arc Welding Techniques, Part 1</td>
<td>286030</td>
<td>233</td>
</tr>
<tr>
<td>Shielded Metal Arc Welding Techniques, Part 2</td>
<td>286031</td>
<td>233</td>
</tr>
<tr>
<td>Shop and Hand Tools (Diesel)</td>
<td>0A14</td>
<td>363</td>
</tr>
<tr>
<td>Shop and Hand Tools, Part 1 (Gasoline)</td>
<td>0B14</td>
<td>360</td>
</tr>
<tr>
<td>Shop and Hand Tools, Part 2 (Gasoline)</td>
<td>0B15</td>
<td>360</td>
</tr>
<tr>
<td>SI Metric</td>
<td>2453</td>
<td>48</td>
</tr>
<tr>
<td>Site Safety &amp; Health Plan</td>
<td>V000SHBP9EW</td>
<td>96</td>
</tr>
<tr>
<td>Size Reduction</td>
<td>6105</td>
<td>334</td>
</tr>
<tr>
<td>Size Separation</td>
<td>6106</td>
<td>335</td>
</tr>
<tr>
<td>Sketching</td>
<td>186050</td>
<td>61</td>
</tr>
<tr>
<td>Slips, Trips, &amp; Falls</td>
<td>K0000429EM</td>
<td>83</td>
</tr>
<tr>
<td>Slips, Trips, &amp; Falls</td>
<td>K0000429EM</td>
<td>78</td>
</tr>
<tr>
<td>Slips, Trips, &amp; Falls</td>
<td>V0000429EM</td>
<td>75</td>
</tr>
<tr>
<td>Small Engine Disassembly</td>
<td>089022</td>
<td>357</td>
</tr>
<tr>
<td>Small Engine Electrical Systems</td>
<td>089020</td>
<td>356</td>
</tr>
<tr>
<td>Small Engine Fuel Systems</td>
<td>089021</td>
<td>356</td>
</tr>
<tr>
<td>Small Engine Ignition Systems</td>
<td>089019</td>
<td>356</td>
</tr>
<tr>
<td>Small Engine Lubrication</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Alphabetical/Subject Index

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Number</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Engine Parts and Operation</td>
<td>089018</td>
<td>356</td>
</tr>
<tr>
<td>Small Engine Reassembly</td>
<td>089025</td>
<td>357</td>
</tr>
<tr>
<td>Small Engine Rebuild, Part 1</td>
<td>089023</td>
<td>357</td>
</tr>
<tr>
<td>Small Engine Rebuild, Part 2</td>
<td>089024</td>
<td>357</td>
</tr>
<tr>
<td>Solid and Pulverized Fuel Burning</td>
<td>6473</td>
<td>288</td>
</tr>
<tr>
<td>Solid State Circuits</td>
<td>2007A-C</td>
<td>140</td>
</tr>
<tr>
<td>Solvent Extraction</td>
<td>6208</td>
<td>335</td>
</tr>
<tr>
<td>Sound</td>
<td>6078</td>
<td>344</td>
</tr>
<tr>
<td>Sound</td>
<td>007093</td>
<td>317</td>
</tr>
<tr>
<td>Special Rectifiers: Electron Tubes</td>
<td>086023</td>
<td>170</td>
</tr>
<tr>
<td>Specification Writing</td>
<td>2175A-B</td>
<td>266</td>
</tr>
<tr>
<td>Spill Cleanup</td>
<td>V0000129EM</td>
<td>80</td>
</tr>
<tr>
<td>Steam Engine and Their Management</td>
<td>2523A-C</td>
<td>285</td>
</tr>
<tr>
<td>Steam Generator Accessories</td>
<td>2585</td>
<td>286</td>
</tr>
<tr>
<td>Steam Generator Design</td>
<td>2598A-B</td>
<td>287</td>
</tr>
<tr>
<td>Steam Generator Settings, Ducts, and Stacks</td>
<td>2587</td>
<td>286</td>
</tr>
<tr>
<td>Steam Generator Supporting Steel Structures</td>
<td>2589</td>
<td>286</td>
</tr>
<tr>
<td>Steam Generator Testing</td>
<td>6802</td>
<td>289</td>
</tr>
<tr>
<td>Steam Heating Systems</td>
<td>4507</td>
<td>269</td>
</tr>
<tr>
<td>Steam Turbine Calculations</td>
<td>2507</td>
<td>285</td>
</tr>
<tr>
<td>Steam Turbine Management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural Design of Pipe Culverts</td>
<td>5451</td>
<td>329</td>
</tr>
<tr>
<td>Structural Steel Drawing</td>
<td>5470A-C</td>
<td>331</td>
</tr>
<tr>
<td>Studies in Hydraulics</td>
<td>Block Y02</td>
<td>212</td>
</tr>
<tr>
<td>Successful Communication for Winning Job Offers</td>
<td>186A10</td>
<td>46</td>
</tr>
<tr>
<td>Supported Scaffolding</td>
<td>K0000PSVEO</td>
<td>98</td>
</tr>
<tr>
<td>Supported Scaffolding</td>
<td>K0000PSVEO</td>
<td>105</td>
</tr>
<tr>
<td>Supporting, Installing, and Testing Pipes</td>
<td>286044</td>
<td>210</td>
</tr>
<tr>
<td>Surface Grinding, Part 1</td>
<td>386012</td>
<td>236</td>
</tr>
<tr>
<td>Surface Grinding, Part 2</td>
<td>386013</td>
<td>236</td>
</tr>
<tr>
<td>Surface Protection of Metals</td>
<td>6026</td>
<td>334</td>
</tr>
<tr>
<td>Suspended Scaffolding</td>
<td>K0000PSVEO</td>
<td>104</td>
</tr>
<tr>
<td>Suspended Scaffolding</td>
<td>K0000PSVEO</td>
<td>101</td>
</tr>
<tr>
<td>Suspended Scaffolding</td>
<td>V0000PSVEO</td>
<td>91</td>
</tr>
<tr>
<td>Switchgear</td>
<td>6613</td>
<td>148</td>
</tr>
<tr>
<td>Switching Circuits</td>
<td>086054</td>
<td>171</td>
</tr>
<tr>
<td>Switching Devices</td>
<td>086021</td>
<td>169</td>
</tr>
<tr>
<td>Symmetrical Components</td>
<td>6728</td>
<td>150</td>
</tr>
</tbody>
</table>
## Alphabetical Index/Subject Index

### Course Title Number Page

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Title</th>
<th>Number</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanks and Pumps</td>
<td>........................................</td>
<td>5389</td>
<td>206</td>
</tr>
<tr>
<td>Tanks, Pumps, and Boilers</td>
<td>..................</td>
<td>286046</td>
<td>210</td>
</tr>
<tr>
<td>Technical Writing</td>
<td>..................</td>
<td>065001</td>
<td>44</td>
</tr>
<tr>
<td>Telemetering</td>
<td>..................</td>
<td>4048</td>
<td>145</td>
</tr>
<tr>
<td>Temperature Measurement</td>
<td>..................</td>
<td>186023</td>
<td>57</td>
</tr>
<tr>
<td>Temperature Measuring and Control Instruments</td>
<td>..................</td>
<td>6306A-B</td>
<td>207</td>
</tr>
<tr>
<td>Tertiary Wastewater Treatment</td>
<td>..................</td>
<td>5045</td>
<td>324</td>
</tr>
<tr>
<td>Testing Solid and Liquid Boiler Fuels</td>
<td>..................</td>
<td>6472</td>
<td>288</td>
</tr>
<tr>
<td>The Business of Electrical Contracting</td>
<td>..................</td>
<td>006020</td>
<td>130</td>
</tr>
<tr>
<td>The Lineman's and Cableman's Handbook</td>
<td>...6070A-I</td>
<td>288</td>
<td></td>
</tr>
<tr>
<td>The Parts of Speech</td>
<td>..................</td>
<td>007072</td>
<td>47</td>
</tr>
<tr>
<td>The Role of Management in Business</td>
<td>..................</td>
<td>060003</td>
<td>371</td>
</tr>
<tr>
<td>The Steel Square</td>
<td>..................</td>
<td>1066A-B</td>
<td>266</td>
</tr>
<tr>
<td>The Trades of Plumbing and Pipefitting</td>
<td>..................</td>
<td>286040</td>
<td>210</td>
</tr>
<tr>
<td>The Writing Process, Part 1</td>
<td>..................</td>
<td>007117</td>
<td>48</td>
</tr>
<tr>
<td>The Writing Process, Part 2</td>
<td>..................</td>
<td>007118</td>
<td>48</td>
</tr>
<tr>
<td>Theory of RL, RC, and RLC Circuits</td>
<td>..................</td>
<td>6601</td>
<td>148</td>
</tr>
<tr>
<td>Time Study, Part 1</td>
<td>..................</td>
<td>006016</td>
<td>316</td>
</tr>
<tr>
<td>Time Study, Part 2</td>
<td>..................</td>
<td>006017</td>
<td>316</td>
</tr>
<tr>
<td>Today's Technician: Medium/Heavy Duty Truck Brake Systems</td>
<td>..................</td>
<td>086E09</td>
<td>354</td>
</tr>
<tr>
<td>Today's Technician: Medium/Heavy Duty Truck</td>
<td>Steering and Suspension Systems</td>
<td>..................</td>
<td>086E08</td>
</tr>
<tr>
<td>Tool Dressing</td>
<td>..................</td>
<td>3194</td>
<td>234</td>
</tr>
<tr>
<td>Tool Grinding</td>
<td>..................</td>
<td>386017</td>
<td>236</td>
</tr>
<tr>
<td>Tool Grinding and Sharpening</td>
<td>..................</td>
<td>186057</td>
<td>58</td>
</tr>
<tr>
<td>Toolholding Systems</td>
<td>..................</td>
<td>386028</td>
<td>236</td>
</tr>
<tr>
<td>Toolmaking</td>
<td>..................</td>
<td>2540A-C</td>
<td>232</td>
</tr>
<tr>
<td>Toolmaking, Part 4</td>
<td>..................</td>
<td>386047</td>
<td>239</td>
</tr>
<tr>
<td>Tools and Trends of the Managerial Trade</td>
<td>..................</td>
<td>060004</td>
<td>371</td>
</tr>
<tr>
<td>Topographic Surveying</td>
<td>..................</td>
<td>5461A-B</td>
<td>330</td>
</tr>
<tr>
<td>Trades Safety: Getting Started</td>
<td>..................</td>
<td>186001</td>
<td>71</td>
</tr>
<tr>
<td>Traffic Control and Operations</td>
<td>..................</td>
<td>5352A-B</td>
<td>327</td>
</tr>
<tr>
<td>Transfer Devices for Machine Tools</td>
<td>..................</td>
<td>6569A-B</td>
<td>245</td>
</tr>
<tr>
<td>Transformation for Lineworkers</td>
<td>..................</td>
<td>786005</td>
<td>291</td>
</tr>
<tr>
<td>Transformer Operation</td>
<td>..................</td>
<td>4041</td>
<td>144</td>
</tr>
<tr>
<td>Transformers</td>
<td>..................</td>
<td>4040</td>
<td>144</td>
</tr>
<tr>
<td>Transformers</td>
<td>..................</td>
<td>086011</td>
<td>153</td>
</tr>
<tr>
<td>Transit Surveying</td>
<td>..................</td>
<td>5460A-C</td>
<td>329</td>
</tr>
<tr>
<td>Transmission Lines</td>
<td>..................</td>
<td>4358</td>
<td>287</td>
</tr>
<tr>
<td>Troubleshooting Diesel Engines</td>
<td>..................</td>
<td>0A19</td>
<td>359</td>
</tr>
<tr>
<td>Troubleshooting Electrical Systems</td>
<td>..................</td>
<td>006018</td>
<td>130</td>
</tr>
<tr>
<td>Troubleshooting Electronic Equipment and Systems</td>
<td>..................</td>
<td>Block B06</td>
<td>157</td>
</tr>
<tr>
<td>Troubleshooting Industrial Computer Systems and Software</td>
<td>..................</td>
<td>086068</td>
<td>174</td>
</tr>
<tr>
<td>Troubleshooting Industrial Control Systems and Output Devices</td>
<td>..................</td>
<td>086067</td>
<td>173</td>
</tr>
<tr>
<td>Troubleshooting Industrial Electrical, Electronic, and Computer Systems</td>
<td>..................</td>
<td>Block B26</td>
<td>173</td>
</tr>
<tr>
<td>Troubleshooting Sensing Devices and Systems</td>
<td>..................</td>
<td>086066</td>
<td>173</td>
</tr>
<tr>
<td>Troubleshooting with Volt-Ohm-Milliamp Meters (VOMs)</td>
<td>..................</td>
<td>086026</td>
<td>154</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>..................</td>
<td>K000TSF9EX</td>
<td>97</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>..................</td>
<td>K000TSF9EX</td>
<td>97</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>..................</td>
<td>006020</td>
<td>130</td>
</tr>
<tr>
<td>Tuned Circuits</td>
<td>..................</td>
<td>3517</td>
<td>142</td>
</tr>
<tr>
<td>Turret Lathe Tools and Setsups</td>
<td>..................</td>
<td>2213</td>
<td>231</td>
</tr>
<tr>
<td>Turret Lathes</td>
<td>..................</td>
<td>3525A</td>
<td>235</td>
</tr>
<tr>
<td>Types of Steam Generators</td>
<td>..................</td>
<td>6632</td>
<td>289</td>
</tr>
<tr>
<td>Types of Steam Turbines</td>
<td>..................</td>
<td>2505</td>
<td>285</td>
</tr>
<tr>
<td>Ultrasonics</td>
<td>..................</td>
<td>6520A-B</td>
<td>147</td>
</tr>
<tr>
<td>Underground Distribution for Lineworkers</td>
<td>..................</td>
<td>786006</td>
<td>291</td>
</tr>
<tr>
<td>Underground Power Systems</td>
<td>..................</td>
<td>006039</td>
<td>284</td>
</tr>
<tr>
<td>Understanding and Using Electronic Diagrams</td>
<td>..................</td>
<td>2021</td>
<td>140</td>
</tr>
<tr>
<td>Understanding Chemical Hazards</td>
<td>..................</td>
<td>000R9N9EW</td>
<td>96</td>
</tr>
<tr>
<td>Understanding HAZWOPER</td>
<td>..................</td>
<td>000HAZ9EW</td>
<td>95</td>
</tr>
<tr>
<td>Unit Operations and Equipment</td>
<td>..................</td>
<td>5178</td>
<td>325</td>
</tr>
<tr>
<td>United States Land Surveys</td>
<td>..................</td>
<td>5465A-B</td>
<td>330</td>
</tr>
<tr>
<td>Using Basic Oscilloscopes</td>
<td>..................</td>
<td>086027</td>
<td>154</td>
</tr>
<tr>
<td>Using Words Well</td>
<td>..................</td>
<td>050001</td>
<td>52</td>
</tr>
<tr>
<td>Vacuum Tube Fundamentals</td>
<td>..................</td>
<td>2010</td>
<td>140</td>
</tr>
<tr>
<td>Vibration Analysis and Control</td>
<td>..................</td>
<td>2511A-E</td>
<td>198</td>
</tr>
<tr>
<td>Voltage Regulation of Distribution Systems</td>
<td>..................</td>
<td>4370</td>
<td>287</td>
</tr>
<tr>
<td>Voltage Regulators for Generators</td>
<td>..................</td>
<td>4368</td>
<td>287</td>
</tr>
<tr>
<td>Water Supply</td>
<td>..................</td>
<td>3395A-C</td>
<td>320</td>
</tr>
<tr>
<td>Welding (Diesel)</td>
<td>..................</td>
<td>0A13</td>
<td>358</td>
</tr>
<tr>
<td>Welding Safety</td>
<td>..................</td>
<td>K000W9DEM</td>
<td>78</td>
</tr>
<tr>
<td>Welding Safety</td>
<td>..................</td>
<td>V000W9DEM</td>
<td>76</td>
</tr>
<tr>
<td>Welding Symbols</td>
<td>..................</td>
<td>186048</td>
<td>60</td>
</tr>
<tr>
<td>Whole Numbers</td>
<td>..................</td>
<td>007013</td>
<td>49</td>
</tr>
<tr>
<td>Winter Safety</td>
<td>..................</td>
<td>K000WINVEM</td>
<td>77</td>
</tr>
<tr>
<td>Wiring Electrical Circuits</td>
<td>..................</td>
<td>006037</td>
<td>134</td>
</tr>
<tr>
<td>Wiring Electrical Components</td>
<td>..................</td>
<td>0060029</td>
<td>132</td>
</tr>
<tr>
<td>Wiring Electrical Components, Part 2</td>
<td>..................</td>
<td>006030</td>
<td>132</td>
</tr>
<tr>
<td>Woodworking Hand Tools</td>
<td>..................</td>
<td>186058</td>
<td>59</td>
</tr>
<tr>
<td>Woodworking Tools</td>
<td>..................</td>
<td>2180</td>
<td>266</td>
</tr>
<tr>
<td>Course Title</td>
<td>Page Number</td>
<td>Course Title</td>
<td>Page Number</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-------------</td>
<td>--------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Word Usage</td>
<td>007073</td>
<td>Word Habits and Practices (Gasoline)</td>
<td>00B2</td>
</tr>
<tr>
<td>Work Habits and Practices, Part 1 (Diesel)</td>
<td>00A2</td>
<td>Work Habits and Practices, Part 2 (Diesel)</td>
<td>00A3</td>
</tr>
<tr>
<td>Work Practices and Engineering Controls</td>
<td>V000EXP9EW</td>
<td>Working Safely with Chemicals</td>
<td>186002</td>
</tr>
<tr>
<td>Working Safely with Electricity</td>
<td>4400</td>
<td>Working with Conduit</td>
<td>006015</td>
</tr>
<tr>
<td>Working with Multimeters</td>
<td>006021</td>
<td>Working with Rigging Tools, Part 1</td>
<td>286018</td>
</tr>
<tr>
<td>Working with Rigging Tools, Part 2</td>
<td>286019</td>
<td>Workplace Stress</td>
<td>K000STR9EM</td>
</tr>
<tr>
<td>Workplace Stress</td>
<td>V000STR9EM</td>
<td>Workplace Stress</td>
<td>000STRVEM</td>
</tr>
<tr>
<td>Workplace Violence</td>
<td>K000VIL9EM</td>
<td>Workplace Violence</td>
<td>K000VILVEM</td>
</tr>
<tr>
<td>Writing Effective Communications</td>
<td>050021</td>
<td>Writing Effective Communications</td>
<td>050023</td>
</tr>
<tr>
<td>Writing the Report</td>
<td>050023</td>
<td>Writing the Report</td>
<td>050023</td>
</tr>
</tbody>
</table>
INDEX

Numerical Index
INDEX

Course Number  Course Title Number  Page  Number
00A2  Work Habits and Practices, Part 1 (Diesel) 00A3  Work Habits and Practices, Part 2 (Diesel) 00A4  Diesel Engine Parts, Part 1 00A5  Diesel Engine Parts, Part 2 00A6  Fuel Systems, Part 1 (Diesel) 00A7  Fuel Systems, Part 2 (Diesel) 00A8  Lubricating Systems (Diesel) 00A9  Cooling, Air Intake, and Exhaust Systems (Diesel) 00B1  Gasoline Engine Mechanics: Introduction 00B2  Work Habits and Practices (Gasoline) 00B3  Gasoline Engine Parts, Part 1 00B4  Gasoline Engine Parts, Part 2 00B5  Fuel Systems, Part 1 (Gasoline) 00B6  Fuel Systems, Part 2 (Gasoline) 00B7  Fuel Systems, Part 3 (Gasoline) 00B8  Electrical Systems (Gasoline) 00B9  Ignition Systems (Gasoline) 00C1  Mack Diesel Engine Mechanics: Introduction 00C2  Engine Disassembly (Mack) 00C3  Cylinder Block and Components, Part 1 (Mack) 00C4  Cylinder Block and Components, Part 2 (Mack) 00C5  Cylinder Block and Components, Part 3 (Mack) 00C6  Cylinder Head Assemblies and Valve Operating Mechanisms (Mack) 00C7  Fuel Systems, Part 1 (Mack) 00C8  Fuel Systems, Part 2 (Mack) 00C9  Air Intake and Exhaust Systems (Mack) 00D1  Detroit Diesel Engine Mechanics: Introduction 00D2  Engine Disassembly (Detroit Diesel) 00D3  Cylinder Block and Components, Part 1 (Detroit Diesel) 00D4  Cylinder Block and Components, Part 2 (Detroit Diesel) 00D5  Cylinder Block and Components, Part 3 (Detroit Diesel) 00D6  Cylinder Block and Components, Part 4 (Detroit Diesel) 00D7  Cylinder Heads, Components, and Valve Operating Mechanisms (Detroit Diesel) 00D8  Fuel Systems (Detroit Diesel) 00D9  Governors (Detroit Diesel) 00E1  Introduction to Caterpillar Diesel Engines 00E2  Engine Disassembly (Caterpillar) 00E3  Introduction to Cummins Diesel Engines 00H2  Introduction to Engine Rebuilding (Cummins) 00H3  Rebuild Shop Practices, Part 1 (Cummins) 00H4  Rebuild Shop Practices, Part 2 (Cummins) 00H5  Engine Disassembly (Cummins) 00H6  Cylinder Block Group, Part 1 (Cummins) 00H7  Cylinder Block Group, Part 2 (Cummins) 00H8  Cylinder Heads, Cam Followers, Tappets, and Rocker Levers (Cummins) 00H9  Cummins PT Fuel System 00J1  Hydraulic Fundamentals (Diesel and Automotive) 00J2  Hydraulic System Components (Diesel and Automotive) 00J3  Hydraulic System Maintenance (Diesel and Automotive) 00K5  Refrigeration Systems 00L1  Power Shift Transmission Systems: Description and Operating Principles 00L2  Power Shift Transmission Systems: Operating Principles and Troubleshooting 00M6  Roosa Master Fuel Injection System (Mack) 00P5  Caterpillar D7, D8, and D9 Tractors, Part 1 00P6  Caterpillar D7, D8, and D9 Tractors, Part 2 00P7  Caterpillar D7, D8, and D9 Tractors, Part 3 00P8  Caterpillar D7, D8, and D9 Tractors, Part 4 0A10  Electrical Systems (Basic Diesel Mechanics) 0A11  Diesel Engine Operations, Part 1 0A12  Diesel Engine Operations, Part 2 0A13  Welding (Diesel) 0A14  Shop and Hand Tools (Diesel) 0A15  Arithmetic for Mechanics (Diesel) 0A16  Drawing and Sketching for the Mechanic (Diesel) 0A17  Reading Micrometers, Dial Gauges, and Other Measuring Instruments (Diesel) 0A18  Engine and Allied Equipment Service Manuals (Diesel) 0A19  Troubleshooting Diesel Engines 0A20  Failure Analysis (Diesel) 0A21  Maintenance of Lubricating and Fuel Systems (Diesel) 0A22  Maintenance of Air Intake, Exhauat, and Cooling Systems (Diesel) 0A23  Maintenance of Electrical Systems (Diesel) 0A24  In-Frame Overhaul, Part 1 (Diesel) 0A25  In-Frame Overhaul, Part 2 (Diesel) 0B10  Lubricating Systems (Gasoline Engine Mechanics) 0B11  Cooling, Air Intake, and Exhaust Systems (Gasoline) 0B12  Arithmetic for Mechanics (Gasoline) 0B13  Reading Micrometers, Dial Gauges, and Other Measuring Instruments (Gasoline) 0B14  Shop and Hand Tools, Part 1 (Gasoline) 0B15  Shop and Hand Tools, Part 2 (Gasoline) 0B16  Tune-Up of Gasoline Engines (Diagnostics), Part 1 0B17  Tune-Up of Gasoline Engines (Diagnostics), Part 2 0B18  Failure Analysis (Gasoline) 0B19  Engine Maintenance: Lubricating, Air Intake, Exhaust, and Cooling Systems (Gasoline) 0B20  Engine Maintenance: Fuel System Maintenance and Overhaul (Gasoline) 0B21  Engine Maintenance: Ignition System Components Maintenance and Overhaul (Gasoline) 0B22  Engine Maintenance: Electrical Systems (Gasoline) 0B23  Engine Overhaul, Part 1 (Gasoline) 0B24  Engine Overhaul, Part 2 (Gasoline) 0B25  Engine Overhaul, Part 3 (Gasoline) 0C10  Cooling and Lubricating Systems (Mack) 0C11  Accessory Equipment (Mack) 0C12  Engine Assembly, Part 1 (Mack) 0C13  Engine Assembly, Part 2 (Mack) 0C14  Engine Testing and Run-In (Mack) 0C15  Mack V8 Diesel Engines
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>006011</td>
<td>Industrial Motor Control (for Programmable Logic Controllers)</td>
<td>129</td>
</tr>
<tr>
<td>006012</td>
<td>Automotive Heating and Air Conditioning (for Programmable Logic Controllers) Part 2</td>
<td>129</td>
</tr>
<tr>
<td>006013</td>
<td>Automotive Heating and Air Conditioning Systems, Part 1</td>
<td>350</td>
</tr>
<tr>
<td>006014</td>
<td>Automotive Heating and Air Conditioning Systems, Part 2</td>
<td>350</td>
</tr>
<tr>
<td>006020</td>
<td>The Business of Electrical Contracting</td>
<td>130</td>
</tr>
<tr>
<td>006021</td>
<td>Working with Multimeters</td>
<td>131</td>
</tr>
<tr>
<td>006022</td>
<td>Reading Electrical Schematic Diagrams</td>
<td>131</td>
</tr>
<tr>
<td>006023</td>
<td>Writing the Report</td>
<td>52</td>
</tr>
<tr>
<td>006024</td>
<td>Creating an Informal Proposal</td>
<td>52</td>
</tr>
<tr>
<td>006025</td>
<td>Getting Started as an Electrician</td>
<td>131</td>
</tr>
<tr>
<td>006026</td>
<td>Electrician's Tools</td>
<td>58, 131</td>
</tr>
<tr>
<td>006027</td>
<td>Electrical Equipment, Part 1</td>
<td>131</td>
</tr>
<tr>
<td>006028</td>
<td>Electrical Equipment, Part 2</td>
<td>132</td>
</tr>
<tr>
<td>006029</td>
<td>Wiring Electrical Components, Part 1</td>
<td>132</td>
</tr>
<tr>
<td>006030</td>
<td>Wiring Electrical Components, Part 2</td>
<td>132</td>
</tr>
<tr>
<td>006031</td>
<td>Electric Lamps, Part 1</td>
<td>132</td>
</tr>
<tr>
<td>006032</td>
<td>Electric Lamps, Part 2</td>
<td>133</td>
</tr>
<tr>
<td>006033</td>
<td>Lighting Control</td>
<td>133</td>
</tr>
<tr>
<td>006034</td>
<td>Electric Heating</td>
<td>133</td>
</tr>
<tr>
<td>006035</td>
<td>Controls for Air Conditioning</td>
<td>197</td>
</tr>
<tr>
<td>006036</td>
<td>Electrical Blueprint Reading</td>
<td>133</td>
</tr>
<tr>
<td>006037</td>
<td>Wiring Electrical Circuits</td>
<td>134</td>
</tr>
<tr>
<td>006038</td>
<td>Local Distribution of Electrical Power</td>
<td>284</td>
</tr>
<tr>
<td>006039</td>
<td>Underground Power Systems</td>
<td>284</td>
</tr>
<tr>
<td>007013</td>
<td>Whole Numbers</td>
<td>49</td>
</tr>
<tr>
<td>007014</td>
<td>Fractions</td>
<td>49</td>
</tr>
<tr>
<td>007015</td>
<td>Decimals</td>
<td>49</td>
</tr>
<tr>
<td>007016</td>
<td>Measurement</td>
<td>50</td>
</tr>
<tr>
<td>007017</td>
<td>Ratio, Proportion, and Percent</td>
<td>50</td>
</tr>
<tr>
<td>007018</td>
<td>General Review of Math</td>
<td>50</td>
</tr>
<tr>
<td>007072</td>
<td>The Parts of Speech</td>
<td>47</td>
</tr>
<tr>
<td>007073</td>
<td>Word Usage</td>
<td>48</td>
</tr>
<tr>
<td>007074</td>
<td>Sentence Skills</td>
<td>48</td>
</tr>
<tr>
<td>007091</td>
<td>Mechanics</td>
<td>317</td>
</tr>
<tr>
<td>007092</td>
<td>Heat</td>
<td>317</td>
</tr>
<tr>
<td>007093</td>
<td>Sound</td>
<td>318</td>
</tr>
<tr>
<td>007094</td>
<td>Chemistry</td>
<td>318</td>
</tr>
<tr>
<td>007095</td>
<td>Light</td>
<td>318</td>
</tr>
<tr>
<td>007096</td>
<td>Electricity and Electronics</td>
<td>318</td>
</tr>
<tr>
<td>007117</td>
<td>The Writing Process, Part 1</td>
<td>48</td>
</tr>
<tr>
<td>007118</td>
<td>The Writing Process, Part 2</td>
<td>48</td>
</tr>
<tr>
<td>014005</td>
<td>Lithium Bromide Absorption System</td>
<td>197</td>
</tr>
<tr>
<td>050001</td>
<td>Using Words Well</td>
<td>52</td>
</tr>
<tr>
<td>050018</td>
<td>Proposals and Special Projects</td>
<td>52</td>
</tr>
<tr>
<td>050021</td>
<td>Writing Effective Communications</td>
<td>52</td>
</tr>
<tr>
<td>050022</td>
<td>Organizing, Researching, and Illustrating Your Material</td>
<td>52</td>
</tr>
<tr>
<td>050023</td>
<td>Writing the Report</td>
<td>52</td>
</tr>
<tr>
<td>050024</td>
<td>Creating an Informal Proposal</td>
<td>52</td>
</tr>
<tr>
<td>055002</td>
<td>Introduction to Truck Diesel Mechanics</td>
<td>353</td>
</tr>
<tr>
<td>060001</td>
<td>Elements of Business Success</td>
<td>371</td>
</tr>
<tr>
<td>060002</td>
<td>Fundamentals of Business</td>
<td>371</td>
</tr>
<tr>
<td>060003</td>
<td>The Role of Management in Business</td>
<td>371</td>
</tr>
<tr>
<td>060004</td>
<td>Tools and Trends of the Managerial Trade</td>
<td>371</td>
</tr>
<tr>
<td>060005</td>
<td>Principles of Business Finance</td>
<td>371</td>
</tr>
<tr>
<td>060006</td>
<td>Introduction to Marketing</td>
<td>371</td>
</tr>
<tr>
<td>060007</td>
<td>Basic Supervision Skills: Management Concepts</td>
<td>371</td>
</tr>
<tr>
<td>060008</td>
<td>Basic Supervision Skills: How to Plan, Organize, and Control</td>
<td>371</td>
</tr>
<tr>
<td>060009</td>
<td>Basic Supervision Skills: The Process of Motivation</td>
<td>372</td>
</tr>
<tr>
<td>Course Number</td>
<td>Course Title</td>
<td>Page Number</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>186E01</td>
<td>Mechanical Design</td>
<td>317</td>
</tr>
<tr>
<td>1830</td>
<td>Limes, Cements, and Mortars</td>
<td>266</td>
</tr>
<tr>
<td>186001</td>
<td>Trades Safety Getting Started</td>
<td>71</td>
</tr>
<tr>
<td>186002</td>
<td>Working Safely with Chemicals</td>
<td>71</td>
</tr>
<tr>
<td>186003</td>
<td>Fire Safety</td>
<td>70</td>
</tr>
<tr>
<td>186004</td>
<td>Safe Handling of Pressurized Gasses and Welding</td>
<td>71</td>
</tr>
<tr>
<td>186005</td>
<td>Electrical Safety for the Trades</td>
<td>70</td>
</tr>
<tr>
<td>186006</td>
<td>Material Handling Safety</td>
<td>71</td>
</tr>
<tr>
<td>186007</td>
<td>Machine Shop Safety</td>
<td>71</td>
</tr>
<tr>
<td>186008</td>
<td>Addition and Subtraction</td>
<td>56</td>
</tr>
<tr>
<td>186009</td>
<td>Multiplication and Division</td>
<td>56</td>
</tr>
<tr>
<td>186010</td>
<td>Fractions, Percents, Proportions, and Angles</td>
<td>56</td>
</tr>
<tr>
<td>186011</td>
<td>Metric System</td>
<td>56</td>
</tr>
<tr>
<td>186012</td>
<td>Formulas</td>
<td>56</td>
</tr>
<tr>
<td>186013</td>
<td>Introduction to Algebra</td>
<td>56</td>
</tr>
<tr>
<td>186021</td>
<td>Linear and Distance Measurement</td>
<td>57</td>
</tr>
<tr>
<td>186022</td>
<td>Bulk Measurement</td>
<td>57</td>
</tr>
<tr>
<td>186023</td>
<td>Temperature Measurement</td>
<td>57</td>
</tr>
<tr>
<td>186024</td>
<td>Energy, Fence, and Power</td>
<td>57</td>
</tr>
<tr>
<td>186025</td>
<td>Fluid Measurement</td>
<td>57</td>
</tr>
<tr>
<td>186034</td>
<td>Jobs, Companies, and the Economy:</td>
<td>45</td>
</tr>
<tr>
<td>186035</td>
<td>Basic Concepts for Employees</td>
<td>45</td>
</tr>
<tr>
<td>186036</td>
<td>Quality Concepts: Terminology for Management</td>
<td>45</td>
</tr>
<tr>
<td>186037</td>
<td>Introduction to ISO 9000: ISO for the Technician</td>
<td>45</td>
</tr>
<tr>
<td>186038</td>
<td>Introduction to ISO 9000: ISO for the Supervisor</td>
<td>45</td>
</tr>
<tr>
<td>186043</td>
<td>Building Drawings</td>
<td>60</td>
</tr>
<tr>
<td>186044</td>
<td>Electrical Drawings and Circuits</td>
<td>60</td>
</tr>
<tr>
<td>186045</td>
<td>Electronic Drawings</td>
<td>60</td>
</tr>
<tr>
<td>186046</td>
<td>Hydraulic and Pneumatic Drawings</td>
<td>60</td>
</tr>
<tr>
<td>186047</td>
<td>Piping: Drawings, Materials, and Parts</td>
<td>60</td>
</tr>
<tr>
<td>186048</td>
<td>Welding Symbols</td>
<td>60</td>
</tr>
<tr>
<td>186049</td>
<td>Sheet Metal Basics</td>
<td>61</td>
</tr>
<tr>
<td>186050</td>
<td>Sketching</td>
<td>61</td>
</tr>
<tr>
<td>186052</td>
<td>Common Hand Tools, Part 1</td>
<td>58</td>
</tr>
<tr>
<td>186053</td>
<td>Common Hand Tools, Part 2</td>
<td>58</td>
</tr>
<tr>
<td>186054</td>
<td>Electric Drilling and Grinding Tools</td>
<td>58</td>
</tr>
<tr>
<td>186055</td>
<td>Power Cutting Tools</td>
<td>58</td>
</tr>
<tr>
<td>186056</td>
<td>Pneumatic Hand Tools</td>
<td>58</td>
</tr>
<tr>
<td>186057</td>
<td>Tool Grinding and Sharpening</td>
<td>58</td>
</tr>
<tr>
<td>186058</td>
<td>Woodworking Hand Tools</td>
<td>59</td>
</tr>
<tr>
<td>186059</td>
<td>Routers, Power Planers and Sanders</td>
<td>59</td>
</tr>
<tr>
<td>186060</td>
<td>J acks, Hoists, and Pullers</td>
<td>59</td>
</tr>
<tr>
<td>186068</td>
<td>Precision Measuring Instruments, Part 1</td>
<td>230</td>
</tr>
<tr>
<td>186069</td>
<td>Precision Measuring Instruments, Part 2</td>
<td>260</td>
</tr>
<tr>
<td>186072</td>
<td>Precision Measuring Instruments, Part 3</td>
<td>230</td>
</tr>
<tr>
<td>186073</td>
<td>Problem Solving and Troubleshooting</td>
<td>46</td>
</tr>
<tr>
<td>186075</td>
<td>Manufacturing Processes, Part 1</td>
<td>230</td>
</tr>
<tr>
<td>186076</td>
<td>Manufacturing Processes, Part 2</td>
<td>230</td>
</tr>
<tr>
<td>186077</td>
<td>Manufacturing Processes, Part 3</td>
<td>230</td>
</tr>
<tr>
<td>186078</td>
<td>Manufacturing Processes, Part 4</td>
<td>230</td>
</tr>
<tr>
<td>186080</td>
<td>Introduction to Print Reading</td>
<td>59</td>
</tr>
<tr>
<td>186081</td>
<td>Print Reading Symbols and Abbreviations</td>
<td>59</td>
</tr>
<tr>
<td>186082</td>
<td>Dimensioning and Tolerancing</td>
<td>59</td>
</tr>
<tr>
<td>186083</td>
<td>Print Reading Applications</td>
<td>60</td>
</tr>
<tr>
<td>1949A-C</td>
<td>Practical Projection</td>
<td>317</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002A-D</td>
<td>Electronics</td>
<td>139</td>
</tr>
<tr>
<td>2007A-C</td>
<td>Solid State Circuits</td>
<td>140</td>
</tr>
<tr>
<td>2008A-B</td>
<td>Advanced Solid State Circuits</td>
<td>140</td>
</tr>
<tr>
<td>2028A-B</td>
<td>Servomechanisms</td>
<td>197</td>
</tr>
<tr>
<td>2010</td>
<td>Vacuum Tube Fundamentals</td>
<td>140</td>
</tr>
<tr>
<td>2019</td>
<td>Plastering</td>
<td>266</td>
</tr>
<tr>
<td>2020</td>
<td>Basic Electronic Components and Schematic Symbols</td>
<td>140</td>
</tr>
<tr>
<td>2021</td>
<td>Understanding and Using Electronic Diagrams</td>
<td>140</td>
</tr>
<tr>
<td>2080</td>
<td>Industrial Electron Tubes</td>
<td>141</td>
</tr>
<tr>
<td>2130A-B</td>
<td>Number Systems and Logic</td>
<td>141</td>
</tr>
<tr>
<td>2131A-B</td>
<td>Digital Methods and Components</td>
<td>141</td>
</tr>
<tr>
<td>2132</td>
<td>Organization of Digital Computers</td>
<td>141</td>
</tr>
<tr>
<td>2133</td>
<td>Analog Systems</td>
<td>141</td>
</tr>
<tr>
<td>2148A-B</td>
<td>Electronics for Numerical Control</td>
<td>141</td>
</tr>
<tr>
<td>2175A-B</td>
<td>Specification Writing</td>
<td>266</td>
</tr>
<tr>
<td>2176</td>
<td>Sheet Metal Work</td>
<td>231</td>
</tr>
<tr>
<td>2179</td>
<td>Millwork</td>
<td>266</td>
</tr>
<tr>
<td>2180</td>
<td>Woodworking Tools</td>
<td>266</td>
</tr>
<tr>
<td>2185</td>
<td>Building Unit Construction</td>
<td>266</td>
</tr>
<tr>
<td>2190</td>
<td>Operations Preliminary to Building</td>
<td>267</td>
</tr>
<tr>
<td>2213</td>
<td>Turret Lathe Tools and Setups</td>
<td>231</td>
</tr>
<tr>
<td>2222</td>
<td>Shapers, Slotters, and Keyscrapers</td>
<td>231</td>
</tr>
<tr>
<td>2243</td>
<td>Gear Calculations</td>
<td>197</td>
</tr>
<tr>
<td>2246A-B</td>
<td>Erecting</td>
<td>267</td>
</tr>
<tr>
<td>2309A-B</td>
<td>Plane Trigonometry</td>
<td>47</td>
</tr>
<tr>
<td>2310A-F</td>
<td>Plane Geometry</td>
<td>47</td>
</tr>
<tr>
<td>2400A-H</td>
<td>Reading Improvement</td>
<td>47</td>
</tr>
<tr>
<td>2443</td>
<td>Going Metric</td>
<td>48</td>
</tr>
<tr>
<td>2446</td>
<td>Gearing</td>
<td>197</td>
</tr>
<tr>
<td>2469A-E</td>
<td>Algebra</td>
<td>49</td>
</tr>
<tr>
<td>2452</td>
<td>High Pressure Pipelining</td>
<td>198</td>
</tr>
<tr>
<td>2453</td>
<td>SI Metric</td>
<td>48</td>
</tr>
<tr>
<td>2468</td>
<td>Formulas</td>
<td>49</td>
</tr>
<tr>
<td>2505</td>
<td>Types of Steam Turbines</td>
<td>285</td>
</tr>
<tr>
<td>2506</td>
<td>Steam Turbine Management and Governing</td>
<td>285</td>
</tr>
<tr>
<td>2507</td>
<td>Steam Turbine Calculations</td>
<td>285</td>
</tr>
<tr>
<td>2511A-E</td>
<td>Vibration Analysis and Control</td>
<td>198</td>
</tr>
<tr>
<td>2512</td>
<td>Materials Handling</td>
<td>318</td>
</tr>
<tr>
<td>2514</td>
<td>Power Plant Economy</td>
<td>318</td>
</tr>
<tr>
<td>2521A-E</td>
<td>Statistical Quality Control</td>
<td>232</td>
</tr>
<tr>
<td>2523A-C</td>
<td>Steam Engines and Their Management</td>
<td>285</td>
</tr>
<tr>
<td>2525</td>
<td>Principles of the I-C Engine</td>
<td>285</td>
</tr>
<tr>
<td>2526</td>
<td>I-C Engine Fuels and Combustion</td>
<td>286</td>
</tr>
<tr>
<td>2527</td>
<td>I-C Engine Testing</td>
<td>286</td>
</tr>
<tr>
<td>2536A-C</td>
<td>Engineering Materials</td>
<td>318</td>
</tr>
<tr>
<td>2539A-E</td>
<td>Hydraulic and Pneumatic Power Transmission</td>
<td>198</td>
</tr>
<tr>
<td>2540A-C</td>
<td>Toolmaking</td>
<td>232</td>
</tr>
<tr>
<td>2545</td>
<td>Heat Transfer</td>
<td>318</td>
</tr>
<tr>
<td>2549</td>
<td>Engineering Economy</td>
<td>318</td>
</tr>
<tr>
<td>2552A-B</td>
<td>Operation Analysis</td>
<td>319</td>
</tr>
<tr>
<td>2555A-B</td>
<td>Plant Layout</td>
<td>319</td>
</tr>
<tr>
<td>2569</td>
<td>Stair Building</td>
<td>267</td>
</tr>
<tr>
<td>2580</td>
<td>Production Planning and Control</td>
<td>319</td>
</tr>
<tr>
<td>2585</td>
<td>Steam Generator Accessories</td>
<td>286</td>
</tr>
<tr>
<td>2587</td>
<td>Steam Generator Settings, Ducts, and Stacks</td>
<td>286</td>
</tr>
<tr>
<td>2588</td>
<td>Pressure Parts for Steam Generators</td>
<td>286</td>
</tr>
<tr>
<td>Course Number</td>
<td>Course Title</td>
<td>Page Number</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>2589</td>
<td>Steam Generator Supporting Steel Structures</td>
<td>286</td>
</tr>
<tr>
<td>2590</td>
<td>Quality Control of Manufactured Products</td>
<td>232</td>
</tr>
<tr>
<td>2592</td>
<td>Oil and Gas Fitting for Steam Generation</td>
<td>286</td>
</tr>
<tr>
<td>2596A-C</td>
<td>Automatic Combustion Control</td>
<td>267</td>
</tr>
<tr>
<td>2598A-B</td>
<td>Steam Generator Design</td>
<td>287</td>
</tr>
<tr>
<td>2600</td>
<td>Control of Materials</td>
<td>319</td>
</tr>
<tr>
<td>2603</td>
<td>Link Mechanisms</td>
<td>198</td>
</tr>
<tr>
<td>2604</td>
<td>Gear Trains</td>
<td>198</td>
</tr>
<tr>
<td>2605</td>
<td>Cams</td>
<td>198</td>
</tr>
<tr>
<td>2607A-B</td>
<td>Belt Power Transmission</td>
<td>198</td>
</tr>
<tr>
<td>2608A-B</td>
<td>Mechanical Testing of Materials</td>
<td>319</td>
</tr>
<tr>
<td>2620</td>
<td>Steam</td>
<td>287</td>
</tr>
<tr>
<td>2720A-C</td>
<td>Design of DC Machines</td>
<td>142</td>
</tr>
<tr>
<td>2727A-C</td>
<td>Design of Alternating Current Machines</td>
<td>142</td>
</tr>
<tr>
<td>2756A-B</td>
<td>Forms and Centering</td>
<td>267</td>
</tr>
<tr>
<td>2766</td>
<td>Loads in Buildings</td>
<td>319</td>
</tr>
<tr>
<td>2773A-B</td>
<td>Hard Pavements</td>
<td>319</td>
</tr>
<tr>
<td>286001</td>
<td>Pumps, Part 1</td>
<td>199</td>
</tr>
<tr>
<td>286002</td>
<td>Pumps, Part 2</td>
<td>199</td>
</tr>
<tr>
<td>286003</td>
<td>Pumps, Part 3</td>
<td>199</td>
</tr>
<tr>
<td>286007</td>
<td>Principles of Mechanics, Part 1</td>
<td>199</td>
</tr>
<tr>
<td>286008</td>
<td>Principles of Mechanics, Part 2</td>
<td>199</td>
</tr>
<tr>
<td>286010</td>
<td>Fluid Mechanics, Part 1</td>
<td>199</td>
</tr>
<tr>
<td>286011</td>
<td>Fluid Mechanics, Part 2</td>
<td>199</td>
</tr>
<tr>
<td>286012</td>
<td>Fluid Mechanics, Part 3</td>
<td>199</td>
</tr>
<tr>
<td>286016</td>
<td>Fundamental Principles of Rigging Technology</td>
<td>200</td>
</tr>
<tr>
<td>286017</td>
<td>Planning the Rigging Operation</td>
<td>200</td>
</tr>
<tr>
<td>286018</td>
<td>Working with Rigging Tools, Part 1</td>
<td>200</td>
</tr>
<tr>
<td>286019</td>
<td>Working with Rigging Tools, Part 2</td>
<td>200</td>
</tr>
<tr>
<td>286020</td>
<td>Rigging: Lifting Equipment and Applications, Part 1</td>
<td>201</td>
</tr>
<tr>
<td>286021</td>
<td>Rigging: Lifting Equipment and Applications, Part 2</td>
<td>201</td>
</tr>
<tr>
<td>286025</td>
<td>Fundamentals of Welding, Part 1</td>
<td>232</td>
</tr>
<tr>
<td>286028</td>
<td>Common Thermal Cutting Processes</td>
<td>232</td>
</tr>
<tr>
<td>286030</td>
<td>Shielded Metal Arc Welding Techniques, Part 1</td>
<td>233</td>
</tr>
<tr>
<td>286031</td>
<td>Shielded Metal Arc Welding Techniques, Part 2</td>
<td>233</td>
</tr>
<tr>
<td>286032</td>
<td>Arc Welding Equipment, Part 1</td>
<td>233</td>
</tr>
<tr>
<td>286033</td>
<td>Arc Welding Equipment, Part 2</td>
<td>233</td>
</tr>
<tr>
<td>286035</td>
<td>Gas Tungsten Arc Welding Fundamentals (GTAW or TIG)</td>
<td>233</td>
</tr>
<tr>
<td>286036</td>
<td>Engineering Mechanics, Part 1</td>
<td>201</td>
</tr>
<tr>
<td>286037</td>
<td>Engineering Mechanics, Part 2</td>
<td>201</td>
</tr>
<tr>
<td>286038</td>
<td>Engineering Mechanics, Part 3</td>
<td>201</td>
</tr>
<tr>
<td>286039</td>
<td>Engineering Mechanics, Part 4</td>
<td>201</td>
</tr>
<tr>
<td>286040</td>
<td>The Trades of Plumbing and Pipefitting</td>
<td>210</td>
</tr>
<tr>
<td>286041</td>
<td>Pipes, Fittings, and Valves</td>
<td>210</td>
</tr>
<tr>
<td>286042</td>
<td>Plumbing and Pipefitting Tools</td>
<td>58, 210</td>
</tr>
<tr>
<td>286043</td>
<td>Joining and Assembling Pipes</td>
<td>210</td>
</tr>
<tr>
<td>286044</td>
<td>Supporting, Installing, and Testing Pipes</td>
<td>210</td>
</tr>
<tr>
<td>286045</td>
<td>Plumbing Fixtures and Appliances</td>
<td>210</td>
</tr>
<tr>
<td>286046</td>
<td>Tanks, Pumps, and Boilers</td>
<td>210</td>
</tr>
<tr>
<td>286047</td>
<td>Insulation for Piping and Ducting</td>
<td>211</td>
</tr>
<tr>
<td>286053</td>
<td>Arc Welding Equipment, Part 3</td>
<td>233</td>
</tr>
<tr>
<td>286059</td>
<td>Gas Metal Arc Welding Fundamentals (GMAW or Mig)</td>
<td>234</td>
</tr>
<tr>
<td>286060</td>
<td>Hydraulic Power Basics</td>
<td>202</td>
</tr>
<tr>
<td>286061</td>
<td>Hydraulic Components: Actuators, Pumps and Motors</td>
<td>202</td>
</tr>
<tr>
<td>286062</td>
<td>Hydraulic Components: Conductors</td>
<td>202</td>
</tr>
<tr>
<td>Course Number</td>
<td>Course Title</td>
<td>Page Number</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>386032</td>
<td>Milling Machine Cutting Tools</td>
<td>237</td>
</tr>
<tr>
<td>386033</td>
<td>Milling Machine Practice and Operation, Part 1</td>
<td>237</td>
</tr>
<tr>
<td>386034</td>
<td>Milling Machine Practice and Operation, Part 2</td>
<td>237</td>
</tr>
<tr>
<td>386035</td>
<td>Milling Machine Indexing and Spiral Work</td>
<td>238</td>
</tr>
<tr>
<td>386036</td>
<td>Lathes, Part 1</td>
<td>238</td>
</tr>
<tr>
<td>386037</td>
<td>Lathes, Part 2</td>
<td>238</td>
</tr>
<tr>
<td>386038</td>
<td>Lathes, Part 3</td>
<td>238</td>
</tr>
<tr>
<td>386039</td>
<td>Lathes, Part 4</td>
<td>238</td>
</tr>
<tr>
<td>386040</td>
<td>Lathes, Part 5</td>
<td>238</td>
</tr>
<tr>
<td>386041</td>
<td>CNC Turning</td>
<td>238</td>
</tr>
<tr>
<td>386042</td>
<td>CNC Milling</td>
<td>239</td>
</tr>
<tr>
<td>386043</td>
<td>Reading Shop Prints, Part 1</td>
<td>239</td>
</tr>
<tr>
<td>386044</td>
<td>Reading Shop Prints, Part 2</td>
<td>239</td>
</tr>
<tr>
<td>386047</td>
<td>Toolmaking, Part 4</td>
<td>239</td>
</tr>
<tr>
<td>386048</td>
<td>Dies and Die Making, Part 3</td>
<td>239</td>
</tr>
<tr>
<td>386049</td>
<td>Jigs and Fixture Making Part 2</td>
<td>239</td>
</tr>
<tr>
<td>4031</td>
<td>Antilock Braking Systems</td>
<td>351</td>
</tr>
<tr>
<td>4031</td>
<td>Alternators</td>
<td>144</td>
</tr>
<tr>
<td>4032</td>
<td>Alternating Current Motors</td>
<td>144</td>
</tr>
<tr>
<td>4033</td>
<td>Fractional Horsepower Motors</td>
<td>144</td>
</tr>
<tr>
<td>4034</td>
<td>Repairing Fractional/Horsepower Motors</td>
<td>144</td>
</tr>
<tr>
<td>4040</td>
<td>Transformers</td>
<td>144</td>
</tr>
<tr>
<td>4041</td>
<td>Transformer Operation</td>
<td>144</td>
</tr>
<tr>
<td>4042</td>
<td>Distribution and Power Transformers</td>
<td>145</td>
</tr>
<tr>
<td>4048</td>
<td>Telemetering</td>
<td>145</td>
</tr>
<tr>
<td>4146A.C</td>
<td>Electrical Measuring Instruments</td>
<td>145</td>
</tr>
<tr>
<td>4210A.C</td>
<td>Electricity</td>
<td>145</td>
</tr>
<tr>
<td>4220A.B</td>
<td>Repairing DC Motors and Generators</td>
<td>145</td>
</tr>
<tr>
<td>4341</td>
<td>Industrial Motor Applications</td>
<td>146</td>
</tr>
<tr>
<td>4342</td>
<td>Efficiency Tests</td>
<td>146</td>
</tr>
<tr>
<td>4343</td>
<td>Storage Batteries</td>
<td>146</td>
</tr>
<tr>
<td>4358</td>
<td>Transmission Lines</td>
<td>287</td>
</tr>
<tr>
<td>4368</td>
<td>Voltage Regulators for Generators</td>
<td>287</td>
</tr>
<tr>
<td>4370</td>
<td>Voltage Regulation of Distribution Systems</td>
<td>287</td>
</tr>
<tr>
<td>4415</td>
<td>Design of Transformers</td>
<td>146</td>
</tr>
<tr>
<td>4400</td>
<td>Working Safely with Electricity</td>
<td>146</td>
</tr>
<tr>
<td>4420A.B</td>
<td>Electric Furnaces</td>
<td>146</td>
</tr>
<tr>
<td>4500B</td>
<td>Servicing Gas Appliances</td>
<td>268</td>
</tr>
<tr>
<td>4501A.C</td>
<td>National Building Code</td>
<td>268</td>
</tr>
<tr>
<td>4502</td>
<td>Drainage Systems</td>
<td>268</td>
</tr>
<tr>
<td>4503</td>
<td>Hot Water Heating</td>
<td>268</td>
</tr>
<tr>
<td>4507</td>
<td>Steam Heating Systems</td>
<td>269</td>
</tr>
<tr>
<td>4512A.B</td>
<td>Concrete Construction</td>
<td>269</td>
</tr>
<tr>
<td>4515A.B</td>
<td>Sanitary Plumbing Fixtures</td>
<td>269</td>
</tr>
<tr>
<td>4516</td>
<td>Plumbing Plans, Specifications, and Inspection</td>
<td>269</td>
</tr>
<tr>
<td>4544</td>
<td>Excavations and Foundations</td>
<td>321</td>
</tr>
<tr>
<td>50001</td>
<td>Plastic Adhesives and Coatings</td>
<td>240</td>
</tr>
<tr>
<td>5002</td>
<td>Plastics: Films, Sheets, Foams, and Laminates</td>
<td>240</td>
</tr>
<tr>
<td>5004A.C</td>
<td>Bench Work</td>
<td>241</td>
</tr>
<tr>
<td>5005A.D</td>
<td>Inorganic Chemistry</td>
<td>321</td>
</tr>
<tr>
<td>5006</td>
<td>Microchemical Analysis</td>
<td>241</td>
</tr>
<tr>
<td>5007A.L</td>
<td>Pulp and Paper Manufacture, Volume 1</td>
<td>321</td>
</tr>
<tr>
<td>5008A.F</td>
<td>Inorganic Chemicals and Processes</td>
<td>322</td>
</tr>
<tr>
<td>5009A.I</td>
<td>Pulp and Paper Manufacture, Volume 2</td>
<td>322</td>
</tr>
<tr>
<td>5010A.L</td>
<td>Pulp and Paper Manufacture, Volume 3</td>
<td>323</td>
</tr>
<tr>
<td>5011</td>
<td>Elements of Chemistry</td>
<td>323</td>
</tr>
<tr>
<td>5012</td>
<td>Engineering Chemistry</td>
<td>323</td>
</tr>
<tr>
<td>5013A.D</td>
<td>Physical Chemistry</td>
<td>323</td>
</tr>
<tr>
<td>Course Number</td>
<td>Course Title</td>
<td>Page Number</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>5455A-H</td>
<td>Quantitative Analysis</td>
<td>329</td>
</tr>
<tr>
<td>5456</td>
<td>Quantitative Analysis Laboratory Manual</td>
<td>329</td>
</tr>
<tr>
<td>5460A-C</td>
<td>Transit Surveying</td>
<td>330</td>
</tr>
<tr>
<td>5461A-B</td>
<td>Topographic Surveying</td>
<td>330</td>
</tr>
<tr>
<td>5462A-B</td>
<td>Mapping</td>
<td>330</td>
</tr>
<tr>
<td>5463</td>
<td>Fundamentals of Law for Surveyors</td>
<td>330</td>
</tr>
<tr>
<td>5465</td>
<td>Determination of True Meridian</td>
<td>330</td>
</tr>
<tr>
<td>5466A-B</td>
<td>United States Land Surveys</td>
<td>330</td>
</tr>
<tr>
<td>5468</td>
<td>Earthwork</td>
<td>330</td>
</tr>
<tr>
<td>5469A-C</td>
<td>Production of Concrete</td>
<td>270</td>
</tr>
<tr>
<td>5470A-C</td>
<td>Structural Steel Drawing</td>
<td>331</td>
</tr>
<tr>
<td>5471A-B</td>
<td>Reading Structural Steel Drawings</td>
<td>331</td>
</tr>
<tr>
<td>5481</td>
<td>Plate Girders for Steel Buildings</td>
<td>331</td>
</tr>
<tr>
<td>5501</td>
<td>Sanitary Chemistry</td>
<td>331</td>
</tr>
<tr>
<td>5523</td>
<td>Foundations and Filings</td>
<td>331</td>
</tr>
<tr>
<td>5532A-B</td>
<td>Gear Making</td>
<td>243</td>
</tr>
<tr>
<td>5543A-B</td>
<td>Geometrical Drawing</td>
<td>331</td>
</tr>
<tr>
<td>5543A-B</td>
<td>Sheet Metal Drafting</td>
<td>331</td>
</tr>
<tr>
<td>5565A-B</td>
<td>Business Mathematics</td>
<td>50</td>
</tr>
<tr>
<td>5567</td>
<td>Practical Geometry and Trigonometry</td>
<td>50</td>
</tr>
<tr>
<td>5581</td>
<td>Pipelining Practice</td>
<td>206</td>
</tr>
<tr>
<td>5587A-C</td>
<td>Steel Roof Trusses</td>
<td>332</td>
</tr>
<tr>
<td>5602A-F</td>
<td>Carpentry</td>
<td>270</td>
</tr>
<tr>
<td>5608</td>
<td>Mechanical Calculations</td>
<td>207</td>
</tr>
<tr>
<td>5645</td>
<td>Drawings for Welded Parts</td>
<td>332</td>
</tr>
<tr>
<td>5649</td>
<td>Elements of Projection Drawing</td>
<td>332</td>
</tr>
<tr>
<td>5636A</td>
<td>Boring Mills</td>
<td>243</td>
</tr>
<tr>
<td>5657A-B</td>
<td>Architectural Drawing</td>
<td>332</td>
</tr>
<tr>
<td>5739</td>
<td>Mechanical Drawing</td>
<td>332</td>
</tr>
<tr>
<td>5751</td>
<td>Hydrographic Surveying</td>
<td>333</td>
</tr>
<tr>
<td>5773A-B</td>
<td>Advanced Mechanical Drawing</td>
<td>333</td>
</tr>
<tr>
<td>5814A-G</td>
<td>Organic Chemistry</td>
<td>333</td>
</tr>
<tr>
<td>5839A-C</td>
<td>Elementary Architectural Drawings</td>
<td>334</td>
</tr>
<tr>
<td>5807</td>
<td>Machine Sketching</td>
<td>333</td>
</tr>
<tr>
<td>5810</td>
<td>Field Sketching</td>
<td>333</td>
</tr>
<tr>
<td>5878</td>
<td>Filtration</td>
<td>333</td>
</tr>
<tr>
<td>5886</td>
<td>Pipes and Fittings</td>
<td>207</td>
</tr>
<tr>
<td>5891</td>
<td>Fireproofing of Buildings</td>
<td>334</td>
</tr>
<tr>
<td>5961A-B</td>
<td>Nondestructive Testing of Castings</td>
<td>243</td>
</tr>
<tr>
<td>5962</td>
<td>Inspection of Shop Products</td>
<td>243</td>
</tr>
<tr>
<td>5970</td>
<td>Advanced Partnership Accounting</td>
<td>376</td>
</tr>
<tr>
<td>5971</td>
<td>Funds Accounting</td>
<td>376</td>
</tr>
<tr>
<td>5972</td>
<td>Consignment and Installment Sales</td>
<td>376</td>
</tr>
<tr>
<td>5983A-B</td>
<td>Practical Geometry</td>
<td>51</td>
</tr>
<tr>
<td>5998A-B</td>
<td>Sales Records and Reports</td>
<td>377</td>
</tr>
<tr>
<td>6026</td>
<td>Surface Protection of Metals</td>
<td>334</td>
</tr>
<tr>
<td>6041</td>
<td>Distillation</td>
<td>334</td>
</tr>
<tr>
<td>6048</td>
<td>Evaporation and Crystallization</td>
<td>334</td>
</tr>
<tr>
<td>6070A-I</td>
<td>The Lineman's and Cableman's Handbook</td>
<td>288</td>
</tr>
<tr>
<td>6078</td>
<td>Sound</td>
<td>334</td>
</tr>
<tr>
<td>6084A-B</td>
<td>Air Conditioning Systems</td>
<td>207</td>
</tr>
<tr>
<td>6091</td>
<td>Broaching</td>
<td>243</td>
</tr>
<tr>
<td>6105</td>
<td>Size Reduction</td>
<td>334</td>
</tr>
<tr>
<td>6106</td>
<td>Size Separation</td>
<td>335</td>
</tr>
<tr>
<td>6118</td>
<td>Planers</td>
<td>271</td>
</tr>
<tr>
<td>6152A-B</td>
<td>Practical Metallurgy for Welders</td>
<td>244</td>
</tr>
<tr>
<td>6154</td>
<td>Safety in Welding and Cutting</td>
<td>244</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>6208</td>
<td>Solvent Extraction</td>
<td>335</td>
</tr>
<tr>
<td>6209</td>
<td>Mixing</td>
<td>335</td>
</tr>
<tr>
<td>6211</td>
<td>Plumbing Drawing</td>
<td>335</td>
</tr>
<tr>
<td>6219</td>
<td>Selling Your Ideas</td>
<td>377</td>
</tr>
<tr>
<td>6227A-C</td>
<td>Painting</td>
<td>271</td>
</tr>
<tr>
<td>6232A-E</td>
<td>Plane Trigonometry</td>
<td>51</td>
</tr>
<tr>
<td>6235A-C</td>
<td>Inventory Control</td>
<td>377</td>
</tr>
<tr>
<td>6255A-B</td>
<td>Light</td>
<td>335</td>
</tr>
<tr>
<td>6256</td>
<td>Power Line Calculations</td>
<td>288</td>
</tr>
<tr>
<td>6272A-B</td>
<td>Gas Welding Equipment</td>
<td>244</td>
</tr>
<tr>
<td>6275A-B</td>
<td>Gas Cutting</td>
<td>244</td>
</tr>
<tr>
<td>6276A-C</td>
<td>Gas Welding Techniques</td>
<td>244</td>
</tr>
<tr>
<td>6278A-B</td>
<td>Fabrication of Pipe by Welding</td>
<td>245</td>
</tr>
<tr>
<td>6290</td>
<td>Common Brickwork</td>
<td>271</td>
</tr>
<tr>
<td>6305A-B</td>
<td>Principles of Automatic Process Control Instruments</td>
<td>207</td>
</tr>
<tr>
<td>6306A-B</td>
<td>Temperature Measuring and Control Instruments</td>
<td>207</td>
</tr>
<tr>
<td>6307</td>
<td>Automatic Process Control Valves</td>
<td>207</td>
</tr>
<tr>
<td>6308A-B</td>
<td>Fluid Flow Measuring and Control Instruments</td>
<td>208</td>
</tr>
<tr>
<td>6309A-B</td>
<td>Process Pressure Measuring and Control Instruments</td>
<td>208</td>
</tr>
<tr>
<td>6330A-B</td>
<td>Field Methods in Concrete Construction</td>
<td>335</td>
</tr>
<tr>
<td>6338A-B</td>
<td>Liquid Level Measuring and Control Instruments</td>
<td>208</td>
</tr>
<tr>
<td>6403A-B</td>
<td>Low Cost Road Surfaces</td>
<td>335</td>
</tr>
<tr>
<td>6421A-B</td>
<td>Builder's Hardware</td>
<td>271</td>
</tr>
<tr>
<td>6427A-F</td>
<td>Pattern Making</td>
<td>245</td>
</tr>
<tr>
<td>6447A-B</td>
<td>Principles of Heating, Ventilating, and Air Conditioning</td>
<td>208</td>
</tr>
<tr>
<td>6463</td>
<td>Plumbing and Pipelining Tools</td>
<td>209</td>
</tr>
<tr>
<td>6465</td>
<td>Radiators, Convector, and Unit Heaters</td>
<td>272</td>
</tr>
<tr>
<td>6472</td>
<td>Testing Solid and Liquid Boiler Fuels</td>
<td>288</td>
</tr>
<tr>
<td>6475</td>
<td>Solid and Pulverized Fuel Burning</td>
<td>288</td>
</tr>
<tr>
<td>6487</td>
<td>Construction Safety</td>
<td>70</td>
</tr>
<tr>
<td>6501</td>
<td>Technical Writing</td>
<td>44</td>
</tr>
<tr>
<td>6513A-D</td>
<td>Elements of Photoengraving</td>
<td>336</td>
</tr>
<tr>
<td>6515</td>
<td>Radio Frequency Circuits</td>
<td>146</td>
</tr>
<tr>
<td>6520A-B</td>
<td>Ultrasonics</td>
<td>147</td>
</tr>
<tr>
<td>6525</td>
<td>Fundamentals of Electronic Instrumentation and Control</td>
<td>147</td>
</tr>
<tr>
<td>6526</td>
<td>Electronic Instrumentation Methods and Circuits</td>
<td>147</td>
</tr>
<tr>
<td>6531A-B</td>
<td>Electronic Test Instruments</td>
<td>147</td>
</tr>
<tr>
<td>6536A-B</td>
<td>Managing Physical Distribution</td>
<td>337</td>
</tr>
<tr>
<td>6538A-B</td>
<td>Protective Relaying</td>
<td>148</td>
</tr>
<tr>
<td>6553</td>
<td>Condensers</td>
<td>209</td>
</tr>
<tr>
<td>6561A-B</td>
<td>Analytic Geometry</td>
<td>148</td>
</tr>
<tr>
<td>6569A-B</td>
<td>Transfer Devices for Machine Tools</td>
<td>245</td>
</tr>
<tr>
<td>6580</td>
<td>Electronic Control Circuits and Applications</td>
<td>148</td>
</tr>
<tr>
<td>6582</td>
<td>Design of Precast Concrete</td>
<td>336</td>
</tr>
<tr>
<td>6585</td>
<td>Reconnecting Induction Motors</td>
<td>148</td>
</tr>
<tr>
<td>6593</td>
<td>National Fuel Gas Code</td>
<td>272</td>
</tr>
<tr>
<td>6588A-D</td>
<td>Instrumental Laboratory Analysis</td>
<td>336</td>
</tr>
<tr>
<td>6589A-B</td>
<td>Electric Power Generating Stations</td>
<td>288</td>
</tr>
<tr>
<td>6590A-B</td>
<td>Electric Power Substations</td>
<td>289</td>
</tr>
<tr>
<td>6598</td>
<td>Batteries and Electronic Power Supplies</td>
<td>148</td>
</tr>
<tr>
<td>6601</td>
<td>Theory of RL, RC, and RLC Circuits</td>
<td>148</td>
</tr>
<tr>
<td>6613</td>
<td>Switchgear</td>
<td>148</td>
</tr>
<tr>
<td>6617</td>
<td>Inductance and Capacitance</td>
<td>149</td>
</tr>
<tr>
<td>6618A-D</td>
<td>Calculus: Function and Use</td>
<td>51</td>
</tr>
<tr>
<td>6631A-B</td>
<td>AC Motor Repair</td>
<td>149</td>
</tr>
</tbody>
</table>
INDEX

Numerical Index

Course Number | Course Title | Page Number
---|---|---
6632 | Types of Steam Generators | 289
6646 | Illumination Principles | 149
665A-K | Intermediate Accounting | 377
6670 | Linear Surveying | 336
6671 | Leveling | 336
6683 | Principles and Uses of Nuclear Energy | 289
6687 | DC Generators and Motors | 149
6688A-B | Reading Highway Blueprints | 337
66901 | Computer Aided Drafting and Design | 316
66902 | Industrial Robotics: Technology, Programming, and Applications | 197
66904 | Productivity Engineering and Management | 316
6691 | Pressure Vessel and Tank Print Reading | 209
6695A-B | Electrical Drafting | 337
6698 | AC Motors, Generators, and Rectifiers | 149
6699A-C | Industrial Motor Control | 149
6705 | Reading Construction Prints | 272
6710A-D | Qualitative Analysis | 337
6711 | Qualitative Analysis Laboratory Manual | 337
6712A-B | Sheet Metal Hand Processes | 245
6716 | Sheet Metal Machine Processes | 245
6718A-C | Hydraulic Turbines | 289
6719A-B | Elements of Print Reading | 51
6727 | Feedwater Treatment and Equipment | 338
6728 | Symmetrical Components | 150
6732 | Reading Piping Prints | 209
6734 | Steam Boiler Operation and Maintenance | 209
6793 | Instrument Transformers | 150
6794A-C | Sewerage | 338
6802 | Steam Generator Testing | 289
6810 | Flue Gas Analysis | 289
6812A-B | Highway Curves | 338
6814 | Insulation for Pipelining | 209
6818A-C | City Surveying | 338
686E1 | Industrial Plastics: Materials, Properties and Manufacturing | 246
686001 | Heat, Part 1 | 338
686002 | Heat, Part 2 | 338
686003 | Physics, Part 1 | 339
686004 | Physics, Part 2 | 339
686005 | Properties of Materials | 339
786E01 | Electrical Power Distribution and Transmission for the Technician | 290
786E02 | Safety for Lineworkers | 290
786E03 | Electrical Concepts for Lineworkers | 290
786E04 | Rigging for Lineworkers | 291
786E05 | Transformation for Lineworkers | 291
786E06 | Underground Distribution for Lineworkers | 291
786E001 | Cable: Introduction to Transmission and Measurement | 150
786E002 | Cable: Performance Characteristics | 150
786E005 | Fundamentals of Power Plant Operation, Part 1 | 291
786006 | Fundamentals of Power Plant Operation, Part 2 | 292
786007 | Fundamentals of Power Plant Operation, Part 3 | 292
786008 | Power Plant Water Treatment, Part 1 | 292
786009 | Power Plant Water Treatment, Part 2 | 292
786010 | Power Plant Water Treatment, Part 3 | 292
786011 | Station Power | 293
786013 | Combustion Turbines, Part 1 | 293
786014 | Combustion Turbines, Part 2 | 293
786015 | Combustion Turbines, Part 3 | 293
786016 | Fundamentals of Linework | 293
786017 | Lineworkers Tools | 293
786018 | Power Plant Fuel Flow Paths, Part 1 | 293
786019 | Power Plant Fuel Flow Paths, Part 2 | 294
786020 | Power Plant Fuel Flow Paths, Part 3 | 294
786021 | Power Plant Steam Flow Paths, Part 1 | 294
786022 | Power Plant Steam Flow Paths, Part 2 | 294
786023 | Power Plant Steam Flow Paths, Part 3 | 294
786024 | Power Plant Auxiliary Equipment | 294
786025 | Power Plant Instrumentation Systems | 295
786026 | Power Plant Boiler and Related Equipment | 295
786027 | Conveyor Systems | 295
86087 | Experiments with Basic DC Theory & Lab Manual | 135
86088 | Experiments with Basic AC Theory & Lab Manual | 135
8932TB | Effective Training | 53
986M01 | Carpentry | 270
ADT02 | Automotive Drive Trains: Automatic and Manual | 357
AE01 | Automotive Engines: Theory and Servicing | 358
Block A21 | DC Principles | 151
Block A22 | AC Principles | 152
Block A23 | Analog Circuit Measurement | 153
Block A24 | Electrical Equipment | 154
Block B06 | Troubleshooting Electronic Equipment and Systems | 157
Block B07 | Pulse Circuits | 159
Block B08 | Logic Circuits | 160
Block B09 | Linear and Digital Integrated Circuits | 161
Block B10 | Basic Industrial Computer Systems | 162
Block B11 | Introduction to Microprocessors | 164
Block B13 | Electronic Instrumentation and Control | 165
Block B14 | Industrial Electronic Circuit Applications | 165
Block B15 | Basic Industrial Electronic System Applications | 166
Block B16 | Advanced Troubleshooting Techniques | 167
Block B22 | Reactive Circuits | 168
Block B23 | Analog Electronic Components | 169
Block B24 | Basic Electronic Circuits | 170
Block B25 | Electronic Systems | 171
Block B26 | Troubleshooting Industrial Electrical, Electronic, and Computer Systems | 173
Block B27 | Industrial Plumbing and Pipelining | 209
Block B02 | Introduction to Algebra, Geometry, and Trigonometry | 53
Block B03 | Industrial Safety | 70
Block B06 | Industrial Materials and Components | 246
Block X07 | Maintenance and Troubleshooting | 54
Block X08 | Basic Machining Skills | 248
Block X21 | Basic Industrial Math | 56
Block X22 | Practical Measurements | 57
Block X23 | Industrial Safety | 70
Block X24 | Hand and Power Tools | 57
Block X25 | Reading Prints and Schematics | 59
Block X27 | Maintenance and Troubleshooting | 61
Block Y01 | Introduction to Fluid Power | 211
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block Y02</td>
<td>Studies in Hydraulics</td>
<td>212</td>
</tr>
<tr>
<td>ELIM07</td>
<td>Practical English and the Command of Words</td>
<td>62</td>
</tr>
<tr>
<td>G14003</td>
<td>Modern Refrigeration and Air Conditioning</td>
<td>215</td>
</tr>
<tr>
<td>K0000129EM</td>
<td>Spill Cleanup</td>
<td>80</td>
</tr>
<tr>
<td>K000012VEM</td>
<td>Spill Cleanup</td>
<td>80</td>
</tr>
<tr>
<td>K0000139EM</td>
<td>Hazardous Labeling</td>
<td>80</td>
</tr>
<tr>
<td>K000019EM</td>
<td>Office Ergonomics</td>
<td>81</td>
</tr>
<tr>
<td>K0000199EM</td>
<td>Office Ergonomics</td>
<td>79</td>
</tr>
<tr>
<td>K000020EM</td>
<td>Office Safety</td>
<td>81</td>
</tr>
<tr>
<td>K000020VEM</td>
<td>Office Safety</td>
<td>79</td>
</tr>
<tr>
<td>K0000219EM</td>
<td>Computer Workstation Safety</td>
<td>81</td>
</tr>
<tr>
<td>K000021VEM</td>
<td>Computer Workstation Safety</td>
<td>80</td>
</tr>
<tr>
<td>K0000329EM</td>
<td>Fire Prevention &amp; Safety</td>
<td>84</td>
</tr>
<tr>
<td>K000032VEM</td>
<td>Fire Prevention &amp; Safety</td>
<td>84</td>
</tr>
<tr>
<td>K0000339EX</td>
<td>DOT General Awareness</td>
<td>105</td>
</tr>
<tr>
<td>K000033VEX</td>
<td>DOT General Awareness</td>
<td>98</td>
</tr>
<tr>
<td>K0000359EX</td>
<td>DOT Safety Training</td>
<td>98</td>
</tr>
<tr>
<td>K0000379EX</td>
<td>DOT Security Awareness</td>
<td>106</td>
</tr>
<tr>
<td>K0000399EX</td>
<td>DOT In-Depth Security</td>
<td>106</td>
</tr>
<tr>
<td>K000039VEX</td>
<td>DOT In-Depth Security</td>
<td>106</td>
</tr>
<tr>
<td>K0000379EX</td>
<td>DOT Security Awareness</td>
<td>106</td>
</tr>
<tr>
<td>K0000429EM</td>
<td>Slips, Trips, &amp; Falls</td>
<td>83</td>
</tr>
<tr>
<td>K000042VEM</td>
<td>Slips, Trips, &amp; Falls</td>
<td>78</td>
</tr>
<tr>
<td>K0000439EM</td>
<td>Back Safety</td>
<td>80</td>
</tr>
<tr>
<td>K000043VEM</td>
<td>Back Safety</td>
<td>78</td>
</tr>
<tr>
<td>K0000449EM</td>
<td>Hand &amp; Power Tool Safety</td>
<td>82</td>
</tr>
<tr>
<td>K000044VEM</td>
<td>Hand &amp; Power Tool Safety</td>
<td>79</td>
</tr>
<tr>
<td>K0000459EM</td>
<td>Fire Prevention &amp; Safety</td>
<td>76</td>
</tr>
<tr>
<td>K0000469EM</td>
<td>Fire Prevention &amp; Safety</td>
<td>76</td>
</tr>
<tr>
<td>K0000479EM</td>
<td>Sexual Harassment</td>
<td>76</td>
</tr>
<tr>
<td>K0000489EM</td>
<td>Sexual Harassment</td>
<td>77</td>
</tr>
<tr>
<td>K0000519EM</td>
<td>Sexual Harassment</td>
<td>76</td>
</tr>
<tr>
<td>K0000519EX</td>
<td>Accident Investigation</td>
<td>81</td>
</tr>
<tr>
<td>K0000519EM</td>
<td>Accident Investigation</td>
<td>78</td>
</tr>
<tr>
<td>K0000A99EO</td>
<td>Indoor Air Quality</td>
<td>102</td>
</tr>
<tr>
<td>K0000A99EO</td>
<td>Asbestos Awareness</td>
<td>102</td>
</tr>
<tr>
<td>K0000A99EO</td>
<td>Asbestos Awareness</td>
<td>97</td>
</tr>
<tr>
<td>K0000B19EO</td>
<td>Bloodborne Pathogens</td>
<td>102</td>
</tr>
<tr>
<td>K0000B29EO</td>
<td>Bloodborne Pathogens</td>
<td>98</td>
</tr>
<tr>
<td>K0000B2V9EO</td>
<td>Bloodborne Pathogens</td>
<td>102</td>
</tr>
<tr>
<td>K0000B2V9EO</td>
<td>Bloodborne Pathogens</td>
<td>102</td>
</tr>
<tr>
<td>K0000B2Y9EO</td>
<td>Bloodborne Pathogens</td>
<td>98</td>
</tr>
<tr>
<td>K0000B3F9EO</td>
<td>Bloodborne Pathogens</td>
<td>98</td>
</tr>
<tr>
<td>K0000B3F9EO</td>
<td>Bloodborne Pathogens</td>
<td>98</td>
</tr>
<tr>
<td>K0000C539ER</td>
<td>Confined Space Entry</td>
<td>88</td>
</tr>
<tr>
<td>K0000C5F9ER</td>
<td>Confined Space Entry</td>
<td>100</td>
</tr>
<tr>
<td>K0000CG9CM</td>
<td>Compressed Gas Cylinders</td>
<td>81</td>
</tr>
<tr>
<td>K0000C9CM</td>
<td>Compressed Gas Cylinders</td>
<td>77</td>
</tr>
<tr>
<td>K0000CH9R9</td>
<td>Right-To-Know</td>
<td>103</td>
</tr>
<tr>
<td>K0000CH9R9</td>
<td>Right-To-Know</td>
<td>100</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>103</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>100</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>81</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>78</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>81</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>78</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>81</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>77</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>81</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>81</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>80</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>81</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>79</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>82</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>82</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>77</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>82</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>79</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>82</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>79</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>82</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>79</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>82</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>79</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>82</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>82</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>77</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>82</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>77</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>81</td>
</tr>
<tr>
<td>K0000C9R9</td>
<td>Right-To-Know</td>
<td>81</td>
</tr>
<tr>
<td>Course Number</td>
<td>Course Title</td>
<td>Page Number</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
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<td>Exposure Monitoring &amp; Medical Surveillance</td>
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<td>Fire Prevention &amp; Safety</td>
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<td>Fitness &amp; Wellness</td>
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<td>Laboratory Glassware</td>
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<td>HAZMAT Labeling</td>
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<td>V000HE9E</td>
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<td>Heat Stress</td>
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<td>Hand, Wrist, &amp; Finger Safety</td>
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<td>V000ZH29E</td>
<td>HAZWOPER General Training Package</td>
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