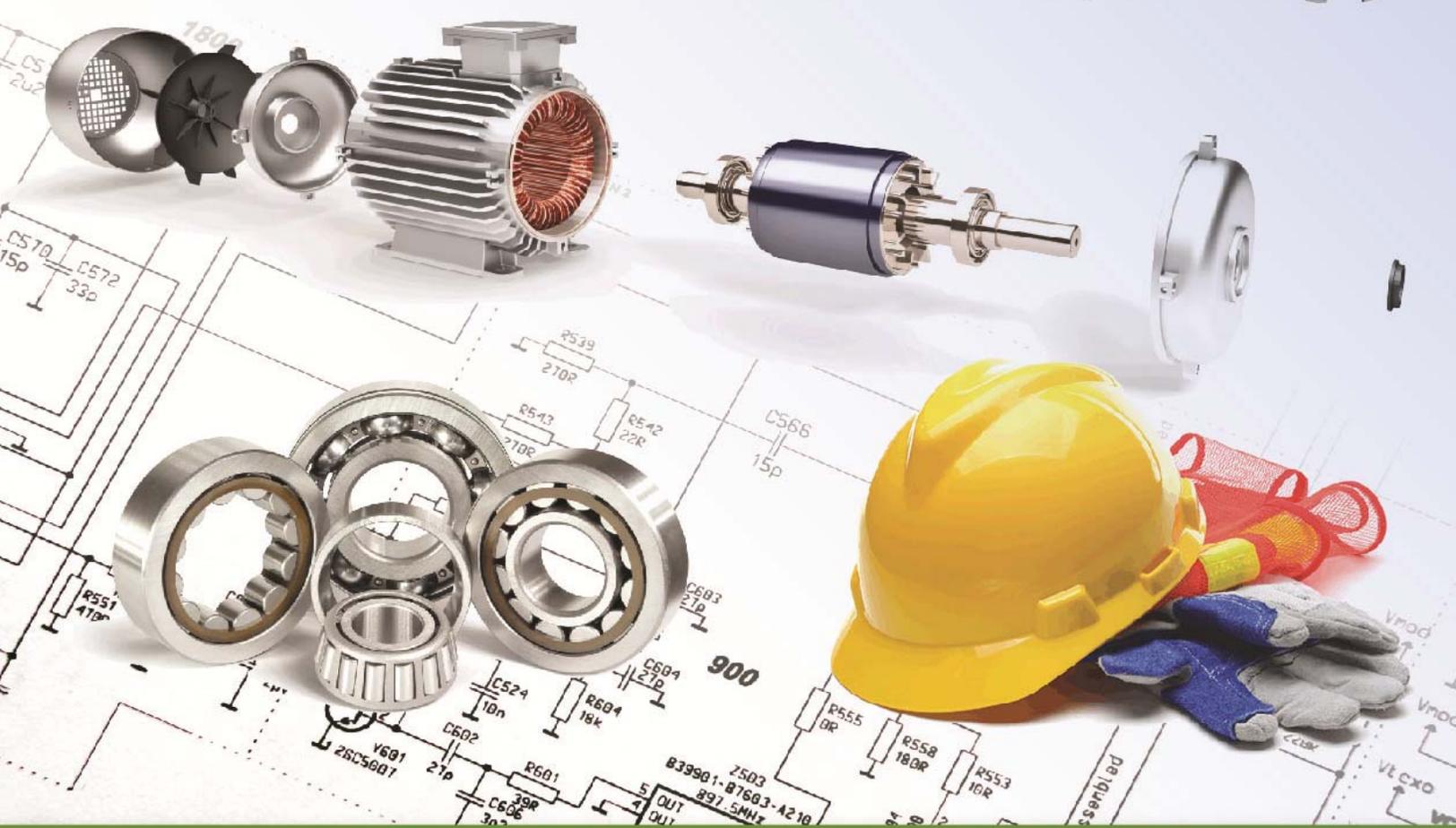




GP Strategies Craft Skills Training Course Catalog



GP STRATEGIES™ AT A GLANCE

Founded in 1966, GP Strategies is a global performance improvement solutions provider of sales and technical training, e-learning solutions, management consulting and engineering services. GP Strategies' solutions improve the effectiveness of organizations by delivering innovative and superior training, consulting and a business improvement service, customized to meet the specific needs of its clients. Customers include Fortune 500 companies, manufacturing, process and energy industries, and other commercial and government organizations. GP Strategies is headquartered in Columbia, Maryland, USA. Additional information may be found at gpstrategies.com.

GP STRATEGIES VISION AND MISSION

We have a vision to equip and enable people and businesses to perform at their highest potential. Our mission is to make a meaningful impact by providing the expertise and solutions needed to solve business challenges and attain ultimate performance results.

YOUR TOTAL SOLUTIONS PARTNER

GP Strategies believes that successful companies are characterized by an unrelenting focus on effectively linking their people, processes, and technology—three interrelated elements that directly impact the achievement of an organization's performance, cost management and compliance objectives. We believe that execution and effectiveness are key when it comes to training, training outsourcing, homeland security, engineering, and issues.

Measurable, sustainable improvements in profitability and efficiency prove the value of GP Strategies' work. Our diverse subject-matter expertise serves as the foundation for a true understanding of the issues surrounding workplace technologies, but it's our extensive experience that really makes the difference for our customers. Ultimately, it's your people that really drive productivity—GP Strategies unlocks their potential, putting it to work for your organization.

CULTIVATING SUCCESS

GP Strategies is well recognized as a provider of training and performance improvement solutions to many Fortune 500 companies. We offer a wide range of services across all functional areas of life sciences.

Our success is based on a commitment to develop long-term, mutually beneficial working partnerships with our clients. This commitment, coupled with GP Strategies' diverse experience, provides the opportunity to incorporate best practices from various industries into GP Strategies' services, helping us provide effective and flexible solutions to meet customers' needs, regardless of their and size.

GP STRATEGIES' GUIDING PRINCIPLES

- ▶ Making a meaningful impact
- ▶ Acting with integrity
- ▶ Communicating directly and honestly
- ▶ Delivering quality services products
- ▶ Developing innovative solutions based on need
- ▶ Striving for continuous improvement
- ▶ Demonstrating teamwork
- ▶ Respecting others
- ▶ Optimizing shareholder value

GP STRATEGIES' CRAFT SKILLS TRAINING

As today's skilled workforce ages, the needs for multi-skilled technicians and innovative workforce solutions become more critical. Off-the-shelf solutions cannot deliver the kind of targeted maintenance training you need to meet your demands for skilled, plant, and process-specific labor. If you want a cost-effective, yet customized, solution, you need GP Strategies.

GP Strategies delivers a proven approach to achieving the world-class competencies that are seen in leading maintenance and reliability, and operational excellence programs. Based on years of on-site maintenance training experience, GP Strategies includes the entire spectrum of maintenance training, not just the foundational pieces. So it enables the flexibility to address different types of maintenance training needs, from traditional program development and supplementation to plant launch and apprenticeship programs.

What makes GP Strategies' Craft Skills training so special?

- ▶ More hands-on training—All of the customized training programs and on-site courses we offer feature 60%–70% hands-on lab instruction to increase the effectiveness of the training and achieve better long-term results for your maintenance professionals.
- ▶ Long-term planning strategies—GP Strategies gets you started through the process of identifying, documenting, and addressing your unique challenges. This enables us to develop a plan that will make your company flexible enough to adapt to new challenges as they emerge in the future.
- ▶ A proven track record of success—GP Strategies has been helping companies like yours improve craft skills, implement new technologies, and enhance maintenance processes since 1966. We have an excellent track record when it comes to performance improvement. We can provide case studies, success stories, and a project list to demonstrate depth of experience and creativity in our approach to maintenance training. Performance improvement and workforce training are our core competencies. And we do them well.

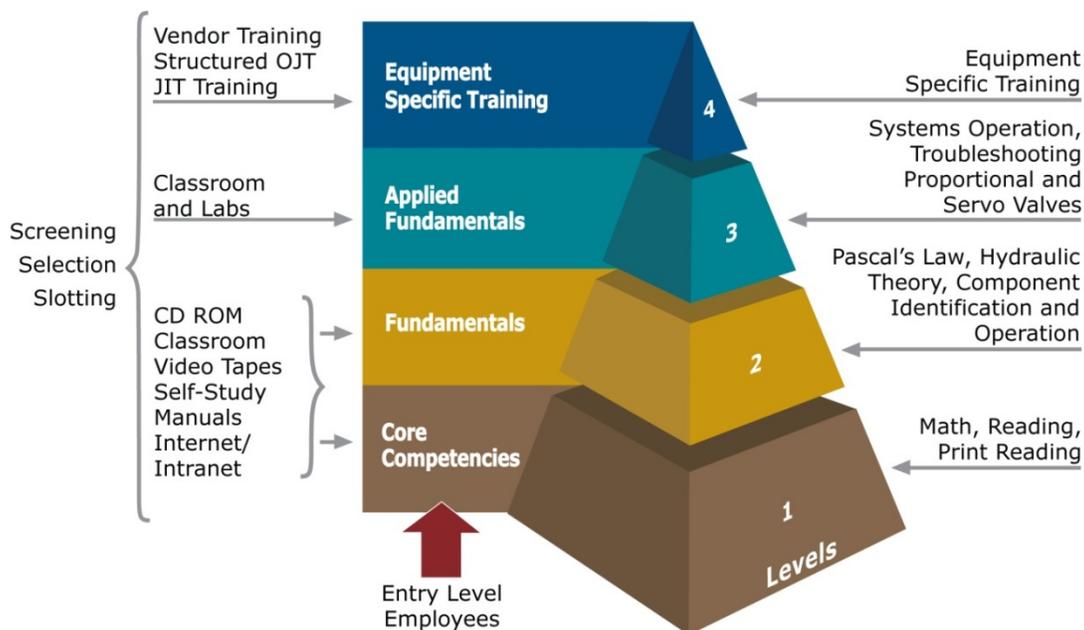
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- ▶ Greater flexibility and agility—GP Strategies can help you develop a multi-skilled workforce that gives you greater workforce, scheduling, and crew mix flexibility, not to mention an enhanced capability to do more with less.

You can obtain most of the courses in a format that works best for you:

- ▶ Off the Shelf—You can select our standard training if a generic course suits your needs.
- ▶ Customized—You can ask us to make minor modifications to better fit your organization’s existing terminology and culture (which we can do quickly and cost effectively), or you can ask us to develop a truly custom curriculum.
- ▶ E-Learning—For certain courses, you can select e-Learning or a blended solution of e-Learning, instructor-led training, and coaching.
- ▶ IP License Agreement—Your company can access GP Strategies’ off-the-shelf courseware through a perpetual intellectual property (IP) license agreement. GP Strategies will customize our courses with your company’s selected headers and footers, and format our materials in accordance with your corporate training template. GP Strategies’ courseware includes student guides, instructor guides, instructor presentations, testing materials, and “hands-on” lab guides.

GP Strategies’ solution, based on years of maintenance training, allows us to deliver the best training solution to your maintenance technicians regardless of their level of need. It all begins with a needs or gap analysis, followed by a training strategy design and customized course development and delivery. Our depth of experience and qualified maintenance experts ensure a highly targeted program that transcends the limitations of canned approaches. It is based on a progression through four competency levels:



- ▶ Level 1: The Core Competencies level provides the basic essentials for new hires or entry-level employees, and focuses on core math, print reading, and technical skills to ensure that they can perform at the higher levels.
- ▶ Level 2: The Fundamentals level introduces much of the theory, such as Kirchhoff's Law and Pascal's Law, associated with the maintenance processes and includes basic concepts of hydraulics, pneumatics, pumps, PLCs, motors, etc.
- ▶ Level 3: The Applied Fundamentals level transfers the theory and knowledge elements into practical applications. This level ensures that your maintenance professionals are trained to perform all of their required tasks and gives them the hands-on learning opportunities to practice these critical skills.
- ▶ Level 4: The Equipment-Specific Training level ensures that your maintenance team is fully capable and well-trained on the use and maintenance practices specific to your equipment.

GP Strategies, your total solutions partner, provides the following services:

- ▶ Assessment and Planning. GP Strategies provides Program Evaluations, Training Needs Assessment, Delivery Mode Analysis, Curriculum Architecture, and Training Plan Development.
- ▶ Training Development. GP Strategies provides review of prior training and the analysis, design, development, and evaluation of customized training.
- ▶ Training. GP Strategies provides structured on-the-job training (OJT) programs, train-the-trainer programs, on-site instruction (classroom or hands-on), computer/web-based training, and a large number of maintenance skills and maintenance systems description.
- ▶ Training Center Management. Apprentice programs. GP Strategies provides employee testing, screening, and selection; establishment, staffing, and management of craft training centers; training administration and logistics; structured OJT; and qualification programs.

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SAF-001: ELECTRICAL SAFETY AND LOCKOUT/TAGOUT

COURSE DESCRIPTION

This course provides information on potential safety hazards, safety precautions, personal protective equipment, general emergency response, and the local lockout/tagout program.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to discuss potential workplace hazards and the associated precautions, general responses to plant emergencies, personal protective equipment used in the plant, and personnel responsibilities under the local lockout/tagout program.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation.

YOU WILL LEARN

- ▶ Discuss the hazards and precautions/countermeasures for each hazard.
- ▶ List and explain the personal protective equipment required for work in mill areas.
- ▶ Discuss some hazards specific to electrical work and the precautions/countermeasures for each hazard.
- ▶ Describe the general response to plant emergencies.
- ▶ Describe the energy isolation requirements for safely working on equipment.
- ▶ Describe the local lockout/tagout program and the requirements placed on the personnel doing work.

CLASS DURATION

8 hours

SAF-002: ELECTRICAL SAFETY FOR QUALIFIED ELECTRICAL PERSONNEL

COURSE DESCRIPTION

This course provides guidance in order to comply with OSHA and NFPA 70E electrical safety regulations, including arc flash protection.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to discuss arc flash protection, working on energized equipment and personal protective equipment used in the plant, and personnel responsibilities under the local lockout/tagout program.

RECOMMENDED AUDIENCE

This course is designed for electrical technicians, electricians, and personnel using lockout/tagout on electrical systems.

RECOMMENDED MEDIA/MODE

Lecture, instructor-led discussion, and hands-on lab exercises.

YOU WILL LEARN

- ▶ Describe general safety hazards and precautions associated with electrical systems.
- ▶ Describe electrical tool and equipment safety.
- ▶ Describe voltage level conventions for electrical systems.
- ▶ Describe electrical system lockout/tagout requirements.
- ▶ Describe the requirements for working on energized equipment.
- ▶ Describe the requirements associated with arc flash protection.
- ▶ Describe the proper use of personal protective equipment.
- ▶ Describe the proper use of electrical protective rubber goods.
- ▶ Describe the requirements for protective grounding.
- ▶ Describe the electrical safety requirements associated with fuses.
- ▶ Describe the electrical safety requirements associated with switchgear and circuit breakers.
- ▶ Describe the electrical safety requirements for batteries and DC systems.

CLASS DURATION

8 hours

SAF-003: MECHANICAL SAFETY AND LOCKOUT/TAGOUT

COURSE DESCRIPTION

This course provides information on potential safety hazards, safety precautions, personal protective equipment, general emergency response, and the local lockout/tagout program.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to discuss potential workplace hazards and the associated precautions, general responses to plant emergencies, personal protective equipment used in the plant, and personnel responsibilities under the local lockout/tagout program.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation.

YOU WILL LEARN

- ▶ Discuss electrical safety hazards.
- ▶ Discuss hydraulics and pneumatics stored-energy hazards.
- ▶ Discuss the hazards and precautions/countermeasures for each hazard.
- ▶ List and explain the personal protective equipment required for work in mill areas.
- ▶ Discuss some hazards particular to mechanical work and the precautions/countermeasures for each hazard.
- ▶ Describe the general response to plant emergencies.
- ▶ Describe the energy isolation requirements for safe work on equipment.
- ▶ Describe the local lockout/tagout program and the requirements placed on the personnel doing work.

CLASS DURATION

8 hours

SAF-004: ELECTRICAL SAFETY FOR NON-ELECTRICAL PERSONNEL

COURSE DESCRIPTION

This course provides an overview for compliance with OSHA and NFPA 70E electrical safety regulations, including arc flash protection.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to describe the following:

- ▶ General safety hazards and precautions associated with electrical systems.
- ▶ Electrical tool and equipment safety.
- ▶ Voltage level conventions for electrical systems.
- ▶ Electrical system lockout/tagout requirements.
- ▶ •Requirements associated with arc flash protection.
- ▶ Proper use of personal protective equipment.
- ▶ Electrical safety requirements for batteries and DC systems.

RECOMMENDED AUDIENCE

This course is designed for all facility non-electrical and non-technical personnel.

YOU WILL LEARN

Review applicable OSHA 1910 and NFPA 70E regulations regarding the following major topics:

- ▶ Arc flash protection
- ▶ Lockout/tagout
- ▶ Personal protective equipment

CLASS DURATION

4 or 8 hours (depending upon audience and audience experience)

GEN-001: BASIC MATH

COURSE DESCRIPTION

This course provides information on the concepts associated with basic algebra, basic geometry, measurements, and basic trigonometry.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to reduce fractions, calculate with mixed numbers, perform calculations with measurements, perform conversion of measurements, read a number line, define exponents, define bases, know formulas, use algebra to solve problems, perform multiplication and division of polynomials, perform calculations using the Pythagorean Theorem, define plane geometry, perform calculations using geometry principles, and use trigonometric functions to calculate the sides of a triangle.

RECOMMENDED AUDIENCE

This course is designed for mechanical and electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

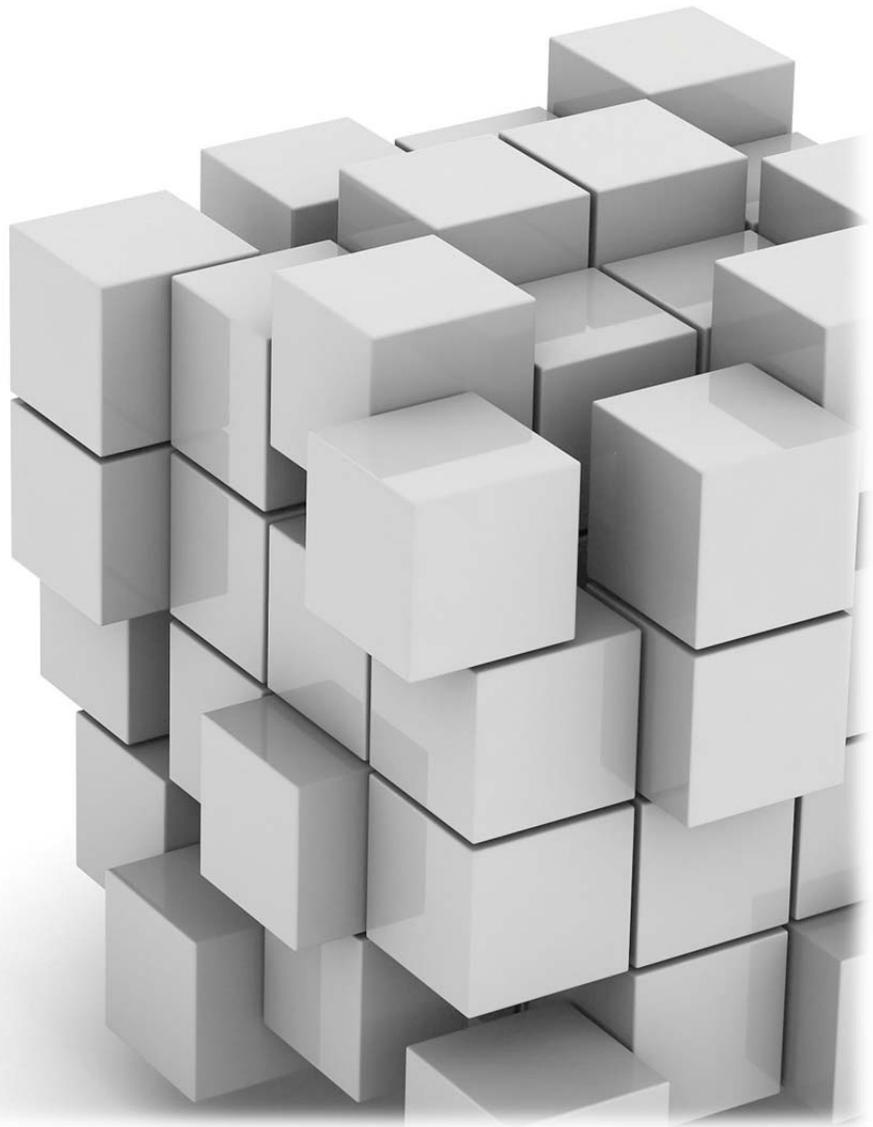
YOU WILL LEARN

- ▶ Describe how to measure an angle.
- ▶ Describe the method of labeling angles.
- ▶ Explain the use of a protractor to measure angles.
- ▶ Define the Pythagorean Theorem.
- ▶ Perform calculations using the Pythagorean Theorem.
- ▶ Define a triangle.
- ▶ List the rules of a triangle.
- ▶ Use the rules of a triangle to calculate the side lengths and angles of a triangle.
- ▶ Define the following types of triangles: equilateral, isosceles, and scalene.
- ▶ Define plane geometry.
- ▶ List five types of polygons.
- ▶ Calculate the perimeter of a polygon.
- ▶ Calculate the area of a square.
- ▶ Calculate the perimeter and area of plane figures.
- ▶ Identify solid figures given a picture.

- ▶ Calculate the volume of a solid figure.
- ▶ Perform calculations using geometry principles.
- ▶ Define sine of an angle.
- ▶ Define cosine of an angle.
- ▶ Define tangent of an angle.
- ▶ Using trigonometric functions, calculate the sides of a triangle.

CLASS DURATION

24 to 40 hours (depending upon audience and audience experience)



GEN-002: SCAFFOLDING

COURSE DESCRIPTION

This course provides information on the concepts associated with procedures, precautions, and limitations for safely erecting and/or dismantling fabricated frame scaffolding. There are hands-on exercises for erecting scaffolding.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to safely set up, inspect, and then dismantle fabricated frame scaffolding.

RECOMMENDED AUDIENCE

This course is designed for electrical and mechanical maintenance technicians.

YOU WILL LEARN

- ▶ Discuss the procedures, precautions, limitations, and practices surrounding the following aspects of erecting, using, and dismantling fabricated frame scaffolding:
 - Base section
 - Support structure
 - Access
 - Fall protection
 - Platform
 - Keeping upright
 - Electrical hazards
- ▶ Review case reports from OSHA files.
- ▶ Erect and dismantle a two-tier scaffold.

CLASS DURATION

16 to 24 hours (depending upon audience and audience experience)

GEN-003: SYSTEMATIC PROBLEM SOLVING AND TROUBLESHOOTING

COURSE DESCRIPTION

This course provides information on the concepts associated with systematic troubleshooting.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to use a systematic method to troubleshoot systems and processes.

RECOMMENDED AUDIENCE

This course is designed for all maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation.

YOU WILL LEARN

- ▶ Define troubleshooting.
- ▶ State the ultimate purpose of troubleshooting.
- ▶ Discuss the need for a troubleshooting methodology.
- ▶ List four general guidelines for good troubleshooting.
- ▶ Identify the key troubleshooting action items.
- ▶ State the preferred troubleshooting philosophy.
- ▶ Explain the importance of maintaining accurate documentation.
- ▶ Describe the type of information that is useful in a trouble log.
- ▶ Using a given scenario, complete a typical trouble log.
- ▶ List the steps of the seven-step troubleshooting method in their logical order.
- ▶ Discuss each step of the seven-step troubleshooting method.
- ▶ Discuss the concept of using flowcharts.
- ▶ Identify standard flowchart symbols.
- ▶ List the steps of the five-step systematic troubleshooting process in their logical order.
- ▶ Describe each step of the five-step systematic troubleshooting process.
- ▶ Discriminate between diagnosis and repair.
- ▶ Discuss the difference between sound and unsound reasons for deviating from ideal troubleshooting strategies.
- ▶ Identify the steps to take to develop a customized troubleshooting strategy.

- ▶ Define intermittent failure.
- ▶ Identify three types of intermittent failure.
- ▶ Describe the basic steps for troubleshooting intermittent failures.
- ▶ Describe the importance of finding the root cause of a trouble.
- ▶ Identify the major elements of a Cause and Effect Diagram.
- ▶ Describe the six basic steps for constructing a Cause and Effect Diagram.
- ▶ Given a sample scenario, construct a Cause and Effect Diagram.

CLASS DURATION

8 hours



EM-101: BASIC ELECTRICITY – DIRECT CURRENT

COURSE DESCRIPTION

This course provides information on the basic concepts of direct current (DC) electricity and magnetism, including electrostatics, basic circuit concepts, and measurement of electrical quantities and associated numerical concepts, Ohm's Law, practical circuits, electromagnetism, and electrical measurements. There are hands-on exercises for device operation and simple circuit construction and analysis.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function and operation of DC electrical devices and the function and characteristics of basic DC circuits.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

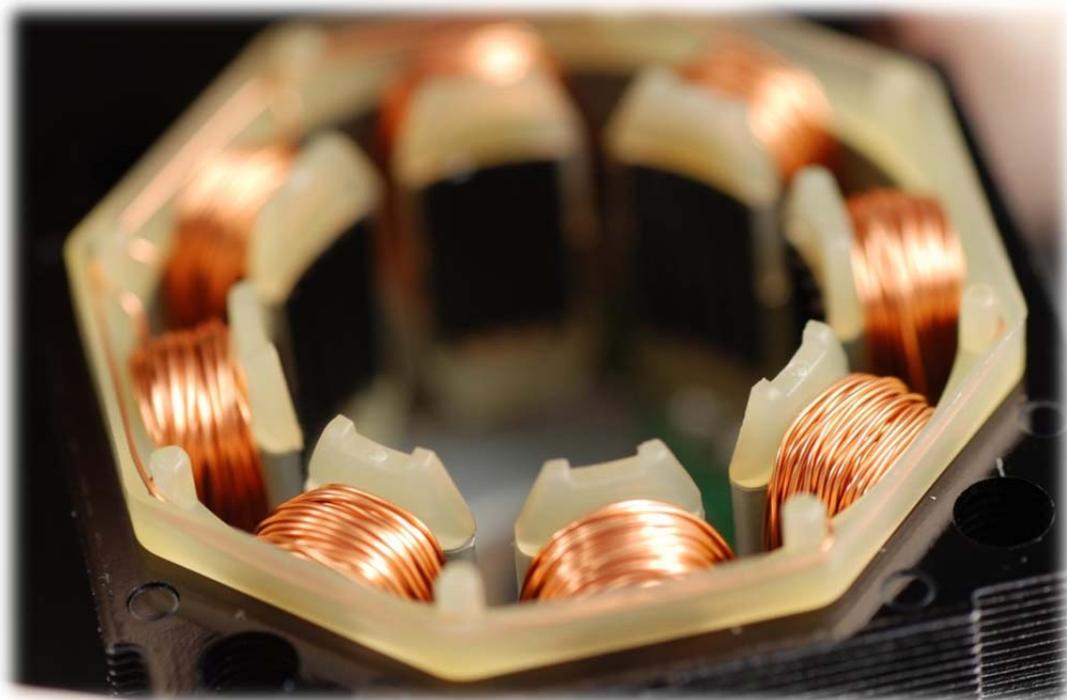
- ▶ Describe the general safety precautions that must be observed when working around electrical equipment.
- ▶ Discuss the composition of the atom and its relation to electrical charge.
- ▶ Describe the characteristics of conductors and insulators.
- ▶ Describe electromotive force (EMF).
- ▶ Explain the characteristics of current flow, voltage potential, and resistance.
- ▶ Explain Ohm's Law.
- ▶ Discuss the unit of power.
- ▶ Describe power equations.
- ▶ Explain the power rating of resistors.
- ▶ Explain Kirchhoff's Current Law and explain Kirchhoff's Voltage Law.
- ▶ List the characteristics of resistance in series circuits.
- ▶ List the characteristics of resistance in parallel circuits.
- ▶ List the characteristics of resistance in series-parallel circuits.
- ▶ Apply Ohm's Law to resistive circuits.
- ▶ List the characteristics of a capacitor.
- ▶ Explain the charging and discharging process of a capacitor.

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- ▶ Discuss the unit of capacitance.
- ▶ Explain the capacitance time constant.
- ▶ Calculate equivalent capacitance.
- ▶ Discuss capacitor specifications.
- ▶ List the characteristics of magnetism.
- ▶ Describe the magnetic effect of current flowing through a current-carrying conductor.
- ▶ Describe the magnetic effect of current flowing through a coil.
- ▶ List the characteristics of an inductor.
- ▶ Discuss the inductive time constant.
- ▶ Calculate equivalent inductance.

CLASS DURATION

Up to 40 hours (depending upon audience and audience experience)



EM-102: BASIC ELECTRICITY – ALTERNATING CURRENT

COURSE DESCRIPTION

This course provides information on the basic concepts of alternating current (AC) electricity, including AC waveforms, electrical measurements, resistance, inductance, capacitance, impedance, multi-phase circuits, and transformer action. There are hands-on exercises, device operation, and simple circuit construction and analysis.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function and operation of AC electrical devices, and the function and characteristics of basic AC circuits.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

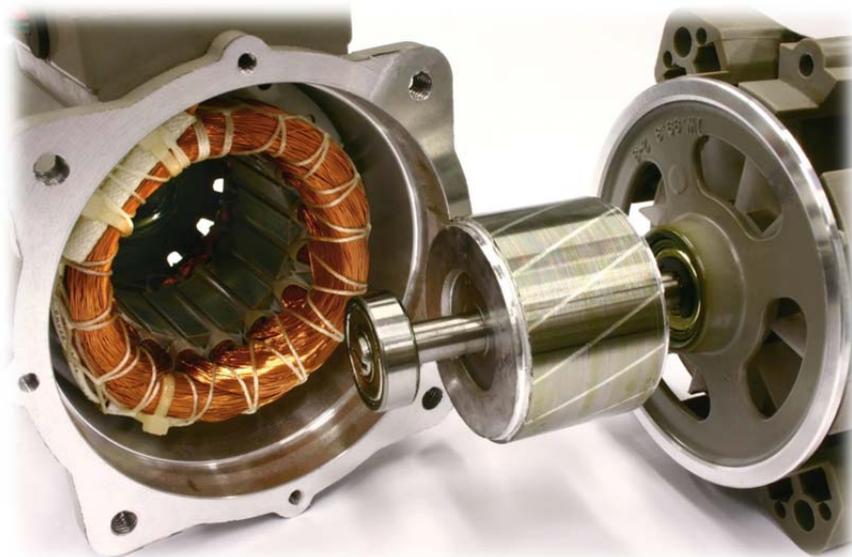
- ▶ Define sine wave and explain how one is generated.
- ▶ Define the following terms: frequency, period, wavelength, peak AC voltage, peak AC current, effective AC voltage, and effective AC current.
- ▶ Given a diagram of a sine wave, identify the peak AC voltage values.
- ▶ Given a diagram of a sine wave, identify the effective AC voltage values.
- ▶ Explain AC phase relationships.
- ▶ Given two diagrams of AC waveforms, calculate the phase relationship between the two.
- ▶ Draw a current and voltage waveform of a resistive AC circuit to show the phase relationship.
- ▶ Given a drawing of a series AC circuit, use Ohm's Law to solve for the unknown quantity.
- ▶ Given a drawing of a parallel AC circuit, use Ohm's Law to solve for the unknown quantity.
- ▶ Given a drawing of a series-parallel AC circuit, use Ohm's Law to solve for the unknown quantity.
- ▶ Explain the characteristics of and factors controlling inductance.
- ▶ Describe the voltage and current transients that occur in an inductive circuit.
- ▶ Define inductive reactance and explain how it is affected by frequency.
- ▶ Define impedance.
- ▶ Explain the relationship between voltage and current in a resistive-inductive (RL) circuit.
- ▶ Given a diagram, calculate impedance in an RL circuit.

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- ▶ Explain the operation of a capacitor.
- ▶ Explain factors affecting capacitance.
- ▶ Describe the voltage and current transients that occur in a capacitive circuit.
- ▶ Define capacitive reactance and explain how it is affected by frequency.
- ▶ Explain the relationship between voltage and current in the following AC circuits: RC circuit, LC circuit, and RLC circuit.
- ▶ Given a diagram, calculate impedance for the following AC circuits: RC circuit, LC circuit, and RLC circuit.
- ▶ Describe how reactive components are used as filters.
- ▶ Explain what a transformer is and how it operates.
- ▶ Explain the phase relationship between primary and secondary voltages of like wound and unlike wound transformers.
- ▶ Explain turn ratio in power transformers.
- ▶ Explain the following power losses in a power transformer: copper losses, eddy-current losses, and hysteresis loss.
- ▶ Identify the following types of transformers and briefly explain the characteristics of each: air core, iron core, shell type, solid core ferrite, autotransformer, current transformer, and potential transformer.
- ▶ Describe the basic components in a power distribution system.
- ▶ Identify and explain the function of protective devices in a distribution system.

CLASS DURATION

Up to 80 hours (depending upon audience and audience experience)



EM-103: ELECTRICAL PRINT READING

COURSE DESCRIPTION

This course provides the participant with the basic understanding of electrical prints and components associated with electrical print reading; it also provides the participant with the ability to interpret simple ladder logic diagrams used for programmable logic controller (PLC) programming. There are hands-on exercises for print reading.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain and interpret electrical prints and ladder logic diagrams.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians, but is also used for cross-training of mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Given an electrical print, identify the organizational make-up of the print.
- ▶ Given common electrical print symbols, identify the components they represent.
- ▶ Identify and interpret an electrical block diagram and a one-line diagram.
- ▶ Identify and interpret an electrical three-line diagram.
- ▶ Analyze a circuit print, using text provided, to understand circuit functions and operations.
- ▶ Describe the purpose of the piping and instrumentation diagram (P&ID).
- ▶ Given common process loop symbols, state their functions.
- ▶ Describe the most frequently used logic symbols.
- ▶ Analyze a basic logic circuit.
- ▶ Describe the most frequently used ladder logic symbols.
- ▶ Understand how these symbols are used to produce a ladder logic diagram.

CLASS DURATION

24 to 40 hours (depending upon audience and audience experience)

EM-104: TEST EQUIPMENT

COURSE DESCRIPTION

This course provides information on the four categories of testing, safety precautions associated with testing, and the use and care of different test equipment to include Doble test sets, megohmmeter function and operation, and various applications for thermography and infrared scanning. There are hands-on exercises for inspection and use of given test equipment.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function, design, and use of given test equipment.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ List and briefly describe the four categories of testing.
- ▶ Describe methods of classifying test equipment.
- ▶ List at least ten general safety precautions.
- ▶ Demonstrate the use and application of the clamp-on ammeter.
- ▶ List the different measurements and ranges of the clamp-on ammeter.
- ▶ Describe oscilloscope operation and use.
- ▶ Calculate waveform values using an oscilloscope.
- ▶ Describe how to take basic measurements using an oscilloscope.
- ▶ Demonstrate the use and application characteristics of the megohmmeter (megger).
- ▶ State the safety precautions associated with using a megger.
- ▶ Explain the purpose of insulation testing.
- ▶ Describe different parameters tested on insulation.
- ▶ Describe high voltage megohmmeter function and operation.
- ▶ Describe the DC high-potential test.
- ▶ Describe the purposes and basic operation of the Doble test.

- ▶ Describe thermography.
- ▶ Discuss the factors affecting infrared sensing.
- ▶ Describe various applications for infrared scanning.
- ▶ Discuss the use of infrared imaging.

CLASS DURATION

24 hours



EM-105: WIRING

COURSE DESCRIPTION

This course provides information on the wiring requirements, material identification, and the installation and splicing of wiring. There are hands-on exercises for wiring installation.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to properly identify wiring materials, determine the wire required for a given installation, and install and splice wiring.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

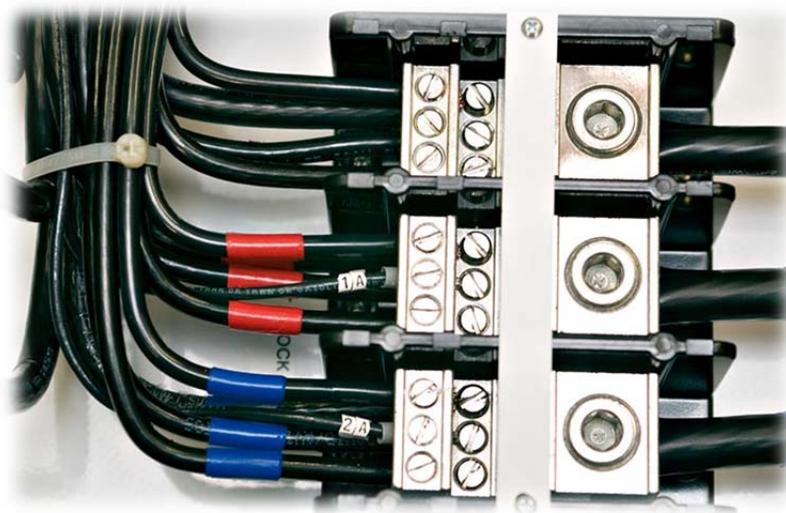
Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Identify wiring and wiring materials.
- ▶ Use an American Wire Gauge to determine wire size.
- ▶ Determine the size wire needed for a given installation.
- ▶ Splice wires.
- ▶ Install wires.

CLASS DURATION

24 hours



EM-106: BATTERIES

COURSE DESCRIPTION

This course provides information on the concepts associated with industrial batteries and Universal Power Supplies (UPS), battery and UPS function, battery and UPS design, battery maintenance, storage and transportation, installation and removal, and potential faults.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function, design, construction, and hazards of industrial batteries; install, remove, and maintain industrial batteries; identify potential battery faults; and describe the purpose of a UPS in a battery system.

RECOMMENDED AUDIENCE

This course is designed for mechanical and electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Identify the differences between primary and secondary batteries.
- ▶ Identify the major types of lead-acid storage batteries.
- ▶ Define the following terms: cell, battery, electrolyte, separator, terminal, electrode, thermal runaway, and gassing.
- ▶ Identify the active materials in the lead-acid cell.
- ▶ Describe the effects of temperature and discharge rate on battery capacity and life.
- ▶ Identify industry and government standards for maintenance, testing, replacement, sizing, and installation of lead-acid batteries.
- ▶ Identify the three most common applications of lead-acid batteries.
- ▶ Identify and describe four charging techniques.
- ▶ Identify safety precautions for operating and maintaining lead-acid batteries.
- ▶ Identify federal regulations governing lead-acid battery disposal.
- ▶ Identify the two basic types of "maintenance-free" batteries.
- ▶ Describe the effect that overcharging has on gassing and thermal runaway.

CLASS DURATION

8 hours

EM-107: NATIONAL ELECTRICAL CODE OVERVIEW

COURSE DESCRIPTION

This course provides an overview of proper wiring practices as presented in the National Electrical Code (NEC).

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to list the general topics covered in the NEC, and given a copy of the NEC, be able to locate and discuss the requirements pertinent to industrial electrical wiring and distribution.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation.

YOU WILL LEARN

- ▶ Understand the layout of the National Electrical Code (NEC).
- ▶ Understand the relationship between the NEC and the National Electrical Safety Code.
- ▶ Differentiate between NEC and OSHA examination, installation, and use requirements.
- ▶ Understand the proper locations for electrical equipment to provide for proper working clearances and free space requirements.
- ▶ Determine proper methods of identification for grounded conductors, grounding conductors, and multi-wire branch circuits.
- ▶ Understand installation requirements for services.
- ▶ Understand bonding and grounding requirements for services, feeders, branch circuits, and utilization equipment.
- ▶ Select the proper size and location of overcurrent protection for various types of utilization equipment.
- ▶ Be knowledgeable of requirements for temporary wiring and GFCI applications.
- ▶ Be knowledgeable of acceptable wiring methods and materials, including recent changes in acceptable industrial wiring methods and materials.
- ▶ Select the proper size of raceway, fitting, and boxes, including wire bending space, component sizing, and conductor identification.

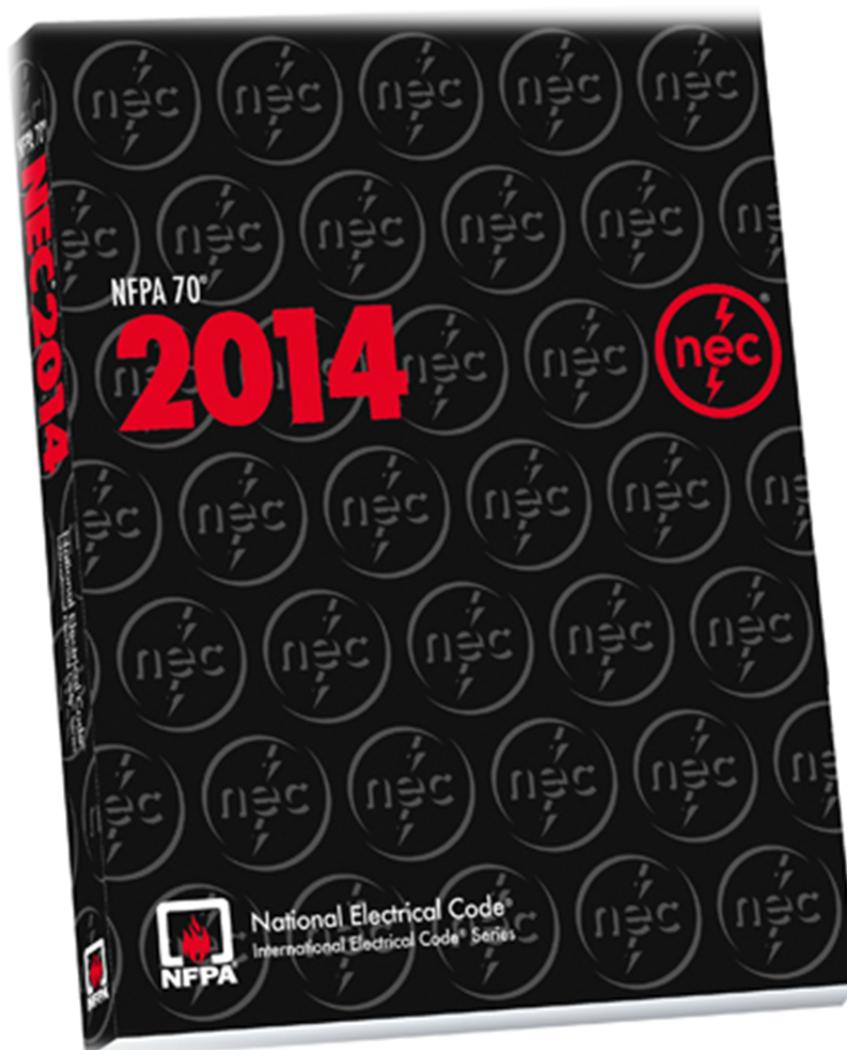
- ▶ Size motor circuits and required components according to recent code changes.
- ▶ Understand transformer installations, including various types of delta and wye connections.
- ▶ Understand acceptable wiring methods for hazardous (classified) locations.

CLASS DURATION

16 hours

SOURCES

National Electrical Code (NEC) Industrial Electricity Training by Training Technology



EM-108: CONDUIT BENDING

COURSE DESCRIPTION

This course provides information on calculating and making conduit bends. There are hands-on exercises for bending and installing conduit.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to calculate bends, make bends, and install conduit runs.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Use basic trigonometry to calculate conduit bends.
- ▶ Use offset and shrink tables to calculate conduit bends.
- ▶ Determine bender take-up, bend gains, and offset shrinkage in order to determine a conduit run.
- ▶ Make various bends with a hand bender.
- ▶ Make various bends with a “Chicago” style bender.

CLASS DURATION

24 hours



EM-200: INDUSTRIAL ELECTRONICS

COURSE DESCRIPTION

This course provides information on the function and circuit analysis of power supplies, amplifiers, integrators, comparators, and oscillators. There are hands-on exercises for wiring and analyzing the various circuits.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to assemble and analyze common electronic circuits.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with hands-on exercises

YOU WILL LEARN

- ▶ Describe the basic structure of a semiconductor atom and the movement of free electrons and holes.
- ▶ Explain the characteristic curves and specification ratings of a diode.
- ▶ Construct and explain the operation of half wave, full wave, and full wave bridge rectifiers.
- ▶ Describe the operation of a light-emitting diode, a photoconductive device, and a photovoltaic device.
- ▶ Discuss the differences between an NPN transistor and a PNP transistor, and identify the schematic symbol for each.
- ▶ State the basic functions of power supplies and power conditioners.
- ▶ Explain AC and DC power supplies and converters.
- ▶ Discuss the functions of filters, voltage regulators, voltage dividers, switching power supplies, and power supplies.
- ▶ Explain how to interpret diode ratings on a manufacturer's specification sheet.
- ▶ Compare the effects of connecting diodes in parallel and in series.
- ▶ Describe the operation of a silicon-controlled rectifier.
- ▶ Compare the operation of half-wave and full-wave rectifiers.
- ▶ Discuss the use of capacitors, inductors, and resistors in filter circuits.
- ▶ Discuss the advantages and disadvantages of capacitance, inductance, RC, and LC power supply filters.

CLASS DURATION

40 hours

EM-201: TRANSFORMERS

COURSE DESCRIPTION

This course provides information on the concepts associated with transformers, transformer function, transformer design, transformer maintenance, transformer faults, and transformer inspecting and testing. There are hands-on exercises for transformer wiring and installation.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function, various designs, and construction of transformers, and maintain and identify causes of transformer failure.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises

YOU WILL LEARN

- ▶ Describe the basic principles of electromagnetic induction.
- ▶ Describe the application of electromagnetic induction in an elementary transformer.
- ▶ Describe the major components of a transformer.
- ▶ Describe the operation of a transformer.
- ▶ Describe the properties of three-phase circuits.
- ▶ Describe the construction of a three-phase transformer.
- ▶ Describe the standard three-phase transformer wiring configurations.
- ▶ Describe the information found on a transformer nameplate.
- ▶ Describe the process of changing taps on a three-phase distribution transformer.
- ▶ Describe transformer general safety precautions.
- ▶ Describe the basic types of transformers.
- ▶ Describe how to size a transformer for a specific application.
- ▶ Describe types of transformer malfunctions.
- ▶ Describe transformer testing and inspection.

CLASS DURATION

Up to 24 hours (depending upon audience and audience experience)

EM-202: MOTOR THEORY

COURSE DESCRIPTION

This course provides information on the principles of operation associated with motors and motor components, and the AC/DC theory of operation, including torque, pullout torque, and slip.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

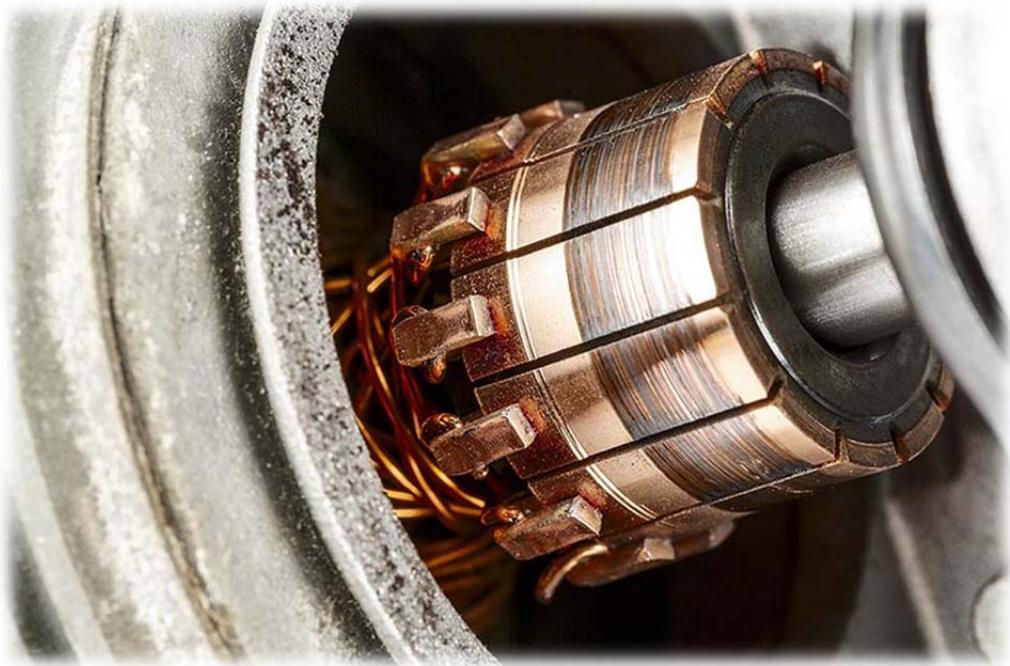
- ▶ Define the following terms: motor, motor action, and generator action.
- ▶ Explain the left-hand and right-hand rules for motors and generators.
- ▶ Define the terms counter-electromotive force and commutator.
- ▶ Describe the operation of an elementary DC motor.
- ▶ Describe the methods used to minimize the effects of armature reaction.
- ▶ Identify the major components of a basic DC motor.
- ▶ State the purpose of the major components of a basic DC motor.
- ▶ Describe the operation and characteristics of the following DC motors: shunt DC motor, series DC motor, and compound DC motor.
- ▶ Explain the operating principles of a basic AC motor.
- ▶ Describe the operation of the following AC motors: three-phase induction motor, three-phase synchronous motor, split-phase induction motor, shaded-pole induction motor, capacitor-start induction motor, capacitor-run motor, repulsion-start motor, and reluctance motor.
- ▶ Describe the construction of a squirrel cage and wound rotor motor.
- ▶ Define the term slip and calculate the percent slip for an induction motor.
- ▶ Define the term torque.
- ▶ Explain pull-out torque.
- ▶ Identify three types of single-phase AC motors.
- ▶ Compare the differences between multiple winding and consequent pole multiple-speed induction motors.
- ▶ List the parameters used to determine a motor's rating.
- ▶ State the four classes of motor insulation.
- ▶ List the information found on a typical motor nameplate.

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- ▶ Compare delta to wye wiring for voltage, current, and power capabilities.
- ▶ Connect motors for multiple voltages.
- ▶ Troubleshoot motors using multimeters and meggers.

CLASS DURATION

Up to 24 hours (depending upon audience and audience experience)



EM-203: AC AND DC GENERATOR THEORY

COURSE DESCRIPTION

This course provides information on the concepts associated with generators, generator function, generator design, three-phase voltage, and load sharing.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function, design, and construction of AC and DC generators.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Explain the principles of magnetism.
- ▶ Define the term generator action.
- ▶ Define the term electromotive force.
- ▶ Explain the purpose of generators.
- ▶ Describe the construction of basic DC generators.
- ▶ Demonstrate the left-hand rule for generators.
- ▶ Explain how voltage is induced in an armature.
- ▶ State the function of the commutator and brushes.
- ▶ Describe the construction and operation of a basic DC generator commutator.
- ▶ Explain why electromagnets are used to produce the field in generators.
- ▶ Describe copper loss and its effects.
- ▶ Explain how voltage is induced in a stationary armature.
- ▶ Explain how a magnetic field is produced on a rotor.
- ▶ Explain how three-phase voltage is produced.
- ▶ Describe the construction of an AC generator stator.
- ▶ Describe the construction, including advantages and disadvantages, of the following: AC generator salient pole rotors and AC generator turbo rotors.
- ▶ Describe armature reaction and its effects in AC generators.
- ▶ Describe armature impedance and its effects.
- ▶ Describe load sharing.

CLASS DURATION

Up to 20 hours (depending upon audience and audience experience)

EM-205: DC CRANES AND CONTROLS

COURSE DESCRIPTION

This course provides information on the function and troubleshooting of DC crane controls.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function, design, and construction of DC cranes and the control equipment; interpret crane control prints; and troubleshoot crane control faults.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Describe the physical layout of the crane.
- ▶ Describe operation of the crane from no speed to full speed.
- ▶ Discuss the function of the resistor banks in the power circuit.
- ▶ Describe the appearance and function of all major crane components.
- ▶ Explain the information in the title block, legend, revisions, and material list portions of a drawing.
- ▶ Given an electrical print, identify the organizational make-up of the print.
- ▶ Identify the common electrical print symbols and the components represented.
- ▶ Identify and interpret an electrical block diagram and a one-line diagram.
- ▶ Identify and interpret connection diagrams.
- ▶ Describe the motor operating quadrants.
- ▶ Explain the function of a freewheeling diode.
- ▶ Explain the use and electrical function of a reversing switch.
- ▶ Explain the use of a synchronous motor as a DC machine.
- ▶ Describe proper motor inspection techniques and points of inspection.
- ▶ Describe common commutator problems.
- ▶ Describe common bearing problems.
- ▶ Describe the electrical operation of the following sections of a crane: bridge control, main trolley, main hoist, auxiliary trolley, and auxiliary hoist.

- ▶ Explain the function of an overload relay.
- ▶ Explain the function of an undervoltage relay.
- ▶ Explain the function of a plugging relay.
- ▶ Explain the functions of timing relays.
- ▶ Explain the operation of dynamic brakes.
- ▶ Describe the proper resistor bank connections.

CLASS DURATION

24 hours



EM-206: ELECTRICAL TROUBLESHOOTING AND MOTOR CONTROLS

COURSE DESCRIPTION

This course provides information on the concepts associated with systematic troubleshooting of instrumentation systems. Participants use practical application of troubleshooting techniques in exercise scenarios.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to apply a systematic method of troubleshooting to electrical and motor control circuits.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Describe a systematic approach to troubleshooting.
- ▶ Describe the techniques for inspecting rotating AC machinery.
- ▶ Describe how to troubleshoot motor control circuits.
- ▶ Identify the basic symbols used in motor control circuits.
- ▶ Explain the difference between manual starters and automatic starters.
- ▶ Describe the operation of main and auxiliary contacts.
- ▶ Define seal-in contacts.
- ▶ Describe the difference between two-wire and three-wire control.
- ▶ Describe how interlocking for reversing control is accomplished.
- ▶ Identify the function of various devices using standard symbology and device numbers.
- ▶ Develop a control circuit using a variety of common control features.
- ▶ Describe the methods of acceleration control.
- ▶ Given an electric print of a motor starting circuit, troubleshoot basic problems associated with motor control circuits.
- ▶ Given an electrical print, identify power supplied for motor primary power and control power.
- ▶ Apply the seven-step troubleshooting process to electrical circuits.
- ▶ Use the one-handed troubleshooting method to troubleshoot electrical circuits.
- ▶ Identify the possible causes and suggested remedies of various contactor troubles.
- ▶ Troubleshoot electrical circuits using both voltage and resistance.

CLASS DURATION

40 hours

EM-300: BASIC PROGRAMMABLE LOGIC CONTROLLERS

COURSE DESCRIPTION

This course provides information on programmable logic controller (PLC) concepts; hardware; software; and ladder logic functions (relay contacts, timers, and counters). There are hands-on exercises for configuration and programming.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to create simple ladder logic programs and trace ladder logic states.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with hands-on exercises.

YOU WILL LEARN

- ▶ Define programmable logic controller (PLC).
- ▶ Discuss the programmable controller operations.
- ▶ List the hardware of a programmable controller.
- ▶ List the programming software features.
- ▶ Describe the function of the programmable controller Central Processing Unit (CPU).
- ▶ Describe the function of the programmable controller Input/Output (I/O) interface system.
- ▶ Describe the difference between a programmable controller and computer controls.
- ▶ Describe the function of the ladder diagram.
- ▶ List the inherent features and benefits of the PLC.
- ▶ Describe the function of the base of a number system.
- ▶ Describe the decimal number system.
- ▶ Manipulate numbers in the decimal number system.
- ▶ Describe the binary number system.
- ▶ Manipulate numbers in the binary number system.
- ▶ Describe the octal number system.
- ▶ Manipulate numbers in the octal number system.
- ▶ Describe the hexadecimal number system.
- ▶ Manipulate numbers in the hexadecimal number system.

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- ▶ Perform conversions from one number system to another.
- ▶ Discuss the binary concept.
- ▶ Describe the purpose of the AND function.
- ▶ Describe the purpose of the OR function.
- ▶ Describe the purpose of the NOT function.
- ▶ Describe basic Boolean logic.
- ▶ Identify general PLC circuit and logic contact symbology.
- ▶ Describe the purpose of the address in memory.
- ▶ Identify contact symbols.
- ▶ Use the programming software to configure a PLC.
- ▶ Use the programming software to create and edit ladder logic programs.
- ▶ Create a ladder logic motor controller.
- ▶ Use the programming software to force bit state.
- ▶ Create a timer-based program.
- ▶ Create a counter-based program.

CLASS DURATION

40 hours



EM-302: AC AND DC DRIVES

COURSE DESCRIPTION

This course provides information on solid-state drive concepts, drive-based motor control, drive and motor setup, and drive programming. There are hands-on exercises for setting up AC and DC drives.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain operation of AC and DC drives, set up AC and DC drives, and configure and program AC and DC drives.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with hands-on exercises.

YOU WILL LEARN

- ▶ Describe the operation of diodes, SCRs, and transistors.
- ▶ Match the proper motor, gearing drive, and electrical power to a load.
- ▶ Describe the basic functions of AC drive hardware.
- ▶ Identify the characteristics of shunt and series wound motors.
- ▶ Differentiate between field control and armature control of a DC motor.
- ▶ Describe the operation of various types of AC drives.
- ▶ Describe the operation of various types of DC drives.
- ▶ Use the parameters associated with a drive to control motor operation.

CLASS DURATION

24 hours

EM-303: BASIC DIGITAL CIRCUITS

COURSE DESCRIPTION

This course provides information on the basic digital electronics concepts, gates, circuits, flip-flop-based circuits, and troubleshooting techniques. There are hands-on exercises for circuit construction.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to perform number system conversions, write simple logical expressions, create simple logic circuits, evaluate expressions using Boolean algebra and Karnaugh maps, and troubleshoot digital circuits.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with hands-on exercises.

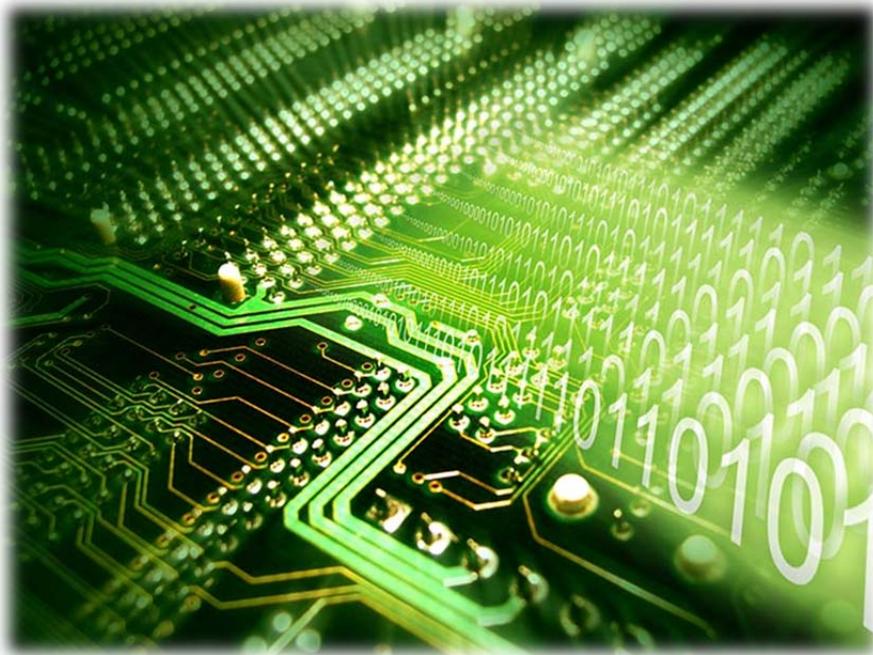
YOU WILL LEARN

- ▶ Represent numbers in decimal, binary, octal, binary-coded decimal, and hexadecimal.
- ▶ Convert between number systems.
- ▶ Create simple Boolean expressions and evaluate the expressions using Boolean algebra.
- ▶ Recognize symbols for logic gates.
- ▶ Recognize descriptions or diagrams of digital signals.
- ▶ Identify techniques used to represent binary data.
- ▶ Differentiate the basic function of logic gates.
- ▶ Convert from a Boolean Expression to a logic circuit.
- ▶ Write a truth table from a Boolean Expression.
- ▶ Convert from a truth table to a logic circuit.
- ▶ Differentiate between the various families of TTL integrated circuits.
- ▶ Identify logic equations for a combinational logic circuit diagram.
- ▶ Select a combinational logic circuit diagram for a given logic equation.
- ▶ Explain the operation of S-R, D, and J-K flip-flops.
- ▶ Connect integrated circuits that use the D and J-K flip-flops.
- ▶ Describe the function of a decoder and encoder.
- ▶ List different counters and describe their characteristics.
- ▶ Calculate the output frequency of a counter.

- ▶ Classify registers and describe their characteristics.
- ▶ Define the characteristics of RAM.
- ▶ Perform basic troubleshooting of logic gates.

CLASS DURATION

40 hours



EM-400: INSTRUMENTATION

COURSE DESCRIPTION

This course provides information on the theory and operation of various process measurement devices and transmitters. Lessons include transmitter operation and calibration using analog and SMART technologies. This course also covers the operation and troubleshooting of several common valve actuators.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the fundamentals of measurement; evaluate temperature, level, flow, pressure, and force weight- and motion-measuring instruments, and troubleshoot various types of actuators.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Explain a basic instrumentation loop.
- ▶ Set up a 24-volt DC bench test loop.
- ▶ Describe the operation and uses for the following measuring instruments:
 - Temperature
 - Pressure
 - Level
 - Flow
 - Force/weight
 - Motion
- ▶ Perform an analog calibration of a pressure transmitter.
- ▶ Perform a SMART calibration of various transmitters.
- ▶ Simulate SMART transmitter calibrations using the HART 475 Communicator.
- ▶ Determine proper use of elevated and suppressed zero settings.
- ▶ Describe the operation and uses for various force-, weight-, and motion-measuring instruments.

- ▶ Discuss the operation and uses for various types of actuators.
- ▶ Describe the operations and uses for conductivity and pH-measuring devices.
- ▶ Evaluate and troubleshoot instrumentation measurement devices.

CLASS DURATION

24 hours



EM-401: VALVE AND VALVE ACTUATORS

COURSE DESCRIPTION

This course provides information on the types of valves and actuator used as control elements, valve components, and valve applications. There are hands-on exercises for equipment setup and evaluation.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to identify valve components, types of valves, and their uses; explain actuator and positioner operation; and identify valve information from markings and nameplate information.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Describe the major functions a valve performs.
- ▶ List the major parts of a valve.
- ▶ Describe the function of the following valve components: actuator, body, bonnet, stem, disc, collar or yoke, seat, packing or stem seal, and valve position indicators.
- ▶ Explain the advantages of a needle valve over a standard globe valve.
- ▶ State the purpose of bench set information of a pneumatic actuator.
- ▶ Explain the function of a valve positioner.
- ▶ State when a valve positioner should and should not be used.
- ▶ Explain how to set up a valve positioner.
- ▶ List the different types of valves.
- ▶ For each type of valve, discuss its typical applications, benefits, and limitations.
- ▶ Identify the information available via valve markings and nameplate information.

CLASS DURATION

40 hours

EM-402: ANALYTICAL MEASUREMENT

COURSE DESCRIPTION

This course provides information on the concepts associated the operation and calibration of analytical sensors.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function and calibration of sensors and instruments for conductivity, pH, ORP, and selected optical and combustion product-measuring equipment.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation.

YOU WILL LEARN

- ▶ Define the properties of matter and the changes that matter undergoes.
- ▶ Define the term electrolytes.
- ▶ Explain the theory and purpose of pH measurement.
- ▶ Define the following terms: pH, acid, base and conductivity.
- ▶ Discriminate between reference electrodes and glass electrodes.
- ▶ Describe the difference between strong acids, weak acids, strong bases, weak bases, and neutral solutions in terms of pH.
- ▶ Explain the different entities that effect pH measurement.
- ▶ List the precautions to take when maintaining pH electrodes.
- ▶ Explain the theory of conductivity measurement.
- ▶ List the type of conductivity cells and applications for each.
- ▶ List the different items that could affect conductivity measurement.

CLASS DURATION

8 hours

EM-403: PROCESS CONTROL FUNDAMENTALS

COURSE DESCRIPTION

This course provides information on the fundamentals of process control and PID loop tuning. Lessons include characteristics of process, criteria for loop response, and controller tuning methods. This course also introduces advanced control methods, including cascade and feedforward control methods. There are extensive hands-on exercises for process measurements, controller setup, and process tuning.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to discuss critical process characteristics; describe control schemes, including two-position, proportional, integral, and derivative (PID) control; manually tune a control loop using different tuning methods; perform auto loop tuning; evaluate process changes on a tuned control loop; and troubleshoot process control problems.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Identify key process characteristics.
- ▶ Explain the importance of process characteristics on process control applications.
- ▶ Describe how feedback is used in closed-loop process control.
- ▶ Define open loop control.
- ▶ Describe closed loop control.
- ▶ Explain various control loop responses to disturbances.
- ▶ Explain the relationship between process gain and time constant.
- ▶ Describe the relationship between proportional band and gain.
- ▶ Describe the impact of offset error in a proportional controller.
- ▶ Evaluate changes to proportional control settings.
- ▶ Discuss integral control action and integral controller settings.
- ▶ Evaluate changes to integral control settings.
- ▶ Discuss derivative control action and derivative controller settings.
- ▶ Evaluate changes to derivative control settings.
- ▶ Describe closed loop tuning methods.

- ▶ Describe open loop tuning methods.
- ▶ Manually tune a PID controller for a minimum area (quarter damped wave) response.
- ▶ Perform a controller auto-tuning function.
- ▶ Describe feedforward and cascade loop control.
- ▶ Troubleshoot common problems with controller tuning.

CLASS DURATION

40 hours



MM-101: MEASUREMENT & TOOLS

COURSE DESCRIPTION

This course provides information on the proper use of measuring tools to make basic linear and angular measurements, hand tools, and power tools.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to use measuring tools to make basic measurements; use hand tools to perform basic operations; and use portable and other power tools to drill, cut, bend, and thread.

RECOMMENDED AUDIENCE

This course is designed for electrical and mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises

YOU WILL LEARN

- ▶ Discuss units of measurement and tolerances.
- ▶ Calculate tolerances.
- ▶ Make measurements with rulers, calipers, squares, micrometers, and verniers.
- ▶ Use hand tools to install and remove fasteners.
- ▶ Use hand tools to cut and strip wires.
- ▶ Use hand tools to cut and flare tubing.
- ▶ Use hand tools and power tools to cut and drill holes in metal.
- ▶ Use hand tools to tap threads.
- ▶ Apply and measure torque to fasteners.
- ▶ Use a pipe machine to cut, bend, and thread small pipes.

CLASS DURATION

16 to 24 hours (depending upon audience and audience experience)

MM-102: RIGGING

COURSE DESCRIPTION

This course provides information on the concepts and principles associated with rigging equipment, its use, inspection, planning, and proper selection of rigging equipment. Hands-on exercises are used to familiarize the trainee with equipment selection and safety when tasked with rigging a given load.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain and demonstrate the different functions and use of equipment used to safely lift a load or install components using given rigging equipment.

RECOMMENDED AUDIENCE

This course is designed for electrical and mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Identify the safety hazards associated with rigging.
- ▶ Identify the actions necessary for safe operation of rigging equipment.
- ▶ Describe wire rope and its proper use.
- ▶ Identify the wire rope inspection points.
- ▶ Describe slings and their proper use.
- ▶ Identify the sling inspection points.
- ▶ Describe the different types of rigging hardware and their proper use.
- ▶ Identify the rigging hardware inspection points.
- ▶ Describe chain hand hoists and their proper use.
- ▶ Describe the proper and safe use of beams.
- ▶ Describe the proper installation/removal and safe use of beam clamps.
- ▶ Describe the proper installation/removal and safe use of trolleys.
- ▶ Describe the proper and safe use of jacks, rollers, and skids.
- ▶ Describe the proper and safe use of winches.
- ▶ Describe the proper and safe use of cribbing.
- ▶ Describe how to properly plan a rigging job.
- ▶ Describe how to properly select and inspect rigging equipment.

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- ▶ Describe proper rigging techniques.
- ▶ Describe the proper use of arm and hand signals.
- ▶ Describe safe operating considerations.
- ▶ Describe the different safe methods to use while moving and manipulating loads, including drifting a load; rotating a load using one hook, two hooks, and single sling; tipping a load; and inverting a load.

CLASS DURATION

16 hours (depending upon audience and audience experience)



MM-103: INTRODUCTION TO BEARINGS AND LUBRICATION

COURSE DESCRIPTION

This course provides information on the concepts associated with bearings, bearing function, bearing design, bearing maintenance, installation and removal, expected load and wear patterns, bearing faults, and lubrication. There are hands-on exercises for bearing removal and installation.

Note: This course is an abbreviated combination of MM-206, Lubrication, and MM-207, Bearings.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function, design, and construction of bearings; install, remove, and maintain bearings; identify causes of bearing failure; explain the function of lubricants; and explain the proper methods for greasing bearings.

RECOMMENDED AUDIENCE

This course is designed for electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises

YOU WILL LEARN

BEARINGS

- ▶ Discuss the basic concepts behind forces and stress.
- ▶ Discuss some of the basic terms used to describe and understand bearing design.
- ▶ Describe some of the materials used in the construction of bearings and why they are used.
- ▶ State the basic requirements of any bearing.
- ▶ Describe the differences between radial and thrust bearings.
- ▶ Describe the types of lubrication systems used for anti-friction and friction bearings.
- ▶ State the importance of and describe how to perform a soft foot check.
- ▶ State the procedure for performing various clearance checks on anti-friction and friction bearings.
- ▶ State the reasons for interference fits.
- ▶ Describe the various methods of heating bearings.
- ▶ Describe the various methods of cold mounting roller bearings.
- ▶ Describe the various methods of mounting tapered bore bearings.
- ▶ Explain the purpose of pre-load.
- ▶ Describe the methods of setting tapered roller bearings.
- ▶ State the differences and purposes of fixed and float bearings.

- ▶ Describe the various methods of roller bearing removal.
- ▶ State the importance of crush and torque on a journal bearing.
- ▶ Describe the various expected load and wear patterns of bearings that have been operating.
- ▶ Identify the various types of failures that occur in bearings.
- ▶ Describe the various types of failures that occur in bearings.
- ▶ Describe methods for reducing the various bearing failures.

LUBRICATION

- ▶ Discuss the origin of oil and its chemical make-up.
- ▶ Discuss the basic principles of lubrication.
- ▶ Describe a basic lubricant and be familiar with the make-up of lubricants.
- ▶ Explain viscosity and use of viscosity terms.
- ▶ Differentiate between sliding and rolling friction.
- ▶ Discuss boundary/thin film lubrication.
- ▶ Discuss the origin of grease and its chemical make-up.
- ▶ Discuss various lubricant contaminants.
- ▶ Discuss lubrication of gears.
- ▶ Discuss the use of extreme pressure (EP) oils versus non-EP oils.
- ▶ Be familiar with various methods of supplying gears with lubrication.
- ▶ Describe various causes of gear failure.
- ▶ Discuss the lubrication of worm gears, couplings, and bearings.
- ▶ Be familiar with the proper methods for greasing bearings.

CLASS DURATION

16 hours

MM-104: BOLTS AND FASTENERS

COURSE DESCRIPTION

This course provides information on the concepts associated with threaded and bolted fasteners, retaining rings, clamps, pins, keys, and locking devices; the specifications for fasteners; and the assembly of fasteners.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function and selection of fasteners and be able to properly assemble fasteners.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation.

YOU WILL LEARN

- ▶ Describe the bolted connection and how it functions.
- ▶ Describe the different types of basic fasteners and their applications.
- ▶ Discuss the appropriate specifications and selection criteria for fasteners.
- ▶ Discuss the effects of fastener system variables and assembly practices on the reliability of the connection.
- ▶ Describe the various types of fasteners in common use.
- ▶ Describe the various types of locking devices in common use.
- ▶ Describe the use of dowel pins, keys, and cotter pins.
- ▶ Explain the various screw thread designations.
- ▶ Discuss materials and grades as they apply to threaded fasteners.
- ▶ Discuss the finishes and coatings sometimes used on threaded fasteners.
- ▶ Describe the dangers associated with using counterfeit fasteners.
- ▶ Describe how to identify counterfeit fasteners.

CLASS DURATION

8 to 16 hours (depending upon audience and audience experience)

MM-105: MECHANICAL PRINT READING

COURSE DESCRIPTION

This course provides an understanding of information found on mechanical drawings and prints, and provides the participant with the ability to understand and identify components and how to identify dimensions of tapered and machined surfaces. There are hands-on exercises for print reading.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to read, understand, and identify given components on a mechanical print and have the ability to draw a pictorial of a mechanical system to include pneumatic or hydraulic circuits.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians, but is also used for cross-training of electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Explain and describe the purpose of the title block, legend, revisions, and material list in terms of location and content.
- ▶ Describe and identify the meaning of each of the six types of lines used in drawings.
- ▶ Identify and define the types of views used in drawings.
- ▶ Given a drawing, identify its construction, size, and location dimensions.
- ▶ Measure and identify screw threads.
- ▶ Identify the dimensions of tapered and machined surfaces.
- ▶ Describe the various types of sketches used in drawings.
- ▶ Identify a pneumatic or hydraulic component by its symbol.
- ▶ Draw the common pneumatic and hydraulic component symbols.
- ▶ Trace the flow of air or fluid through a drawing of a circuit.
- ▶ Draw a pictorial of a circuit using a pneumatic or hydraulic schematic as a reference.
- ▶ Draw schematics of simple pneumatic and hydraulic systems.

CLASS DURATION

24 to 40 hours (depending upon audience and audience experience)

MM-106: COMBUSTION

COURSE DESCRIPTION

This course provides information on the theory of combustion, associated equipment applied to combustion, safety, and related safety issues associated with combustion. There are hands-on exercises for inspection and identification of equipment.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the theory, function, and design of combustion equipment and understand heat transfer and the safety issues when working on or maintaining this equipment.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Discuss the theory of combustion.
- ▶ Describe the flame structure.
- ▶ Define the relationship between heat, temperature, and specific heat.
- ▶ Recognize the concept of fuel-air ratio.
- ▶ Explain the significance of percent CO₂, O₂, and combustibles.
- ▶ Identify the general types of burners.
- ▶ List the various control valves, blowers, regulators, and switches associated with various burners.
- ▶ Describe the three modes of heat transfer.
- ▶ Discuss the factors affecting heat transfer rates.
- ▶ Review the combustion fundamentals regarding preheating and drying in steel mills.
- ▶ Discuss the modes of heat transfer in the steel-making and casting shops.
- ▶ Recognize the chemical make-up of natural gas, coke oven gas, and blast furnace gas.
- ▶ Explain coal preheating.
- ▶ Describe the stove blast air operation at the blast furnaces.

CLASS DURATION

24 hours

MM-201: POWER TRANSMISSION: CLUTCHES

COURSE DESCRIPTION

This course provides information on the concepts associated with clutches; clutch function; clutch design; clutch maintenance, installation, and removal; and basic clutch faults.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function, design, and construction of clutches; install, remove, and maintain bearings; and identify causes of clutch failure.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Identify the various methods of clutch engagement.
- ▶ Identify the various types of clutches.
- ▶ Describe how to properly install a clutch and perform maintenance.

CLASS DURATION

8 hours



MM-202: POWER TRANSMISSION: BELT DRIVES

COURSE DESCRIPTION

This course provides information on the concepts associated with belt drives; belt drive function; belt drive design; belt drive maintenance, installation, and removal; and belt drive faults.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function, design, and construction of belt drives; install, remove, and maintain belt drives; and identify causes of belt drive failures.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises

YOU WILL LEARN

- ▶ Describe the purpose of the belt drive.
- ▶ List the factors affecting the selection of the belt.
- ▶ Describe the advantages of the belt drive.
- ▶ Describe the disadvantages of the belt drive.
- ▶ Describe the three principles that determine the potential of grip.
- ▶ Describe the proper technique for belt tensioning.
- ▶ Define coefficient of friction.
- ▶ Describe the construction of the V-belt.
- ▶ Describe the construction of the double V-belt.
- ▶ Describe the use of the power band V-belt.
- ▶ Identify the method for correct V-belt selection.
- ▶ Describe the advantages of the poly V-belt.
- ▶ Describe the construction of the variable speed belt.
- ▶ Describe the use of the variable speed sheave.
- ▶ Describe the three basic variable speed drives that are used.
- ▶ Describe the advantages of the positive drive belt.
- ▶ Describe the construction of the positive drive belt.
- ▶ Describe the purpose of the pulley.

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- ▶ Describe the positive drive belt codes.
- ▶ Describe the purpose of the positive idler drives.
- ▶ Describe the construction of the three common flat belts.
- ▶ Define pulley crown.
- ▶ Describe the different flat belt pulleys used.
- ▶ Describe the method for checking belt alignment.

CLASS DURATION

8 hours



MM-203: POWER TRANSMISSION: COUPLINGS

COURSE DESCRIPTION

This course provides information on the concepts associated with couplings, coupling function, coupling design, and the difference between a rigid and flexible coupling.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function, design, and construction of couplings; explain the difference between rigid and flexible couplings; and explain the following coupling terms: hub, shaft, key, match, marks, bore, and gap.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Explain the purpose of a coupling.
- ▶ Explain the difference between a rigid and flexible coupling.
- ▶ Explain the following terms as they relate to a coupling: hub, shaft, key, match marks, bore, and gap.

CLASS DURATION

8 hours

MM-204: POWER TRANSMISSION: CHAIN DRIVES

COURSE DESCRIPTION

This course provides information on the concepts associated with chain drives; chain drive function; chain drive design; chain drive maintenance, installation, and removal; and chain drive faults.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function, design, and construction of chain drives; install, remove, and maintain chain drives; and identify causes of chain drive failure.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

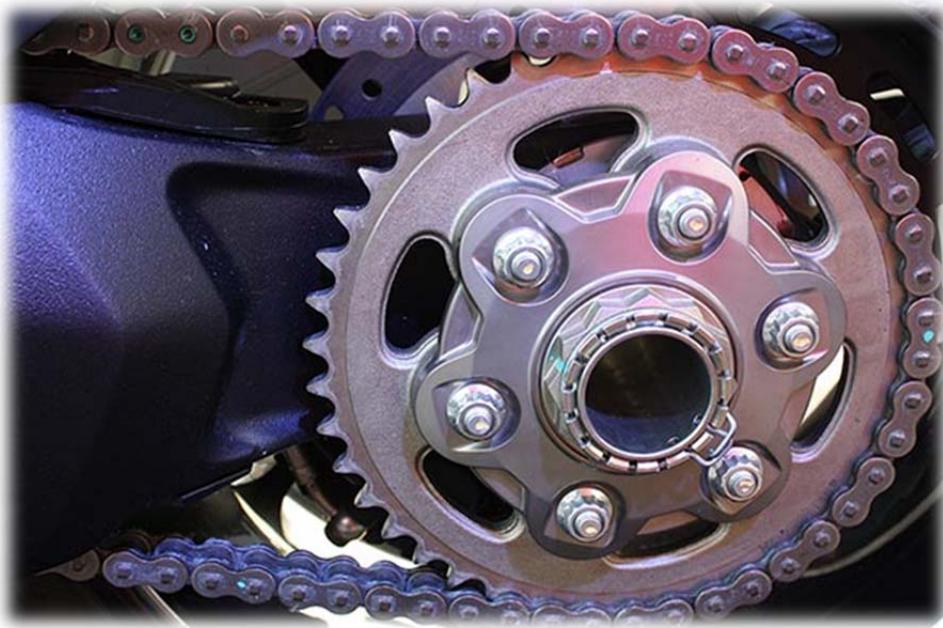
YOU WILL LEARN

- ▶ Describe the purpose of the chain drive.
- ▶ Describe the three basic functions of the chain.
- ▶ Describe the advantages of the chain drive.
- ▶ Describe the disadvantages of the chain drive.
- ▶ Describe the principle of operation of the chain drive.
- ▶ List the six styles of chain used for power transmission.
- ▶ Describe the construction of the six styles of chain.
- ▶ Define chain pitch.
- ▶ Define tolerances of chain length.
- ▶ Define measuring load.
- ▶ Describe minimum ultimate tensile strength.
- ▶ Describe the function of the standard roller chain numbers.
- ▶ Describe the construction of the multiple strand roller chain.
- ▶ Describe the special features of the roller bearings.
- ▶ Describe the use of the detachable chain.
- ▶ Describe the use of the silent chain.
- ▶ Discuss the various silent chain assemblies.
- ▶ Describe the use of the leaf chain.

- ▶ Describe the basic construction of the roller chain sprocket.
- ▶ Identify the four designs of sprocket hubs.
- ▶ Define the following as related to the sprocket: pitch diameter, bottom diameter, caliper diameter, outside diameter, and face width.
- ▶ List the factors that affect shaft location chain drives.
- ▶ Describe the function of the chain tightener.
- ▶ Describe the effects of the incorrect chain tension.
- ▶ Describe the procedure for aligning shaft and sprocket.
- ▶ List the points checked on a chain inspection.
- ▶ Describe the elements that affect lubrication.
- ▶ Describe the five methods for chain lubrication.

CLASS DURATION

8 hours



MM-205: POWER TRANSMISSION: GEARING

COURSE DESCRIPTION

This course provides information on the concepts associated with gears, gear function, gear backlash, gear lubrication, and gear ratios.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function of gears; define terminology associated with gears; identify the following gear arrangements: spur gear, helical gear, herringbone gear, bevel gear, worm gear, and planetary gear; and describe how to measure backlash in a gearing arrangement.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ State the purpose of gears.
- ▶ Define the terminology associated with gears.
- ▶ Identify the following types of gear arrangements: spur gear, helical gear, herringbone gear, bevel gear, worm gear, and planetary gear.
- ▶ Describe how to measure backlash in a gearing arrangement.

CLASS DURATION

8 hours



MM-206: LUBRICATION

COURSE DESCRIPTION

This course provides information on the concepts associated with lubrication, lubrication properties, lubrication testing, lubricant contaminants, and gear lubrication.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the chemical composition of lubricants and the testing methods for lubricants; discuss hydraulic lock, hydrodynamic lubrication, elasto-hydrodynamic lubrication, EP oils, and non-EP oils; describe causes of gear failure and the proper methods for greasing bearings; and explain the aspects of a good lubrication program.

RECOMMENDED AUDIENCE

This course is designed for mechanical and electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Discuss the origin of oil and its chemical make-up.
- ▶ Discuss the basic principles of lubrication.
- ▶ Describe a basic lubricant and be familiar with the make-up of lubricants.
- ▶ Explain viscosity and use of viscosity terms.
- ▶ Differentiate between sliding and rolling friction.
- ▶ Discuss boundary/thin film lubrication.
- ▶ Be familiar with the additives used with oil and the reasons for their use.
- ▶ Be familiar with factors that determine oil compatibility.
- ▶ Describe some applications for which oil is used as a lubricant.
- ▶ Be familiar with various oil testing procedures.
- ▶ Discuss the origin of grease and its chemical make-up.
- ▶ Be familiar with the additives used with grease and the reasons for their use.
- ▶ Be familiar with some factors that determine grease compatibility.
- ▶ Describe some applications for which grease is used as a lubricant.
- ▶ Be familiar with various grease testing procedures.
- ▶ Differentiate between hydrodynamic lubrication and elasto-hydrodynamic lubrication.
- ▶ Discuss various lubricant contaminants.

- ▶ Discuss lubrication of gears.
- ▶ Discuss the use of extreme pressure (EP) oils versus non-EP oils.
- ▶ Be familiar with various methods of supplying gears with lubrication.
- ▶ Define hydraulic lock.
- ▶ Describe various causes of gear failure.
- ▶ Discuss the lubrication of worm gears, couplings, and bearings.
- ▶ Be familiar with the proper methods for greasing bearings.
- ▶ Discuss basic hydraulic principles.
- ▶ Describe characteristics of hydraulic fluid.
- ▶ Be familiar with additives used with hydraulic oils and reasons these additives are used.
- ▶ Understand the reason for filtering hydraulic fluids.
- ▶ Be familiar with methods of preventing fluid-related hydraulic system problems.
- ▶ Discuss the differences between synthetic and mineral oils.
- ▶ Be familiar with various types of synthetic oils and their origins.
- ▶ Discuss the advantages of synthetic oils over mineral oils.
- ▶ Be familiar with various uses and applications of synthetic oils.
- ▶ Discuss the purpose of a lubrication program.
- ▶ Be familiar with some aspects of a good lubrication program.
- ▶ Be familiar with proper storage and handling procedures for lubricants.
- ▶ Be familiar with proper oil sampling techniques, reports, and analysis.
- ▶ Discuss the benefits of a good lubrication program.

CLASS DURATION

24 to 40 hours (depending upon audience and audience experience)



MM-207: BEARINGS

COURSE DESCRIPTION

This course provides information on the concepts associated with bearings; bearing function; bearing design; bearing maintenance, installation, and removal; expected load and wear patterns; and bearing faults. There are hands-on exercises for bearing removal and installation.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function, design, and construction of bearings; install, remove, and maintain bearings; and identify causes of bearing failure.

RECOMMENDED AUDIENCE

This course is designed for mechanical and electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Discuss the basic concepts behind forces and stress.
- ▶ Discuss some of the basic terms used to describe and understand bearing design.
- ▶ Describe some of the materials used in the construction of bearings and why the materials are used.
- ▶ State the basic requirements of any bearing.
- ▶ Describe the differences between radial and thrust bearings.
- ▶ Given an anti-friction bearing, classify it as to type and operating characteristics.
- ▶ Given an anti-friction bearing, identify its individual components and give their purpose.
- ▶ Given a friction bearing, classify it as to type and operating characteristics.
- ▶ Given a friction bearing, identify its individual components and give their purpose.
- ▶ Describe the types of lubrication systems used for anti-friction and friction bearings.
- ▶ State the importance of and describe how to perform a soft foot check.
- ▶ State the procedure for performing various clearance checks on anti-friction and friction bearings.
- ▶ State the reasons for interference fits.
- ▶ Describe the various methods of heating bearings.
- ▶ Describe the various methods of cold mounting roller bearings.
- ▶ Describe the various methods of mounting tapered bore bearings.
- ▶ Explain the purpose of pre-load.

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- ▶ Describe the methods of setting tapered roller bearings.
- ▶ State the differences and purposes of fixed and float bearings.
- ▶ Describe the various methods of roller bearing removal.
- ▶ State the importance of crush and torque on a journal bearing.
- ▶ Describe the various expected load and wear patterns of bearings that have been operating.
- ▶ Identify the various types of failures that occur in bearings.
- ▶ Describe the various types of failures that occur in bearings.
- ▶ Describe methods for reducing the various bearing failures.

CLASS DURATION

16 to 40 hours (depending upon audience and audience experience)



MM-208: MECHANICAL CRANE INSPECTIONS

COURSE DESCRIPTION

This course provides information on the mechanical inspection of Electrical Overhead Traveling (EOT) cranes.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to discuss the mechanical inspections performed on EOT cranes and be able to assist in the inspection of EOT cranes.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom.

YOU WILL LEARN

- ▶ List and discuss the major mechanical assemblies of EOT cranes.
- ▶ List the inspection points on an EOT crane.
- ▶ Locate the inspection points on an EOT crane.
- ▶ Discuss the criteria for the inspection points.

CLASS DURATION

16 hours

SOURCES

IPT's Crane and Rigging Handbook

MM-209: FANS, BLOWERS, AND COMPRESSORS

COURSE DESCRIPTION

This course provides information on the concepts associated with air systems; air system functions; air system design; air system maintenance, installation, and removal; and air system faults.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function, design, and construction of air systems; install, remove, and maintain air systems; and identify causes of air system failures.

RECOMMENDED AUDIENCE

This course is designed for mechanical and electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Explain the purpose of a fan as compared to a blower.
- ▶ State the differences in operation between a centrifugal fan and an axial fan.
- ▶ State the major design classification of blowers.
- ▶ Explain the operation of a positive displacement blower.
- ▶ Explain the operation of an axial flow blower.

CLASS DURATION

24 Hours



MM-301: SHAFT AND COUPLING ALIGNMENT

COURSE DESCRIPTION

This course provides information on the importance of proper alignment and alignment methods, the cause of misalignment and how to correct for error such as soft foot and thermal growth using dial indicators, and coupling alignment using dial indicators and lasers where applicable. There are hands-on exercises for shaft and equipment alignments.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to successfully identify and correct a given source of misalignment using dial indicators or lasers where applicable; the participant will also be able to demonstrate an alignment exercise using given tools and equipment.

RECOMMENDED AUDIENCE

This course is designed for electrical and mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Explain the importance of shaft alignment.
- ▶ Describe the symptoms of misalignment.
- ▶ Define the goal of the alignment process.
- ▶ Understand the most common causes of misalignment.
- ▶ Explain the effects of misalignment on machines.
- ▶ Describe the relationship between vibration and shaft alignment.
- ▶ Describe the tools used in alignment work.
- ▶ Understand the types and use of laser alignment tools specific to your plant.
- ▶ Explain the importance of conducting a thorough inspection of the machine prior to attempting to perform an alignment.
- ▶ Describe the effects of not conducting a thorough inspection of the machine prior to attempting to perform an alignment.
- ▶ Explain the term soft foot.
- ▶ Describe the effects soft foot has on a machine.
- ▶ Describe the various types of soft foot.
- ▶ Explain how to measure and correct soft foot.
- ▶ Describe the phases of alignment and the acceptable methods of completing them.

- ▶ Make accurate adjustments in each phase of alignment (lab assignment).
- ▶ Describe the various methods available to perform alignment.
- ▶ Explain the advantages and disadvantages of each method.
- ▶ Measure bar sag.
- ▶ Perform an alignment using the reverse dial indicator method.
- ▶ Make accurate elevation changes on the machine.
- ▶ Make controlled horizontal moves.
- ▶ Describe acceptable solutions for the problem of a machine becoming bolt bound.
- ▶ Explain the importance of thermal growth in a machine.
- ▶ Calculate thermal growth.
- ▶ Determine acceptable limits of an alignment.
- ▶ Describe factors that can affect the limits of an alignment.
- ▶ Be aware of various alignment procedures for equipment other than horizontally mounted motors and pumps.
- ▶ Perform an alignment on machines with multiple feet.
- ▶ Perform an alignment on multiple machine trains.
- ▶ Perform an alignment on non-rotational machines.
- ▶ Perform an alignment on machines with jackshafts.
- ▶ Perform an alignment on machines with an unobtainable indicator reading.
- ▶ Explain the purpose of a coupling.
- ▶ Explain the difference between a rigid and flexible coupling.
- ▶ Explain the following terms as they relate to a coupling: hub, shaft, key, match marks, bore, and gap.

CLASS DURATION

40 hours

MM-302: PIPEFITTING

COURSE DESCRIPTION

This course provides information on the codes and standards, types of piping and associated components, specifications, and fitting and supporting techniques. There are hands-on exercises for bending fitting and installing pipe.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to read and interpret pipefitting information from drawings and blueprints; identify piping materials; identify and discuss standards and specifications; and fit up and join pipes, tubes, and associated system components.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Discuss common codes/standards processes.
- ▶ List codes/standards applicable to pipefitting.
- ▶ Identify the authority system used to enforce private codes and standards.
- ▶ Describe typical ASME code symbols.
- ▶ Discuss ANSI, ASTM, AWS, and ASNT applicable codes to pipefitting.
- ▶ Identify the multitude of terms associated with piping.
- ▶ Describe the appropriate safety precautions associated with pipefitting.
- ▶ Identify piping specifications used in pipefitting.
- ▶ Interpret and illustrate piping drawings.
- ▶ Describe the three major dimensions associated with piping.
- ▶ Identify methods used to identify pipes and their associated components.
- ▶ Identify basic tools used in pipefitting and their appropriate uses.
- ▶ Describe basic pipe bending techniques.
- ▶ Identify the four major types of metal piping.
- ▶ Identify ferrous and non-ferrous materials.
- ▶ Describe the basic manufacturing techniques employed for the various types of metal piping.
- ▶ Discuss the advantages/disadvantages of the different types of metal piping.
- ▶ List some examples of special metals and their unique applications.

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- ▶ Identify the five major types of non-metallic piping.
- ▶ Identify the three forms of concrete and their applications.
- ▶ Discuss advantages/disadvantages and applications of glass piping.
- ▶ Identify the types of plastic piping, its uses, and advantages.
- ▶ Describe types of piping resins.
- ▶ Discuss basic differences between tubing and piping.
- ▶ List the advantages of using tubing.
- ▶ Identify the common types of tubing.
- ▶ Describe tubing joints and their make-up.
- ▶ Identify tube bending techniques commonly used.
- ▶ Identify the means of joining piping systems.
- ▶ Describe the different methods to perform welding connections.
- ▶ Identify the types of flanges and their applications.
- ▶ Identify forms of threaded connections.
- ▶ Describe joint preparation and fit-up.
- ▶ Identify different types of valves available and discuss the characteristics of each type.
- ▶ Identify different types of valve actuators available and discuss the characteristics of each type.
- ▶ Describe the three types of steam traps and their operations.
- ▶ Describe the operations of filters and strainers.
- ▶ Describe the operation and construction of a tube and shell heat exchanger.
- ▶ Describe miscellaneous piping components commonly seen in piping systems.
- ▶ Identify the basic designs of pipe hangers and supports.
- ▶ Describe hanger selection and support location criteria.
- ▶ Describe the effects of thermal transients on the hangers/piping systems.
- ▶ List the two major types of hangers.
- ▶ Identify various pipe hangers and attachments.
- ▶ Describe the types of snubbers and their uses.
- ▶ Discuss the operation, installation, and maintenance of snubbers.

CLASS DURATION

Up to 40 hours (depending upon audience and audience experience)

MM-303: SEALS AND PACKING

COURSE DESCRIPTION

This course provides information on identification and installation of packing and mechanical seals and their applications. There are hands-on exercises for removing and installing packing and mechanical seals.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain and/or demonstrate the correct way to safely inspect and install packing and/or mechanical seals on a given piece of equipment.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Identify the different types of compression packing, and explain when each is used.
- ▶ Identify the different types of molded packing, and explain when each is used.
- ▶ List the advantages and disadvantages of pump mechanical seals.

CLASS DURATION

8 hours

MM-304: PUMPS AND PUMP REPAIR

COURSE DESCRIPTION

This course provides information on the concepts associated with pumps and pump application, operation, hazards, and troubleshooting and repairing common problems; it also explains how to draw and label simple pump curves. There are hands-on exercises for inspection and repair of pumps and their associated equipment.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the function, design, and construction of given pumps and be able to troubleshoot a given problem.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ State the centrifugal pump laws.
- ▶ Define the terms used when discussing centrifugal pumps.
- ▶ State the safety hazards associated with rotating equipment.
- ▶ Describe the hazards associated with pumps.
- ▶ Explain the operation of a centrifugal pump.
- ▶ Identify and state the function of the various centrifugal pump components.
- ▶ Classify centrifugal pumps as to position, impeller design, number of stages, and direction of flow.
- ▶ Explain how slip affects the operation of a centrifugal pump.
- ▶ Draw and label simple pump curves.
- ▶ Define net positive suction head and cavitation.
- ▶ Describe the process for troubleshooting a centrifugal pump.
- ▶ Identify and state the function of the various positive displacement pump components.
- ▶ Explain the operation of a positive displacement pump.
- ▶ Explain how slip affects the operation of a positive displacement pump.
- ▶ Describe the process for troubleshooting a positive displacement pump.

CLASS DURATION

16 to 24 hours (depending upon audience and audience experience)

MM-400: HYDRAULICS AND PNEUMATICS

COURSE DESCRIPTION

This course provides information on the concepts associated with hydraulics and pneumatics, hydraulic and pneumatic systems and their components, fluid principles, hydraulic and pneumatic system design, hydraulic and pneumatic schematic symbology, and the use of schematics to troubleshoot these systems.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to explain the advantages of hydraulics and pneumatics, Pascal's Law, Boyle's Law, Charles' Law, the General Gas Law, fluid dynamics, pneumatic system symbols, filtration in pneumatic systems, and pneumatic system cylinders and valves.

RECOMMENDED AUDIENCE

This course is designed for mechanical and electrical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

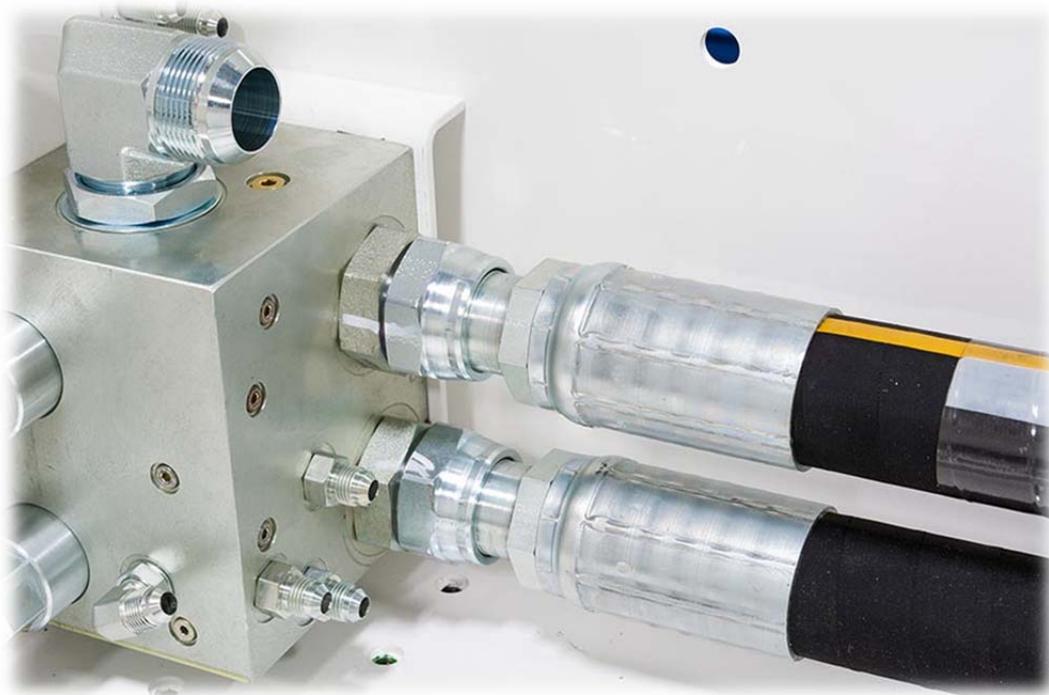
- ▶ List the advantages of hydraulics.
- ▶ Explain Pascal's Law.
- ▶ State the relationship between force, pressure, and area.
- ▶ Describe the basic principle of fluid dynamics.
- ▶ List the different properties of hydraulic fluids.
- ▶ State the functions of a reservoir.
- ▶ List the different types of pumps used in hydraulic systems.
- ▶ Describe the types and uses of control valves used in hydraulic systems.
- ▶ Describe the types and uses of actuators used in hydraulic systems.
- ▶ Identify the types and uses of accumulators used in hydraulic systems.
- ▶ Describe a basic hydraulic system.
- ▶ Explain the operation of a hydraulic circuit, given a system schematic.
- ▶ List the types and uses of seals used in hydraulic systems.
- ▶ Discuss the common failures of hydraulic systems and how they can be prevented.
- ▶ List and describe the advantages offered by the use of pneumatics.

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- ▶ Discuss the compressibility and expansion of gases as defined by Boyle's Law, Charles' Law, and General Gas Law.
- ▶ Identify standard symbols used to illustrate the operation of a pneumatic system.
- ▶ Given a drawing of a plant pneumatic system, identify the components and how they function in that system.
- ▶ Discuss the use of filtration and purification equipment installed in pneumatic systems.
- ▶ List the types and uses of cylinders installed in pneumatic systems.
- ▶ List the types and uses of valves installed in pneumatic systems.

CLASS DURATION

Up to 40 hours (depending upon audience and audience experience)



MM-403: INDUSTRIAL ELECTRICITY AND ELECTRONICS FOR MECHANICS

COURSE DESCRIPTION

This course provides information on basic electricity and electronic concepts and devices. There are hands-on exercises for component and circuit operation.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to identify electrical and electronic components, and explain the operation of these components and the operation of simple circuits.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Describe the structure of an atom.
- ▶ Tell the difference between a compound and an element.
- ▶ Explain how electrical forces cause objects to attract or repel other objects.
- ▶ Describe electron flow.
- ▶ State the definition of a cell.
- ▶ Explain the difference between a conductor and an insulator.
- ▶ State the definition of grounding.
- ▶ List the common causes of static electricity in an industrial plant.
- ▶ State the definition of bonding.
- ▶ List the main methods of producing potential difference.
- ▶ State the main difference between a primary cell and a secondary cell.
- ▶ Explain how to connect cells in parallel and in series.
- ▶ Describe how a photoelectric device works.
- ▶ Identify potential hazards when recharging batteries.
- ▶ State the most basic law of magnetic force.
- ▶ Describe how magnetic force operates.
- ▶ Describe the left-hand rule for magnetic field direction.
- ▶ Describe an electromagnet.
- ▶ Explain how to use lifting magnets, magnetic pulleys, and magnetic clocks.
- ▶ State the characteristics of an electrical conductor and an electrical insulator.

- ▶ State the definition of electric current.
- ▶ Explain the relationship of potential difference to the flow of electric current.
- ▶ State the definition of Ohm's Law.
- ▶ Identify the purpose and parts of an ammeter.
- ▶ Identify symbols for resistors, capacitors, and relays in an electric circuit diagram.
- ▶ Explain the operating principles of resistors, capacitors, and inductors.
- ▶ State the meaning of each band in the resistor color-code system.
- ▶ List the factors to consider when choosing a resistor.
- ▶ Explain how to connect capacitors in parallel and in series.
- ▶ State the difference between AC and DC.
- ▶ Solve for R, E, I, and P in a simple electrical problem.
- ▶ Solve for potential difference, current, and resistance in a series and parallel circuit.
- ▶ Describe the operation of a transformer.
- ▶ Explain the difference between the primary winding and the secondary winding in a transformer.
- ▶ Explain the importance of the transformer in AC electricity.
- ▶ Explain what a complete cycle of AC consists of and how it is produced.
- ▶ State the definition of AC inductance.
- ▶ List the ways inductive reactance differs from resistance.
- ▶ Explain the difference between the terms in-phase and out-of-phase in an AC circuit.
- ▶ List the main advantages of the three-phase AC system.
- ▶ Explain the difference between system grounding and equipment grounding.
- ▶ List the benefits of system grounding.
- ▶ Name the parts of a vacuum tube, and describe the function of each part.
- ▶ Explain the difference between P-type semiconductor materials and N-type semiconductor material.
- ▶ List the parts of a transistor.
- ▶ State the definition of an integrated circuit.
- ▶ Name each of the blocks of the block diagram of a programmable logic controller system.
- ▶ Explain how each of the blocks functions with the system as a whole.
- ▶ Describe the relationship of the programmable logic controller system to the real world.
- ▶ Explain the basic concepts of ladder logic software.
- ▶ Describe the relationship of an input device to an input point on an input module.
- ▶ Identify the symbols for common input and output devices.

CLASS DURATION

40 hours

MM-500: MECHANICAL CONCEPTS

COURSE DESCRIPTION

This course provides information on the concepts associated with plant maintenance, operation, hazards, troubleshooting and repair common problems. There are hands-on exercises for inspection and repair of equipment associated with this program.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to read and understand precision measuring tools, understand fastener standards and bolting practices, identify different types of bearings and their application, describe the characteristics of both centrifugal and positive displacement pumps, and demonstrate how to properly align equipment using dial indicators and lasers.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Describe the construction and proper use of the following precision measurement tools:
 - Scale (machinist rule)
 - Vernier caliper
 - Dial caliper
 - Dial indicator
 - Micrometer
 - Precision level
 - Torque wrench
- ▶ Identify different fastener standards.
- ▶ Describe the common types of bolts, screws, studs, and nuts.
- ▶ Describe the properties associated with bolt diameter.
- ▶ Describe the property class of different fastener.
- ▶ Describe the different types of bolted joints.
- ▶ Describe the different types of flanged connections.
- ▶ Describe the process for torquing fasteners.

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- ▶ Describe the forces that affect bearing performance.
- ▶ Describe the different types of bearings.
- ▶ Describe the different types of bearing seals and housings.
- ▶ Describe the requirements of bearing lubrication.
- ▶ Identify the different types of maintenance-related bearing failures.
- ▶ Describe the operation of a belt drive system.
- ▶ Describe the operation of a chain drive system.
- ▶ Describe the different types of couplings.
- ▶ Identify types of gear arrangements.
- ▶ Describe the operation of a gearbox.
- ▶ Install and align a belt
- ▶ Install and align a chain and sprocket.
- ▶ Inspect a gearbox.
- ▶ Describe the construction of a typical slider bed conveyor
- ▶ Describe how conveyors typically wear.
- ▶ Describe how conveyors typically fail.
- ▶ Inspect a conveyor.
- ▶ Describe the difference between a fan and a blower.
- ▶ Describe the operating characteristics of fans
- ▶ Describe the operating characteristics of blowers.
- ▶ Inspect fans and blowers.
- ▶ Describe the characteristics of centrifugal pumps.
- ▶ Describe the characteristics of positive displacement pumps.
- ▶ Inspect a pump.
- ▶ Identify the ANSI standard piping color code.
- ▶ Inspect piping system components.
- ▶ Describe pipe testing methods.
- ▶ Describe the major components of a hydraulic system.
- ▶ Describe the wear and failure modes of hydraulic system components.
- ▶ Perform a visual inspection of a hydraulic system.
- ▶ Describe the major components of a pneumatic system.
- ▶ Describe the wear and failure modes of pneumatic system components.
- ▶ Perform a visual inspection of a pneumatic system.
- ▶ Describe the importance of shaft alignment.

- ▶ Describe the fundamental principles of shaft alignment.
- ▶ Identify the tools required to perform a shaft alignment.
- ▶ Describe necessary pre-alignment checks.
- ▶ Describe the phases of alignment.
- ▶ Perform a soft-foot correction.
- ▶ Describe the various methods of shaft alignment.

CLASS DURATION

40 hours



WE-101: STRUCTURAL WELDING

COURSE DESCRIPTION

This course provides information on oxyfuel cutting and Shielded Metal Arc Welding (SMAW) structural welding. There are extensive hands-on exercises for burning and welding.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to make cuts using oxyfuel equipment and weld T-joints using SMAW equipment.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Describe fusion welding, resistance welding, filler rods, and electrodes.
- ▶ Compare the oxyfuel and arc welding processes, and compare the SMAW, Gas Metal Arc Welding (GMAW), and Gas Tungsten Arc Welding (GTAW) processes.
- ▶ Describe and sketch the following kinds of joints-butt, lap, tee, corner, and edge.
- ▶ Describe the following kinds of welds: groove, fillet, plug, slot, spot, and seam.
- ▶ Name and locate the parts of a weld.
- ▶ Discuss basic considerations in joint design and fitup.
- ▶ Explain the importance of good housekeeping in an area where welding is taking place.
- ▶ List at least three precautions to take to avoid fires and explosions when welding.
- ▶ Describe two methods of protecting yourself against the fumes and gases associated with welding.
- ▶ Describe the personal protective equipment required when welding.
- ▶ Explain the precautions to take when using and handling cylinders and regulators.
- ▶ Briefly describe the oxyfuel welding process and the components of an oxyfuel welding outfit, including the lighting device.
- ▶ Discuss safety precautions and personal protective gear required for working with oxyfuel equipment.
- ▶ List the steps involved in preparing to weld.
- ▶ Compare the neutral, carburizing, and oxidizing flames.

- ▶ List the steps in safely shutting down an oxyfuel welding system.
- ▶ List similarities and dissimilarities between oxyfuel welding and arc welding.
- ▶ Describe the electric welding circuit, including choice of AC or DC, DC polarity, and power sources.
- ▶ Discuss welding machine ratings in terms of amperage and duty cycle, and describe features and uses of transformer, generator, rectifier, and inverter welding machines.
- ▶ Discuss welding cable considerations, and describe the electrodes and electrode holders used for SMAW, GMAW, and GTAW processes.
- ▶ Discuss the personal safety gear and precautions necessary for arc welding, and explain how arc welding accessories are used.
- ▶ Explain what considerations affect the selection of a welding process.
- ▶ Describe the four welding positions.
- ▶ Explain why overhead welds are difficult to make, and tell how to make them.
- ▶ Describe the preparation required for oxyfuel welding, SMAW, GMAW, and GTAW processes.
- ▶ Describe the procedures involved in oxyfuel welding, SMAW, GMAW, and GTAW processes.
- ▶ Describe the effects of electrode selection, current, arc length, and travel speed on arc welding procedures.
- ▶ Describe common causes of arc blow, a hard-to-start arc, and spatter, and explain why proper fitup is important.
- ▶ Define the terms overlap, undercut, blowhole, and inclusion, and explain the causes of each.
- ▶ Explain how expansion and contraction can be controlled when welding.
- ▶ Name and describe the various tests used to identify metals.
- ▶ Identify the kind of chamfer to be cut on a joint to be welded and which part is to be chamfered.
- ▶ State the required dimensions of a weld.
- ▶ Identify the contour required on a finished weld.
- ▶ State how a weld contour is to be finished.
- ▶ Differentiate between welds that are to be made at the site of final assembly and welds that are to be made before the parts are shipped to the site.
- ▶ Explain the similarities and differences between oxyfuel cutting and oxyfuel welding.
- ▶ Describe the equipment and safety precautions necessary for torch cutting, and list standard steps in the torch cutting operation.
- ▶ Describe special equipment or methods used in cutting bevels, piercing holes, cutting circles, and cutting away rivets.
- ▶ Explain why gouging, scarfing, and washing are used.
- ▶ Explain methods used on metals that are otherwise difficult to cut.

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- ▶ Explain how the shielded metal arc welding process works.
- ▶ Tell what provides the shield in shielded metal arc welding.
- ▶ Define arc length and explain its importance.
- ▶ List factors to consider when selecting an electrode.
- ▶ Describe the personal protective equipment necessary for welding.
- ▶ Explain the factors involved in selecting SMAW electrodes.
- ▶ Explain how to identify different welding electrodes.
- ▶ Give examples of several kinds of electrode coverings, and tell when each is used.
- ▶ Describe correct procedures for handling, storing, and conserving electrodes.
- ▶ Cut metal using oxyfuel equipment.
- ▶ Make T-joint welds using SMAW equipment.

CLASS DURATION

200 hours (5 weeks)



WE-102: PIPE WELDING

COURSE DESCRIPTION

This course provides information on SMAW pipe welding. There are extensive hands-on exercises for welding.

TERMINAL OBJECTIVE

Upon completion of this course, the participants will be able to weld pipe in 2G and 5G positions using SMAW equipment.

RECOMMENDED AUDIENCE

This course is designed for mechanical maintenance technicians.

RECOMMENDED MEDIA/MODE

Instructor-led classroom presentation with workshop hands-on exercises.

YOU WILL LEARN

- ▶ Compare the advantages of welded pipe joints to bolted or screwed connections.
- ▶ Discuss pipe welding codes and what they cover.
- ▶ List the welding processes used for joining pipe and their advantages and disadvantages.
- ▶ Identify some special methods and accessories that are used in pipe welding as opposed to flat welding.
- ▶ Give examples of the uses of preheating and post-heating in pipe welding.
- ▶ Make 2G and 5G pipe welds.

CLASS DURATION

200 hours (5 weeks)





Performance Matters





Tampa Technical Training Center
8401-F Benjamin Rd.
Tampa, FL. 33634
813-569-4047

