

# Online Multicraft Industrial Maintenance

# Course Objectives and Descriptions

**INTRODUCTION**

REA5-Study Skills

* Construct spoken and numbered outlines
* Summarize a paragraph
* Know the three types of reading: study reading, skimming, and scanning
* Apply study skills to mathematics
* Know a series of steps to solve problems Maintenance Principles
* Shows workers how solid maintenance principles can be used to reduce the influence of defects that come from 5 sources: Workmanship, Operation, Materials, Design, Failure Events

TRB1 – Maintenance Troubleshooting: Procedures

* Identify the abnormality or symptom based on normal operation behavior
* Determine the faulty element or component based on symptoms
* Plan a course of action to repair the equipment
* Safely perform repairs on the equipment
* Apply observation techniques to prevent reoccurrence once the problem is repaired. TPC) Basic Mechanics
* Covers force and motion, work and energy, and fluid mechanics as applied in industrial maintenance. Explains principles of operation for simple machines, such as the lever, inclined plane, wheel and axle, pulley, and screw. Explains the basic elements of industrial machines, as well as common measurement tools used to monitor and adjust equipment. Covers hand tools, power tools and fasteners, ending with a discussion of ways to reduce friction and wear.

# MATH

MAT1-Whole Numbers

* Learn to recognize and use symbols of arithmetic
* Learn the place value of numbers
* Learn to add, subtract, multiply and divide whole numbers
* Learn to solve arithmetic problems MAT2-Fractions
* Learn the parts of a fraction
* Learn to determine fractional parts of quantities
* Learn to add & divide fractions
* Learn basic arithmetic functions using fractions and mixed numbers MAT3-Decimals
* Learn about the use of decimals
* Learn the value of zeros in decimals
* Learn to round off decimals
* Learn to identify repeating decimals
* Learn to add, subtract, multiply, and divide decimals
* Learn to calculate percents MAT4-Algebra
* Learn about signed numbers and how they are represented on a number line
* Learn to subtract, multiply, and divide signed numbers
* Learn to use variables in solving equations
* Learn to determine the value of square roots
* Learn to use numbers with exponents and powers of 10
* Learn to simplify algebraic expressions by removing grouping symbols
* Learn to perform operations in their proper sequence
* Learn to solve equations that have one unknown

# PRINT READING

PRT1-Print Reading: Orthographic Projections

* Identify the principle views used in orthographic projections
* Identify the types of lines used in projection drawings and the purpose of each
* Identify auxiliary and sectional views
* Identify the differences between first and third angle projections PRT2-Print Reading: Format and Dimension
* Identify characteristics of standard sheet sizes
* Identify features of engineering drawings
* Explain how an object's features are defined and located using dimensions
* Explain tolerance dimensioning PRT3-Print Reading: Types and Symbols
* Identify the differences between layout, detail, prefix, and assembly drawings
* Recognize general identification and revision notes and symbols
* Identify special markings, including surface texture, welds, rivets, and datums PRT4-Thread Specifications
* Identify thread features
* Describe the most common thread forms and their characteristics
* Recognize the differences between English and metric thread notes (TPC) Reading Schematics & Symbols

Covers all types of schematics and symbols used in commercial and industrial settings. Examines symbols on schematics, electrical symbols and diagrams, piping symbols and diagrams, hydraulic and pneumatic diagrams and symbols. Discusses air conditioning and refrigeration systems, including explanations of electrical/electronic control schematics. Covers welding and joining symbols.

# SAFETY

 Personal Protective Equipment: Don’t Start Work without It

At work, every body part is vulnerable to injury and you have to make sure that your employees are well- protected. They face unique dangers depending on the job each one does. Accordingly, their PPE must be customized so that they can cope with the risks. Get this comprehensive PPE course, covering eye, face, hearing, head, hand and foot protection, and other PPE rules. Covers:

* Personal Protective Equipment
* Eye and Face Protection
* Hearing Protection
* Head Protection
* Hand Protection
* Foot Protection

Lockout Tagout: Lightening In A Bottle

* Lockout/Tagout Basics and Standard
	+ Energy Types and Lockout/Tagout Basics
	+ OSHA's Lockout/Tagout Standard
* Six Steps For Lockout/Tagout
	+ Preparation, Shutdown and Isolation
	+ Application, Restraint and Verification
* Removal And Re-Energizing
	+ Three Steps of Removal/Re-Energizing
	+ Inspection and Training Electrical Safety: Beware the Bite
* Levels of Protection: Conductivity, Engineering Controls
* Safe Work Practices: Safety at Work, Lockout/Tagout, Lockout/Tagout for Energized Systems
* Effective Safety Measures: Personal Protective Equipment, Emergency Rescue and First Aid ArcFlash: Live to Tell
* Definition of arc flash
* Safety documentation and regulations
* Latest information on NFPA 70E
* Qualified vs. unqualified persons
* Three critical approach boundary areas
* Job planning and hazard analysis
* Lockout/tagout procedures
* Proper PPE application

Machine Guarding: Safeguarding Your Future

Practically every machine has some sort of machine guarding – a shield, automatic shutoff or even a laser curtain – to protect workers if a body part should come in contact with the machine. In fact, OSHA requires specific machines to have specific guards. Make sure your employees understand the importance of knowing about and using the machine guards meant to protect them.

HAzCom: In Sync with GHS

As you know, the chemicals that your employees work with everyday can cause a multitude of physical and health hazards including chemical burns, respiratory problems, and fires and explosions. The Occupational Safety and Health Administration's (OSHA) Hazard Communication standard has recently been enhanced with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). This new HazCom standard not only gives workers the right to know the chemicals and hazards they face, but the right to understand them and how to protect themselves from danger. DuPont Sustainable Solutions' new HazCom: In Sync With GHS will help employees understand this new standardized process of communicating chemical hazards. Covers:

* Classes of Hazards
	+ Hazard Classification
* Labels
	+ Labels on Shipped Containers
	+ Pictograms
	+ Workplace Labeling
* Safety Data Sheets
	+ Communicating Chemical Hazards
* Communication
	+ Written Program
	+ Information for Workers (TPC) Industrial Safety & Health

Explains government involvement in ensuring a safe workplace. Discusses safety in various situations. Discusses personal protective equipment and fire safety. Includes expanded coverage of many health hazards. Covers ergonomics, environmental responsibility and importance of maintaining a safe work environment.

OSHA 10hr General Industry

The 10-hour General Industry Outreach Training Program is intended to provide an entry level general industry worker's broad awareness on recognizing and preventing hazards on a general industry site. Students will be introduced to OSHA policies, procedures and standards as well as general industry safety and health principles and work practices covered in OSHA Act Part 1910. Special emphasis will be placed on areas most hazardous using OSHA standards as a guide. General industry workers must receive additional training, when required by OSHA standards, on specific hazards of the job Upon successful completion of the course, participants will receive an OSHA 10- Hour General Industry Outreach DOL course completion card within 4-6 weeks.

# LUBRICATION

MLU1-Lube Oil: Types Properties and Handling

* Understand the significance of proper lubrication
* Identify the types of oils used, their characteristics, and the various ways to apply lubricants
* Describe the centralized and portable methods for applying lubricants and various fittings that may be necessary for proper lubrication
* Understand the guidelines for proper lubricant storage, both indoors and outdoors MLU2-Lube Oil: Equipment and Procedures
* Describe lubricant applications and standards
* Properly dispense machinery oils using lubrication equipment and fittings
* Describe the proper procedures for oiling with various lubrication systems MLU3-Lube Grease: Types Application and Equipment
* Describe the key grease properties and functions
* Identify grease types
* Use manual, powered, and automatic lubricators properly
* Understand safe procedures to handle, store, and dispense grease INS9-Lubrication System Inspection
* Identify the types of lubrication oils
* Inspect grease packs, pumps, distribution valves, pipes, joints, and bearings
* Inspect suction filters, pump units, and pressure and check valves
* Inspect lubrication parts

# DRIVE COMPONENTS

MDR1-Industrial Drive Systems: Belt Drives

* Identify common industrial belt drive systems
* Identify the different drive systems and discuss drive ratios
* Perform basic installation and maintenance procedures
* Troubleshoot

MDR2-Industrial Drive Systems: Chain Drivese common belt drive system problems

* Perform basic chain drive installation and maintenance procedures
* Troubleshoot some common chain drive system problems INS7-Operator Inspection: Belt Drive,chain drive, & gear box inspection
* Identify and describe the types and functions of belts and gears
* Describe the inspection procedures of belt and chain transmission parts and units
* Explain methods for inspecting gears.

CDP1-Complete Drive Packages

* Identify the components of a directly coupled drive system
* Understand the characteristics of operation unique to directly coupled drive systems
* Identify the components of jackshaft and auxiliary drive systems
* Explain the unique properties of jackshaft and auxiliary drive systems
* Explain the effects of changing input and output speeds on auxiliary and jackshaft drive systems
* Compute drive system efficiency
* Understand the principles of operation for spring operated, shear pin, and heat-actuated overload devices
* Learn troubleshooting strategies for drive packages EDS1 - Enclosed Drive Systems
* Understand the principles of operation and terminology used in enclosed drive systems
* Identify the components used in an enclosed gear drive
* Identify different gear types
* Understand applications for enclosed gear drives
* Identify the various types of adjustable speed enclosed drives
* Understand applications of an enclosed chain drive system
* Identify and describe the component parts and operation of an enclosed chain drive
* Install an enclosed drive
* Explain proper maintenance procedures
* Describe proper procedures when troubleshooting an enclosed drive system CBR1-Clutches & Brakes : Types, Principles, and Functions
* Describe the different types of mechanical clutches and brakes, their components, and operation
* Describe applications and troubleshooting procedures for mechanical clutches and brakes
* Describe pneumatic and hydraulic clutches and brakes, their components, and operation
* Describe pneumatic and hydraulic control systems
* Describe applications and troubleshooting procedures for pneumatic and hydraulic clutches and brakes
* Explain the purpose and operation of electrically controlled clutches and brakes
* Identify an electric control system CBR2-Clutches & Brakes: Troubleshooting
* Troubleshoot several problems in mechanical clutch and brake systems
* Troubleshoot several problems in pneumatic and hydraulic clutch and brake systems
* Troubleshoot several problems in electric clutch and brake systems INS8-Operator Inspection: Clutch & Brake Inspection
* Identify and describe the types and functions of clutches and brakes
* Identify and describe the types and functions of cams and guide surfaces
* Describe the inspection procedures of clutches and brakes
* Describe the inspection procedures of cams and guide surfaces. GGS1 - Gear and Gear Systems
* Understand parallel and perpendicular shaft configurations
* Identify and describe the attributes of gears
* Understand gear considerations, Calculate critical dimensions of gears
* Explain installation procedures specific to spur, helical, bevel, miter, and worm gearing
* Describe the types of wear associated with open gearing systems
* Explain the inspection procedures for spur, helical, bevel, miter, and worm gear sets
* Identify common symptoms and how to determine causes of failure
* Explain solutions for open gear systems. Understand safety procedures with open gear systems SJC1-Shaft Joining and Coupling Devices
* Identify different types of shaft joining and coupling devices
* Understand the operating principles governing shaft joining and coupling devices
* Identify critical application considerations when selecting a connecting device
* Differentiate between rigid, flexible, fluid couplings, and universal joints based upon construction, purpose, and application
* Understand the safety precautions to follow when performing inspection, maintenance, and repairs
* Install and align mechanical couplings
* Maintain mechanical couplings
* Install, mount, align, test, and maintain a fluid coupling
* Recognize symptoms of and troubleshoot fluid couplings and Coupling Devices

# BEARINGS

BRG1-Ind. Bearings: Application and Technology

* Understand the definition of a bearing
* Understand the different types of bearings, including plain, ball, cylindrical, spherical, tapered, and needle
* Understand bearing wear and life expectancy
* Understand protective housings for bearings
* Explain the different types of loads BRG2-Ind. Bearings: Maint. and Installation
* Learn the proper way to install and care for both plain and rolling-element bearings
* Identify the different types of fittings for installation
* Check proper operating clearances
* Understand the importance of proper bearing alignment BRG3-Ind. Bearings: Troubleshooting
* Understand the various ways to identify potential problems and their sources
* Understand how to maintain a schedule of monitoring on four major areas of identification
* Explain the proper procedures for removing failed bearings
* Determine the reasons for failed bearings

# PIPING / PLUMBING/BOILERS

(TPC) Piping

Examines piping system materials and sizing. Includes coverage of codes, valves and fittings, and the cutting and joining of piping and tubing. Explains the function and unique requirements of the discharge line, liquid line, and suction line. Concludes with a lesson on piping system maintenance, including handling dirt and scale, expansion, vibration, corrosion, and leaks

# VALVES

FVB1-Shutoff Valve Designs and Application Considerations

* Explain the general characteristics, construction options, and application considerations of various shutoff valves
* Identify the features and limitations of the various valve types
* Evaluate shutoff valve performance FVB2-Selecting Shutoff Valves And Accessories
* Understand the major considerations for selecting a shutoff valve type
* Identify pressure and temperature requirements
* Identify the unique valve requirements imposed by the nature of the controlled fluid
* Identify the features, limitations, and suitability of different valve styles
* Select an appropriate valve
* Select an appropriate means of operating the valve (handwheel, gear drive, power actuator, etc) FVB3-Installing Shutoff Valves
* Explain good piping practices, including proper valve location and orientation in the pipeline
* Understand the importance of pipeline and valve supports
* Prevent line hammering
* Explain installation considerations for specific types of shutoff valves, including plug, ball, butterfly, globe, gate, and check valves
* Properly install valves with screwed, flanged, and welded-end connections
* Describe actuator mounting and adjustment FVB4-Maintaining Shutoff Valves
* Identify components and their functions for various valve types
* Explain routine preventive maintenance procedures for each valve type
* Explain common procedures involved in complete valve repair CVA1-Basics and Function
* Identify the characteristics, function, and application of the control valve
* Describe the factors that must be considered when selecting the proper control valve
* Describe the functions of a valve actuator and a control valve positioner and how these work within a control system

CVA2-Types & Design

* Describe the functions, applications, and differences of linear motion control valves and rotary motion control valves
* Describe the functions, applications, and differences of pneumatically operated actuators, electrically operated actuators, and rotary motion actuators
* Describe the basic operation and function of the components of the control valve
* Identify factors that affect control valve safety CVA3-Fundamentals and Selection
* Describe the different types of fluid flow
* Identify the factors that affect fluid flow
* Explain the formulas used for determining valve selection
* Describe the conditions of fluid flowing through a restriction such as a Herschel venture, a concentric orifice, and Vena Contracta
* Explain cavitation, flashing, and fluid flow
* Explain the considerations for selecting a control valve
* Describe the preliminary criteria for selecting the proper actuator and auxiliary devices CVA4-Sizing and Installation
* Describe the factors to consider for correctly sizing a valve
* Recognize what items are needed to determine proper valve sizing
* Determine the proper control valve to be used for a liquid, gas, and vapor application
* Describe the factors involved with actuator sizing, such as static force, valve leakage classification, and dynamic forces
* Recognize the proper installation and maintenance procedures of a control valve (TPC) Valve Maintenance & Piping Systems Protection

Covers maintenance and operation of gate, globe, ball, plug, check, and special-purpose valves. Details actuators and various accessories. Explains valve selection based on application. Describes methods of protecting piping systems.

# PNEUMATICS

PNM1-The Power of Compressed Air

Power transmission systems are found in equipment ranging from simple devices to complex industrial machines. This course introduces pneumatics — the transfer, control, and use of energy contained in compressed and flowing air. It provides a basic description of the characteristics of matter and describes the relationship between pneumatic properties. In addition, it describes the factors that affect air flow and velocity as well as the effects that temperature, water vapor, air saturation, and condensation have on a pneumatic system. The course covers: The characteristics of matter, Molecular level, Air, Properties of pneumatics, Specific volume, pressure, and temperature; Air flow, Factors affecting air flow, Air saturation, Condensation.

PNM2-The Pneumatic Circuit

A pneumatic circuit is a combination of components that work together to produce, control, and transmit energy. This course introduces several of these energy transferring and air control components and the symbols used to represent them. The course covers:

* Energy transferring components, Compressors, Valves, Actuators
* Air control components. Directional control valves, Flow control valves
* Regulators, Tanks and filters
* Pneumatic symbols, Communicating with pictures
* Pumps, filters, and lubricators PNM3-Processing Air

This course introduces components that process air by compressing, storing, treating, and distributing air to the actuator. Although sometimes overlooked, these components have a major impact on system operation. The course covers:

* Compressors, Single-stage, Multi-stage and dynamic
* Pressure and flow rate capacities, Sustaining compression
* Air storage, Tank accessories, Air sustaining components
* Branch and loop systems.

PNM4-Using Compressed Air

linkages can produce complex motion patterns, the origin of the motion is always one of these two types. This course focuses on the pneumatic components that produce motion. The course covers:

* Linear actuators, Cylinders, cylinder accessories
* Theory of operation
* Seals, Nonlinear actuators, Rotary actuators
* Air motors, Torque, Nozzles and orifices. PNM5-Pneumatic Control Valves

To be effective, actuators must move loads in the proper sequence, at the correct time, and at the desired speed. In pneumatic systems, this type of control is accomplished through the use of valves that control the direction of air flow, regulate actuator speed, and respond to changes in air pressure. This course focuses on pneumatic control valves. The course covers:

* Directional control valves, One- and two-way valves, Three- and four-way valves
* Methods of actuation, Flow control valves
* Exhaust valves and air fuses
* Simple and specialized regulators
* Valve performance, Selecting valves. PNM6-Working Safely With Pneumatic Systems

This course describes the safety hazards associated with pneumatic systems. It also covers the safety rules that should be followed when working with individual pneumatic components. The course covers:

* Pneumatic system safety, Common hazards and remedies
* Working with air tools, Oil and water
* Safe installation and operation
* Compressors, tanks, and actuators
* Control valves
* Air treatment devices

PNM7-Pneumatic System Maintenance

This course explains the importance of a pro-active maintenance program for pneumatic systems. It describes the major categories of tasks that should be part of a preventative maintenance program and identifies some specific tasks that should be performed during routine maintenance. The course covers:

* Pro-active maintenance, Types of maintenance systems
* Inspection, Valves and conductors, Checking alignment
* System cleanliness, Servicing, Preparing for servicing
* Air treatment components, Final maintenance tasks, Testing
* Reconditioning and scheduling. PNM8-System Troubleshooting

This course explores the concept of troubleshooting and covers one systematic approach to identifying problems and determining their causes. The course also examines the various root causes of bearing failure, including over-lubrication, contamination, and misalignment. The course covers:

* The four indicators for determining bearing condition
* Temperature, Noise and vibration, Seals, Lubrication
* Removing and inspecting failed bearings
* Causes of premature failure
* Pitting and spalling, Electrostatic pitting, True brinelling
* Fretting corrosion, Heat damage, Frictional bearing wear
* Rust or corrosion, Equipment adjustment INS1-Pneumatic System Inspection
* Understand the basic characteristics of air, including pressure, flow, and volume
* Explain how external conditions can affect air
* Identify the operating principles of pneumatic systems, including Pascal's Law
* Identify the components and function of the air compression system
* Understand the general safety procedures for operating a pneumatic system
* Differentiate between suction pressure and discharge pressure
* Describe the three-step process for establishing the general inspection components and inspection points of the pneumatic system

# HYDRAULICS

IDH1- Basic Principles and Application

* Understand the basic principles and components of hydraulic power systems
* Explain proper storage, handling, and maintenance procedures IDH2-Types and Concepts
* Identify and explain hydraulic piping, fitting, and connections
* Understand hydraulic pumps
* Identify and explain hydraulic system and pump mechanisms
* Understand pressure control valves IDH3-Function and Operating Principles
* Identify the types and functions of directional control valves and accumulators
* Identify the types of hydraulic cylinders
* Understand operating principles and applications of hydraulic motors
* Identify types, operating principles, and common uses of rotary actuators
* Explain maintenance and troubleshooting practices that apply to the entire hydraulic system IDH4-Maintenance and Troubleshooting
* Perform reservoir, heat exchanger, and pump maintenance
* Understand maintenance safety
* Explain troubleshooting procedures for hydraulic systems HDL1-Harnessing Hydraulic Power
* Identify the conditions that cause fluids to flow and exert pressure
* Explain Pascal's law
* Describe the relationship between fluid pressure and fluid flow
* Identify factors that affect pressure level, flow rate, and fluid velocity in a hydraulic circuit HDL2-The Hydraulic Circuit
* Identify the components of a typical hydraulic circuit
* Describe the function of components found in a basic hydraulic circuit
* Explain the structure and operation of basic hydraulic components
* Identify graphic symbols used to represent basic hydraulic components HDL3-The Hydraulic Pumps & Actuators
* Describe the basic structure and operation of balanced and unbalanced vane pumps, internal and external gear pumps, and radial and axial piston pumps
* Identify methods of varying the displacement in vane pumps and radial and axial piston pumps
* Describe the basic structure and operation of various types of motors and rotary actuators
* Describe the basic structure and operation of various types of cylinder devices such as rod gland bushings and seals, piston seals, air bleed passages, stroke adjusters, stop tubes, and cushions

HDL4-Hydraulics: Control Valves

* Describe the basic structure and operation of normally closed and normally open pressure control valves
* Describe the uses for relieve, unloading, sequence, counterbalance, brake, pressure-reducing valves, and flow control valves
* Explain how pressure compensation enables a flow control valve to maintain a desired flow rate regardless of pressure fluctuations
* Describe the function and basic operation of one-way, two-way, three-way, and four-way directional control valves
* Identify methods of spool actuation for directional control valves HDL5-Hydraulic Fluid
* Identify the characteristics that enable hydraulic fluid to perform required functions within a hydraulic system
* Describe the function, structure, and basic operation of reservoirs and accumulators, various types of conductors and fittings, hydraulic seals, and hydraulic filters
* Describe the structure and basic operation of various types of hydraulic heat exchangers HDL6-Hydraulics: System Safety & Maintenance
* Identify common hazards associated with the workplace
* Describe proper procedures for working with various hydraulic components
* List the safety rules that must be followed when operating or maintaining a hydraulic system
* Describe the factors that determine the intervals at which proactive maintenance tasks should be performed
* Describe the inspections and tests that should be part of a preventative maintenance program HDL7-The Hydraulic Systems Troubleshooting
* Identify the factors that must be considered when evaluating the operation of a hydraulic system
* Describe the tasks that should be part of a systematic troubleshooting process
* Identify symptoms of several hydraulic components
* Identify possible causes of some common hydraulic component and system failures HPS1-Identification and Operation
* Describe the operation of basic hydraulic circuits
* Explain how load sensing and demand circuits operate
* Describe how intensification and hydrostatic circuits operate
* Discuss the operation of regenerative, prefill, and high-low circuits
* Explain the importance of using a print when working with hydraulic systems
* Describe the procedure for analyzing a complex hydraulic circuit
* Identify pressure, drain, and control lines in a hydraulic system
* Separate the various functions of a hydraulic circuit for closer analysis HPS2-Troubleshooting Techniques
* Describe proper troubleshooting techniques
* Describe various kinds of modern hydraulic system test equipment
* Explain how to select proper test points in a circuit
* Describe repair procedures when troubleshooting and repairing a hydraulic system
* Troubleshoot problems that occur in hydraulic power systems, including lack of motion, poor motion, and temperature and system malfunctions

# MEASUREMENT / INTRUMENTATION

PME1 - Thermometers and Thermocouples

* Temperature scales
* Factors affecting accuracy of measurement
* Types of thermometers
* Thermocouples

PME3 - Pressure 1: Manometers and Gages

* Manometers
* Mechanical pressure transducers PME5 - Level 1: Measurement and Gages
* Visual level sensors
* Variable displacement devices PME7 - Flow 1: Measuremen Overview
* Fluid properties
* Measuring flow

# BASIC ELECTRCITY / ELECTRICAL MEASUREMENTS

ELS1-Basic Principles

* Identify the parts of an atom
* Understand how electrons move and react
* Define terms associated with electricity, static electricity, and magnetism
* Discuss how current flows through basic electrical circuits ACDC1-Current
* Identify the electronic charge of the atom, electron, proton, neutron, nucleus, and ion
* Describe Coulomb's Law
* Define terms associated with current
* Measure current with an ammeter ACDC2-Voltage
* Explain how connecting batteries in series or in parallel will affect voltage and current capability
* Differentiate between voltage drop and rise
* Explain ground, negative, and positive voltage
* Measure voltage with a voltmeter ACDC3-Resistance
* Differentiate between conductors and insulators and describe the characteristics that affect them
* Interpret resistor color codes
* Describe various types of resistors
* Describe how resistors can be connected to achieve different amounts of total resistance ACDC4-Ohm’s Law
* Write Ohm's Law in three different forms
* Select the proper equation to calculate voltage, current, and resistance
* Calculate the amount of power in a circuit ACDC5-Magnetism
* Define electromagnetic terms
* Explain basic electromagnetic rules and principles
* Describe the operation of generators and motors ACDC6-Electrical Measurements
* Explain how the VOM works and should be connected to a circuit
* Calculate the value of shunt required to increase the current capability
* Calculate the series dropping resistance required to increase the voltage capability
* Define voltmeter loading ACDC10-AC Measurements
* Explain the operation of AC meters and the oscilloscope
* Measure alternating current, AC voltage, amplitude, period, and frequency
* Analyze phase relationships of AC waveform (TPC) Electrical Measuring Instruments
* Covers the principles on which electrical test instruments operate. Basic instruments covered include voltmeter, ammeter, wattmeter, ohmmeter, and megohmmeter. Covers AC metering, split- core ammeter, use of current and potential transformers. Includes detailed coverage of modern multimeters. Explains functions and uses of oscilloscopes.

# DC CIRCUITS / FUNDAMENTALS

ACDC7-DC Circuits

* Explain how a voltage divider works
* Describe an application for a bridge circuit
* Describe Kirchhoff's Law
* Explain the superposition theorem, Thevenin's Theorem, and Norton's Theorem ADC2-Ohm's Law and DC Circuits
* Understand the various Ohm's law relationships
* Understand known and unknown values and how to use the proper Ohm's law relationships to solve for the unknown values
* Calculate the total equivalent resistance of series, parallel, and series-parallel resistive currents
* Calculate currents and voltages in series and parallel circuits
* Understand the proper formula for calculating DC-circuit power
* Explain simple rules and formulas for calculating circuit values
* Calculate voltages and currents for circuits consisting of both series- and parallel-connected resistors
* Determine resistance values for multi-range voltmeter and ammeter circuits
* Calculate the power dissipated by each resistor in a series DC circuit
* Calculate the power dissipated by each resistor in DC circuits consisting of both parallel- and series- parallel-connected resistors

ADC3-Electronic Components and Magnetism

* Select the proper wire gage and insulation for a specific application
* Explain hole and electron flow in N-type and P-type semiconductor materials
* Understand the operation and function of a diode
* Describe LED and LCD indicators and displays and their advantages and disadvantages
* Understand the operation of bipolar PNP and NPN transistors in switching and amplifier circuits
* Understand passive components such as capacitors, inductors, and resistors
* Identify the different types of magnets and their operating principles
* Explain how a magnetic field can induce current in a conductor
* Identify different types of relays and their applications
* Describe the operation of analog meter movements
* Understand the operation and characteristics of DC motors
* Explain how magnetism deflects the electron beam in a cathode-ray tube (CRT) ADC4-Electronic Schematics and Circuit Analysis
* Identify the electronic circuit symbols for conductors, connectors, batteries, capacitors, inductors, and various grounded and undergrounded tie points
* Identify the electronic circuit schematic symbols for solid-state devices and other miscellaneous devices
* Identify various types of electronic system documentation and how they are used
* Apply Kirchhoff's current and voltage laws to determine circuit values
* Determine unknown component values in circuits with more than one voltage source
* Calculate simple voltage divider output voltages and currents
* Determine the voltage divider components required to provide specific outputs
* Analyze voltage divider circuits for simple problems, such as component shorts and opens
* Describe the effects of fluctuations in load resistance on voltage divider outputs

# AC CIRCUITS / TRANSFORMERS

ELS2-Alternating Current

* Understand the differences between alternating and direct current
* Describe how alternating current is generated
* Learn the difference between single- and three-phase alternating current systems
* Understand inductance and capacitance
* Explain how transformers work ELS3-Conductors
* Explain the basic principles of conductivity and conductors
* Understand the principles of circuit protection, including fuses and circuit breakers
* Discuss the reasons for grounding electrical components and systems ACDC8-Inductance & Capacitance
* Define the terms, units, and symbols related to inductance and capacitance
* Explain inductance and capacitance
* Calculate total capacitance and solve time constant problems ACDC11-Capacitive Circuits
* Describe commonly used capacitors
* Calculate total capacitance for capacitors in series and parallel
* Describe the phase relationships between current and voltage in different types of capacitor circuits
* Calculate impedance in series and parallel RC circuits ACDC12-Inductive Circuits
* Explain how inductors operate and which features affect them
* Explain mutual inductance
* Describe the phase relationship between current and voltage
* Compute inductive reactance ACDC13-AC/DC Electronics: Transformers
* Describe the construction and operation of transformers
* Describe sources of loss in transformers
* Solve problems dealing with turns ratio, voltage ratio, current ratio, and impedance
* Describe how the autotransformer and isolation transformer work ACDC14-Tuned Circuits
* Calculate impedance, current, voltage, power factor, and phase angle in RLC circuits
* Calculate resonant frequency, capacitance value, or inductance value in RLC circuits
* Describe series and parallel resonant circuits
* Explain the relationship between bandwidth and Q
* Describe four basic types of filters.

# MOTOR DRIVES

MTD1-Motor Drive Identification

* Identify regenerative and nonregenerative DC drives
* Identify voltage source and current source inverters
* Understand and identify pulse width modulated inverters
* Identify vector control drives MTD2-Open and Closed Loop Systems
* Understand the concept of feedback
* Identify open and closed loop systems
* Identify direct and inverse feedback
* Identify tachometers and understand their use
* Identify encoders and understand their use MTD3-Variable Speed AC Drives
* Understand voltage rectification
* Identify controlled and uncontrolled rectifiers
* Identify silicon controlled rectifiers
* Identify and understand the operation of the DC bus
* Identify and understand the operation of the inverter section
* Describe the operation of pulse width modulated drives
* Describe the operation of vector control in AC drives MTD4-Servo & Stepper Motors
* Identify servo motors and their uses
* Understand stepper motor operation
* Identify and understand the types of stepper motors and stepper motor controls. MTD5-AC Motor Operation
* Understand how a rotating magnetic field is created
* Understand how voltage is induced in a rotor
* Understand and calculate slip
* Understand and calculate torque and horsepower
* Understand and calculate power factor MTD6-AC Drive Selection and Setup
* Determine drive requirements based on motor application
* Set up a drive for basic control requirements
* Determine run, protection, and stop parameters for common applications INS6-Operator Inspection: Motor Drive System Inspection
* Identify and describe the types and function of drive units
* Describe the inspection of three-phase AC induction motors
* Describe the inspection of step motors
* Describe the inspection of bearings, shafts, and couplings

# AC/DC EQUIPMENT & CONTROLS

ELS6-Generators and Motors

* Explain the basic differences between motors and generators
* Discuss how motors and generators function and are controlled
* Understand basic maintenance and troubleshooting techniques ELS7-AC Motor Control and Current Measurement
* Describe motor control devices and methods
* Describe different types of motor overload protection devices
* Troubleshoot common motor control problems
* Determine how to effectively use voltage and current measuring devices DCM1-DC Motors: Basics and Internal Parts of DC Motors
* Identify and locate the basic parts of a DC motor
* Describe the effects magnetic fields have on the armature of a motor
* Define the right-hand rule
* Describe the effects of force and motion on a motor
* Explain the physical differences between the various DC motors
* Select the proper DC motor for a specific task
* Describe the internal construction of a field coil
* Locate the poles in a DC motor field
* Explain the function of an interpole
* Describe the types of windings used in the armature coil
* Describe the interaction between coils and other parts of the DC motor
* Identify the types of armature construction
* Identify the elements of the commutator segment
* Describe how connections are made to other parts of the motor
* List the types of insulation material used in commutators
* Describe how brushes interact with the commutator DCM2-DC Motors: Wiring Diagrams and Troubleshooting
* Read and understand motor wiring diagrams
* Connect a motor properly and identify connection errors
* Select the proper terminal identifiers
* Locate the lubrication ports on a DC motor
* Designate the proper lubricant for the DC motor
* Identify a bad brush and how to replace it
* Detect problems within a DC motor using the correct inspection methods DCC1-DC Motor Controllers-Controller Function and Operation
* Explain basic controller functions
* Identify the three types of speed controllers and describe their operation
* Describe typical applications for DC motor speed control systems
* Define commonly used terms in DC motor control systems
* Describe how to control motor speed using a rheostat in the shunt field of a DC motor
* Explain how a rheostat in the armature of a DC motor can be used to control the motor's torque
* Explain how variable voltage controllers operate
* Describe how a chopper controller works
* Explain the operation of a single-phase motor controller
* Describe the operation of a three-phase motor controller
* Identify a Ward/Leonard motor controller and describe its operation DCC2-DC Motor Controllers-Maintenance and Troubleshooting
* Identify each type of maintenance and when it is applicable
* List typical inspection procedures to use for DC motor control systems
* Identify proper testing procedures for DC motor controllers
* Describe proper cleaning procedures for DC motor controllers
* Describe the correct troubleshooting technique for a specific problem
* Isolate a problem in a DC motor controller

INS5-Operator Inspection: Electrical Equipment Control System Inspection

* Understand electricity and control system basics
* Identify inspection procedures for equipment main switches, control panels, and external wiring
* Identify general inspection procedures for junction boxes, electrical motors, and detectors.

# MOTOR CONTROLS

MTR1-Basic Motor Controls & Relays

* Describe the three basic types of control systems
* Discuss the operation of magnetic relays
* Draw schematic symbols for normally open and closed contacts
* Draw the standard symbol for a coil
* Discuss the operation of solid state relays MTR2-Overload Protection Devices
* Discuss the difference between overloads and fuses
* List the major types of overload relays
* Differentiate between the major types of thermal overload relays
* Describe the operation of a dashpot timer
* List the ways of changing the time setting of a dashpot timer MTR3-Motor Controls: Time Delay Relays
* Describe the operation of an ON delay timer
* Describe the operation of an OFF delay timer
* Draw the standard NEMA schematic symbols for ON and OFF delay timers MTR4-Motor Controls: Schematic Symbols
* Recognize the symbols used in schematic diagrams
* Determine when a contact should be connected normally open or normally closed
* Draw schematic diagrams using the proper NEMA symbols MTR5-Motor Controls: Schematics and Wiring Diagrams
* Describe the differences between schematics and wiring diagrams
* Determine the logic of a control circuit by reading a schematic diagram
* Read a wiring diagram
* Convert a schematic diagram into a wiring diagram

MTR6-Motor Controls: Starting Methods for Squirrel Cage Motors

* Discuss across the line starting
* Explain resistor starting
* Describe reactor staring
* Discuss auto-transformer starting

MTR8-Motor Controls-Installing/Troubleshooting

* Explain the different methods of installing control systems
* Describe the steps required to install a control system using terminal strips and identifying wires with numbers
* Troubleshoot a control system from a properly installed control cabinet TRB3-Maintenance Troubleshooting: Motors and Motor Controls
* Identify motor and motor control problems
* Test motor windings
* Wire and troubleshoot two- and three-wire motor control circuits
* Troubleshoot variable speed frequency drive systems

# BASIC ELECTRONICS

BEC1-Types and Diagrams

* Become familiar with various types of electronic diagrams
* Become familiar with interconnection diagrams
* Read linear and nonlinear scale meters
* Calculate circuit values
* Understand analog and digital multimeters
* List sources of measurement error with VOMs
* Define the procedures for measuring voltage and current with an electronic VOM
* Define the procedures for measuring resistance with a VOM
* Explain the operation of bridge instruments BEC2-Controls and Application
* Identify the basic parts and controls of an oscilloscope and explain how they work
* Identify and use the vertical deflection, horizontal deflection, and triggering controls
* Check vertical and horizontal calibration
* List the steps necessary to align and measure sine wave voltages, frequencies, and DC offset voltages
* Identify Lissajous figures
* Determine an amplifier's response to a square wave input by identifying the output waveforms BEC3-Operation and Troubleshooting
* Operate RF generators, function and pulse generators, and counter-timers for appropriate signal- testing operations
* Identify the steps for troubleshooting a circuit using signal tracking and signal injection
* Test the functioning of capacitors and inductors
* Test a transformer and calculate transformer power losses
* Perform function and specification tests on diodes
* Use an ohmmeter to determine transistor types, identify transistor terminals, and test transistors
* Use an ohmmeter to test silicon-controlled rectifiers and triacs
* Describe the function of semiconductor testers ECI1-Basic Principles
* Define voltage, current, and resistance in operational terms
* Calculate voltage, current, and resistance drops in series and parallel circuits
* Identify the operation of capacitors in series and parallel circuits and calculate related circuit values
* Describe the action of magnetic fields in inductors and how to calculate the inductance of series and parallel circuits
* Calculate sine wave values
* Describe the relationship between current and voltage in resistive, capacitive, and inductive circuits ECI2-Characteristics and Operations
* Identify circuit configurations of half-wave and full-wave rectifiers and how to compute output voltages from rectifiers
* Describe the functions of power supply components and voltage multipliers and how to compute power supply ripple and regulation percent
* Describe how to bias transistors and calculate amplifier gains
* Identify the circuit configurations and characteristics of basic operational amplifiers
* Identify the sequence of events in a tank circuit
* Describe the operation and the resonant frequency of a Hartley oscillator
* Describe the operation and the resonant frequency of a lag-lead network used in RC oscillators
* Describe and determine the characteristics of a pulse waveform, including rise time, pulse width, period, pulse repetition rate, and duty cycle
* Identify clipper and clamper circuits
* Identify RC and RL differentiating and integrating circuits
* Describe the operation of multivibrator and Schmitt-trigger pulse-generation circuits ECI3-Logic Fundamentals, Types, and Applications
* Identify relay circuits arranged to perform AND, OR, and inversion functions
* Create truth tables for the inverter and for the AND and OR functions
* Count in the binary number system and add and subtract binary numbers
* Count in the hexadecimal number system and add and subtract hexadecimal numbers
* Count in the octal number system and add and subtract octal numbers
* Convert binary, hexadecimal, and octal numbers to decimal equivalents
* Identify logic symbols and truth tables for NAND and NOR gates
* Identify S-R and J-K flip-flop outputs resulting from different inputs
* Describe the uses and functions of shift registers, counters, half adders, and full adders
* Identify whether a flip-flop is triggered by a positive or a negative edge of the clock pulse
* Describe the operation of bilateral switches and divide-by-N counters
* Describe how the modulus of a counter can be changed to some other modulus

# PROGRAMMABLE LOGIC CONTROLLERS

PLC1-Fundamentals

* Understand how the components of the PLC interact with each other
* Discuss the different types of ladder logic
* Explain AND, OR, and NOT functions with PLC ladder logic and Boolean identities
* Explain the difference between decimal, BCD, binary, hexadecimal, and octal numbering systems
* Complete simple conversions PLC2-Programming
* Use programming codes for normally open and normally closed contacts
* Program AND, OR, and NOT logic functions with mnemonic codes or ladder logic Interpret addressing schemes
* Properly document a PLC program PLC3-Inputs and Outputs
* Discuss the different types of discrete and analog inputs/outputs
* Understand how to use the MOVE and COMPARE functions to handle analog derived inputs
* Understand multiplexing wiring schemes PLC4-Troubleshooting
* Understand how to use the troubleshooting devices and functions common to most PLCs
* Troubleshoot a PLC system for a problem PLC5-Communications and Advanced Programming
* Discuss PLC communications
* Program the Add, Subtract, Multiply, and Divide math functions
* Program the One Shot, R-S, D, and T Flip-Flops
* Use the Sub-routine commands JUMP, SKIP, and MCR
* Understand how to use the Sequencer function

RSX1-Configuring Hardware and Software

* Identify the hardware necessary for communicating with the PLC
* Create and configure drivers
* Access the software and select drivers
* Go online to the PLC and access essential help functions RSX2-Programming and Editing
* Open a new file, add rungs and instructions, edit and address, and add comments and symbols
* Verify, save, and download files
* Edit online and access program files RSX3-Testing/Troubleshooting Functions
* Apply forcing in RSLogix™
* Understand forcing conventions, inputs, and outputs
* Understand data monitors and searches, including histograms
* Discuss advanced tools such as configuring intelligent modules and trending

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