



**Regional Workforce
Development**

Electrical Maintenance Technician (online)

Program Objectives & 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.

BASIC 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

(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 and HEALTH

Personal Protective Equipment: Don't Start Work without It

At work, everybody 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

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.

- Safety guards
- Safety devices
- Lockout/tagout
- PPE

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

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

OSHA 10 HOUR 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.

BASIC ELECTRICITY / 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

ELECTRICAL MEASURING INSTRUMENTS (TPC)

- 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 starting
- 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

POWER SUPPLIES

ELS4-Wiring

- Identify the different types of cable trays and conduit systems
- Understand the uses and techniques of wiring splices and connections
- Explain basic soldering tools and techniques
- Identify the different types of wiring diagrams

ELS5-Installation, Distribution, Lighting

- Discuss how power is distributed throughout an industrial plant
- Understand how plant lighting systems are designed, installed, and maintained

TRB2-Maint Troubleshooting: Power Distribution & Lighting Systems

- Locate problems in power distribution and lighting systems involving power quality, overcurrent protective devices, transformers, equipment switches and disconnecting devices, and fluorescent and high intensity discharge lighting

CONTROL VALVES

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

ELECTRONIC COMPONENTS & CIRCUITS

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

EMS1 - Solid-State Devices

- Produced in conjunction with ISA — The Instrumentation, Systems, and Automation Society (ISA™)
— the course covers:
 - PN junction transistors
 - Bipolar junction transistors
 - Semiconductor devices
 - Amplifiers

EMS2 - Integrated Circuits and Op Amps

- Produced in conjunction with ISA — The Instrumentation, Systems, and Automation Society (ISA™)
— the course covers:
 - Integrated circuits and operational amplifiers
 - Negative feedback
 - Amplifying circuits
 - Op amp configurations

EMS3 - Sensor and Transducer Principles

- Produced in conjunction with ISA — The Instrumentation, Systems, and Automation Society (ISA™)
— the course covers:
 - Temperature, pressure, level flow, and weight sensors
 - Current-to-pneumatic (I/P) transducers
 - Electronic transducers
 - A/D and D/A converters
 - Fiber optics

EMS4 – Transmitters

- Produced in conjunction with ISA — The Instrumentation, Systems, and Automation Society (ISA™)
- the course covers:
 - Transmitter operation
 - Pressure transmitter troubleshooting
 - RTD transmitter operation and calibration
 - Vortex shedding flow meter operation
 - Capacitance level transmitters

EMS5 – Transducers

- Produced in conjunction with ISA — The Instrumentation, Systems, and Automation Society (ISA™)
- the course covers:
 - Transducer operation and maintenance
 - I/P transducer operation, maintenance, and calibration
 - Pneumatics and electronic troubleshooting and maintenance
 - Fiber optic circuit operation
 - Pressure transmitter calibration

EMS6 - Controllers, Indicators, and Recorders

- Produced in conjunction with ISA — The Instrumentation, Systems, and Automation Society (ISA™)
- the course covers:
 - Analog controller types and functions
 - Controller calibration and troubleshooting
 - Indicators and annunciators
 - Types and functions of recorders
 - Troubleshooting recorders

MEC1-Introduction to Control Schematics

- Understand how a schematic differs from a wiring diagram or component arrangement
- Understand the advantages of using a schematic for design and troubleshooting
- Recognize symbols commonly used in control system schematics

MEC2- Creating Schematics

- Use available information to draw a schematic
- Understand the difference between branching circuits and return legs
- Use the schematic to understand the workings of an unfamiliar system

MEC3-Electrical Lockout

- Recognize electrical lockout circuits in a schematic
- Understand how the lockout circuit protects a particular system
- Understand the difference between automatic reset and manual reset, and appropriate uses of each

MEC4-Design And Troubleshooting

- Determine specifications for a control system and use those specifications to design a schematic
- Identify various methods of meeting a set of specifications and using a schematic to troubleshoot a control system design

MEC5-Energy Management

- Understand the importance of energy management in an electrical control system
- Explain basic energy management principles
- Incorporate energy management functions in a control system design

MEC6-Electronic Controls

- Learn to use schematics to understand more intricate control systems
- Diagnose computer control problems using flow charts

MEC7-Responsive Systems

- Identify various "response" situations and controls needed in commercial and industrial buildings

- Determine the specific requirements of a building or area and how to use schematic designs to fulfill those requirements through control systems

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

MEASUREMENT / INSTRUMENTATION

PME1 - Thermometers and Thermocouples

- Temperature scales
- Factors affecting accuracy of measurement

- Types of thermometers
- Thermocouples

PME2 - Temperature 2: Resistance and Radiation Devices

- Resistance temperature detectors
- Thermistors
- Radiation pyrometers

PME3 - Pressure 1: Manometers and Gages

- Manometers
- Mechanical pressure transducers

PME4 - Pressure 2: Indicators and Transmitters

- Electrical/electronic pressure elements
- Installation considerations

PME5 - Level 1: Measurement and Gages

- Visual level sensors
- Variable displacement devices

PME6 - Level 2: Indicators and Transmitters

- Electrical level sensors
- Ultrasonic and sonic sensors

PME7 - Flow 1: Measurement Overview

- Fluid properties
- Measuring flow

PME8 - Flow2: Flow Sensors

- Mass flow meters
- Positive displacement flow meters
- Axial turbine flow meters
- Rotameters
- Vortex shredders

CTE1 - Primary Calibration Standards

- Manometers
- Hydraulic deadweight testers
- Pneumatic deadweight testers

CTE2 - Pneumatic Test Equipment

- Test gages
- Deadweight testers as calibration pressure sources
- Digital-display pneumatic instruments

CTE3 - Electronic Test Equipment

- Multimeters
- Multifunction calibrators, parts I and II
- Function generators and frequency counters

CTE4 – Oscilloscopes

- Introduction to functions and features
- Using the oscilloscope
- Advanced measurements and applications

CTE5 - Instrumentation Errors

- Characteristics of measuring instruments
- Analysis of instrumentation errors
- Installation and interpretive errors

CTE6 - Instrument Calibration

- Introduction to instrument calibration

- Calibration preparation and pneumatic instrument calibration
- Electronic instrument calibration

PROCESS CONTROL / INSTRUMENTATION

BPR1 - Feedback Control

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

BPR2 - Process Control Modes

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

BPR3 - Process Characteristics

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

BPR4 - Process Variables

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

BPR5 - Instrumentation Symbols

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

BPR6 - Instrumentation Loop Diagrams

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

BPR7 - Piping & Instrumentation Diagrams

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

BPR8 - Mechanical Connections

- Tubing materials and applications
- Calculating tubing gain

- Fittings and plastic tubing
- Cleaning, tubing, and fittings for silver soldering

BPR9 - Electrical Connections

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

Kent State University Regional Workforce Development

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