C-201 Electrical Systems 1

- **Standard 201.01 Apply electrical system safety**
  - Performance Indicators
    - Perform a lockout/tagout
    - Identify electrical hazards
  - Knowledge Indicators
    - Describe how to identify electrical hazards
    - Describe PPE/ safe dress for operating electrical systems
    - Describe how to determine if equipment is properly grounded
    - Describe the basic rules of electrical safety
    - Describe the basic elements of NFPA 70E Arc Flash and live cabinet safety rules
- **Standard 201.02 Connect and operate basic electrical circuits**
  - Performance Indicators
    - Use an AC tester to check a wall outlet power
    - Connect and operate a power supply
    - Connect and operate circuits that use knife, push button, and selector switches
    - Connect and operate circuits that use resistors, buzzers, and lamps.
    - Connect and operate basic series and parallel circuits
  - Knowledge Indicators
    - Define electricity and give an application
    - Describe the two types of electrical current: AC and DC
    - Describe the operation of a circuit tester
    - Describe the basic operation of common input and output devices
    - Define series and parallel circuits
    - Describe the operation of two types of power supplies: AC and DC
    - Describe the operation of N.O. and N.C. switch contacts
- **Standard 201.03 Interpret electrical schematics and diagrams**
  - Performance Indicators
    - Identify the schematic symbols for resistors, transistors, transformers, lamps, motors, solenoids, meters, fuses, and switches
    - Identify series and parallel circuits in a schematic
    - Interpret a basic electrical schematic
  - Knowledge Indicators
    - Describe resistor color codes
    - Describe the function of an electrical schematic
    - Explain the difference between a schematic and a wiring diagram
- **Standard 201.04 Use a digital multimeter (DMM) to make electrical measurements**
  - Performance Indicators
    - Use a DMM to measure voltage drops in series and parallel circuits
    - Use a DMM to measure current in series and parallel circuits
    - Use a DMM to measure the resistance of a component

- - Measure the resistance in series and parallel circuits
    - Use a DMM to test wire continuity
  - o Knowledge Indicators
    - Define voltage and give its units of measurement
    - Describe the basic operation of a digital multimeter
    - Describe the basic operation of a clamp-on ammeter
    - Describe the voltage characteristics of series and parallel circuits
    - Define current and give its units of measurement
    - Describe current characteristics of series and parallel circuits
    - Define resistance and give its units of measurement
    - Describe the resistance characteristics of series and parallel circuits
    - Describe two methods of measuring continuity
- **Standard 201.05 Analyze basic load circuits**
  - o Performance Indicators
    - Calculate voltage, current, and resistance in a series circuit
    - Calculate the total power used in a series circuit
    - Calculate the main line current in a parallel circuit
    - Calculate the total parallel resistance
    - Calculate the total power used in a parallel circuit
    - Knowledge Indicators
    - State Ohm's Law and explain its importance
    - State Kirchhoff's voltage and Current Laws and explain their importance
    - Define power and give its units of measurement
- **Standard 201.06 Test and replace/reset fuses and circuit breakers**
  - o Performance Indicators
    - Test and replace a fuse
    - Test and reset a circuit breaker
  - o Knowledge Indicators
    - Describe the function and application of two types of circuit protection
    - Describe the operation of a fuse
    - Describe the operation of two types of circuit breakers
    - Describe how fuses and circuit breakers are rated
- **Standard 201.07 Connect and operate basic reactive components**
  - o Performance Indicators
    - Connect and operate a circuit with an inductor
    - Connect and operate a circuit with a capacitor
    - Discharge a capacitor
    - Test a capacitor with a DMM
  - o Knowledge Indicators
    - Define electromagnetism and give an application
    - Describe the operation of an inductor and give its schematic symbol
    - Describe the effect of an inductor in an AC and DC circuit and give an application
    - Describe the operation of a capacitor and its schematic symbol
    - Describe the effect of a capacitor in an AC and DC circuit and give an application

- ▪ Describe the functions of 3 types of capacitors
- **Standard 201.08 Analyze basic combination circuits**
  - o Performance Indicators
    - ▪ Trace the current path in a combination circuit
    - ▪ Connect and operate a basic lighting circuit
    - ▪ Connect and operate a voltage divider network
    - ▪ Connect and operate a rheostat as a load dimmer
    - ▪ Design a voltage divider network given parameters
    - ▪ Solve a combination circuit
  - o Knowledge Indicators
    - ▪ Define a series-parallel circuit
    - ▪ Describe how to identify series and parallel circuit sections
    - ▪ Describe the operation of 3 types of voltage dividers
- **Standard 201.09 Troubleshoot basic series and parallel electrical circuits**
  - o Performance Indicators
    - ▪ Locate a short circuit in a basic series or parallel circuit
    - ▪ Locate an open circuit in a basic series or parallel circuit
  - o Knowledge Indicators
    - ▪ Explain the effects of short and open circuits
    - ▪ Describe how to troubleshoot short and open circuits
    - ▪ Describe the basic steps for troubleshooting an open circuit
- **Standard 201.10 Connect and operate single-phase transformer circuits**
  - o Performance Indicators
    - ▪ Connect and operate a transformer
    - ▪ Test a transformer
    - ▪ Size a transformer
    - ▪ Design a control transformer circuit to provide a given output voltage
  - o Knowledge Indicators
    - ▪ Describe the operation of a transformer
    - ▪ Describe the function of a control transformer
    - ▪ Describe the function/ application of a secondary tap on a transformer
- **Standard 201.11 Analyze Inductive Circuits**
  - o Performance Indicators
    - ▪ Calculate the total load on an AC inductive circuit
    - ▪ Calculate the total inductance in series and parallel circuits
    - ▪ Calculate the current load on a transformer
    - ▪ Calculate the secondary coil voltage of a transformer
  - o Knowledge Indicators
    - ▪ Describe how to calculate total series inductance and inductive reactance
    - ▪ Describe how to calculate total parallel inductance and inductive reactance
- **Standard 201.12 Analyze Capacitive Circuits**
  - o Performance Indicators
    - ▪ Calculate the total load on an AC capacitive circuit
    - ▪ Calculate the time to charge and discharge a capacitor

- Calculate the total capacitance in series and parallel circuits
  - Knowledge Indicators
    - Describe how to calculate total series capacitance and capacitive reactance
    - Describe how to calculate total parallel capacitance and capacitive reactance

C-202 Electric Motor Control Systems 1

- **Standard 202.01 Apply approved safety practices for electric motor control systems**
    - Performance Indicators:
        - Perform a lockout/tagout
        - Identify and correct electrical hazards
    - Knowledge Indicators:
        - Describe electrical and electric motor hazards
        - Describe PPE/ safe dress for operating or troubleshooting motor control systems
        - Describe the purpose of the lockout/tagout system used in industry
        - Describe how to determine if equipment is properly grounded
        - Describe the basic rules of electrical safety
- **Standard 202.02 Interpret Ladder logic Schematics**
    - Performance Indicators:
        - Identify the symbols for transformers, lamps, motors, solenoids, meters, fuses, coils, contacts, limit switches, float switches, pressure switches, magnetic motor starters, manual motor starters, and pushbutton switches, and selector switches
    - Knowledge Indicators:
        - Interpret ladder diagram of a control circuit
        - Draw a ladder diagram of a control circuit
        - Describe the function of an electrical ladder diagram
        - Describe six rules of drawing a ladder diagram
        - Describe the function of electrical control systems
        - Describe the operation of a separate control and power circuits
        - Describe the operation of AND, OR, NOT,NOR, and NAND circuits
- **Standard 202.03 Make proper electrical ground connections**
    - Performance Indicators:
        - Use a multimeter to measure the voltage at a point referenced to ground
        - Install a grounding circuit for an electrical control system
        - Inspect and verify an installed grounding circuit
        - Identify and interpret NEC code for an electrical system
    - Knowledge Indicators:
        - Define a ground
        - Describe the parts of an electrical control system grounding circuit
        - Explain the importance of the equipment ground connection
        - Describe the operation of grounded and ungrounded systems
        - Explain the function of a neutral line
        - Describe the National Electrical Code (NEC) grounding requirements for electrical systems
- **Standard 202.04 Connect and operate a 3-phase motor**
    - Performance Indicators:

- - Connect and operate a dual-voltage three-phase motor for low voltage operation
  - Connect and operate a dual-voltage three-phase motor for high voltage operation
  - Knowledge Indicators:
    - Interpret a motor nameplate
    - Describe the functions of common standards associated with electrical control
    - Describe the basic operation of three-phase power
    - Describe the three-phase voltage systems: Wye and Delta
    - Explain why time-delay fuses are used with motor starting circuits
    - Describe the operation of overcurrent protection devices
    - Define service factor and explain its importance
    - Explain why dual-voltage motors should be run on the highest available voltage
    - Select heaters for a NEMA overload
- **Standard 202.05 Connect and operate a manual motor control circuit**
  - Performance Indicators:
    - Connect and operate a motor control circuit with a manual motor starter
    - Test the operation of a manual motor starter using a multimeter
    - Test the low-voltage protection of a manual starter
    - Adjust and test the trip level of a bimetallic overload
    - Connect and operate a drum switch to reverse a motor
  - Knowledge Indicators:
    - Describe functions of motor control
    - Describe the basic requirements for motor installation
    - Describe types of motor starters
    - Describe the operation and importance of low-voltage protection
    - Describe the function and operation of magnetic and thermal overloads
- **Standard 202.06 Select and install a control transformer**
  - Performance Indicators:
    - Calculate the turns ratio of a transformer
    - Calculate the secondary voltage of a transformer
    - Connect and operate a control transformer
    - Test a control transformer
    - Size a control transformer
  - Knowledge Indicators:
    - Describe the operation of a control transformer and give its schematic symbol
- **Standard 202.07 Connect and operate a basic ladder logic control circuit**
  - Performance Indicators:
    - Connect and operate a basic electrical control circuit with pushbutton switch
    - Connect and operate a basic electrical control circuit with selector switch
    - Connect and operate a control circuit given a ladder diagram
    - Connect and operate a control relay in a memory logic circuit

- ▪ Connect and operate a forward/reverse jog control circuit
  - o Knowledge Indicators:
    - ▪ Describe the three steps of a control process
    - ▪ Describe the functions of the components of a ladder diagram
- **Standard 202.08 Connect and operate a 2/3 wire magnetic motor starter circuit**
  - o Performance Indicators:
    - ▪ Connect and operate a two-wire motor control circuit
    - ▪ Connect and operate a three-wire motor control circuit
    - ▪ Design a multiple operator station three-wire control circuit
  - o Knowledge Indicators:
    - ▪ Describe the operation of a control relay and give an application
    - ▪ Describe the operation/construction of 2 types of control relays
    - ▪ Describe the operation of a magnetic motor starter
- **Standard 202.09 Connect and operate a reversing motor control circuit**
  - o Performance Indicators:
    - ▪ Connect and operate a reversing magnetic motor starter to reverse a motor
    - ▪ Connect and operate a reversing motor circuit with mechanical and auxiliary contact interlocking
  - o Knowledge Indicators:
    - ▪ Describe two methods used to reverse a three-phase motor
    - ▪ Describe the function of interlocking control
    - ▪ Describe three interlocking methods used in reversing motor control
    - ▪ Describe the function of manual and automatic modes
    - ▪ Describe the operation of two types of motor jogging circuits
    - ▪ Describe the operation of a hand-off-automatic motor control circuit
    - ▪ State the NEMA and IEC standards for reversing the rotation of a three-phase motor
- **Standard 202.10 Connect and operate a hands-off-auto motor control circuit**
  - o Performance Indicators:
    - ▪ Connect and operate a hand-off-automatic motor control circuit
    - ▪ Design a hands-off-automatic motor control circuit
    - ▪ Design a pump control circuit that includes hand-off operation
  - o Knowledge Indicators:
    - ▪ Describe the function of a hand-off-automatic motor control circuit
    - ▪ Describe the function of a hand-off automatic circuit
- **Standard 202.11 Connect and operate automatic input devices**
  - o Performance Indicators:
    - ▪ Connect and operate a limit switch, pressure switch and a float switch
    - ▪ Connect and operate a pump control circuit
    - ▪ Connect and operate a motor control sequence control circuit
    - ▪ Design a sequence control circuit
  - o Knowledge Indicators:
    - ▪ Describe the function of a motor control sequence control circuit
    - ▪ Describe the operation of a limit switch, pressure switch, and float switch
- **Standard 202.12 Connect and operate basic timer control circuits**

- o Performance Indicators:
  - Connect and operate an On-Delay timer circuit
  - Design a control circuit to perform an unloaded start of a motor
  - Connect and operate an Off-Delay timer circuit
  - Design a motor control circuit to perform time-driven sequencing
- o Knowledge Indicators:
  - Describe the function and application of a time-delay relay
  - Describe the function of 2 types of timer relays: on-delay and off-delay
  - Describe the operation of an On-Delay timer relay and give its schematic symbol
  - Describe the operation of an unloaded motor start circuit
  - Describe the operation of an Off-Delay timer relay and give its schematic symbol
  - Describe the operation of a time-delay relay in a time-driven sequencing

C-203 Variable Frequency Drive Systems 1

- **Standard 203.01 Use a keypad to operate an AC variable frequency drive (VFD)**
  - Performance Indicators:
    - Verify that keypad input is enabled
    - Use a keypad to manually operate an AC variable frequency drive, including changing speed, direction
    - Perform a manual startup, drive enable, and normal shutdown of an AC VFD
  - Knowledge Indicators:
    - Describe the function of an AC VFD and give an application
    - Describe types of Variable Speed AC Drives
    - Describe the basic operation of an AC VFD
    - Describe the main parts of an AC VFD
    - Describe the keypad menus of an AC VFD
- **Standard 203.02 View and edit basic VFD parameters**
  - Performance Indicators:
    - Set VFD to factory default settings
    - View and edit basic VFD parameters
  - Knowledge Indicators:
    - Define a VFD parameter
    - Describe types of VFD parameters
    - Describe how to interpret a VFD parameter code
- **Standard 203.03 Interpret a PLC program that controls 2/3-wire VFD operation**
  - Performance Indicators:
    - Interpret a PLC program that controls 2-wire VFD operation
    - Interpret a PLC program that controls 3-wire VFD operation
    - Interpret a VFD wiring schematic
  - Knowledge Indicators:
    - Describe the operation 2 and 3-wire AC VFD
    - Describe the wiring connections to an AC VFD
    - Describe the I/O wiring connections to 2/3-wire operation AC VFD
- **Standard 203.04 Operate and monitor a VFD**
  - Performance Indicators:
    - Enter and operate a PLC program that controls 2/3-wire VFD
    - Configure VFD parameters for 2 or 3-wire operation
    - Perform a normal startup and shutdown of a VFD/PLC system
    - Pause a VFD
    - Perform an emergency shutdown of a VFD
  - Knowledge Indicators:
    - Describe the parameters required for 2 or 3-wire VFD operation
    - Describe how VFD systems are paused
    - Describe the operation of an e-stop VFD circuit
- **Standard 203.05 Reset a VFD after an error occurs**

- o Performance Indicators:
  - Interpret a VFD error code
  - Reset and restart a VFD after an error has occurred
- o Knowledge Indicators:
  - Describe types of VFD error codes
- **Standard 203.06 Program and operate a VFD for multi-speed operation**
  - o Performance Indicators
    - Program and Operate an AC VFD using programmable preset speeds
    - Program and operate an AC VFD to provide low speed boost
    - Calculate Volts per Hertz Ratio to determine motor speed
    - Program a variable speed AC drive to skip frequencies
  - o Knowledge Indicators
    - Describe how frequency affects the speed on an AC induction motor
    - Describe the output characteristics of a variable frequency drive
    - Describe the effect of reflected wave voltage on AC motor operation
    - Describe how to reduce the effects of reflected wave voltage
- **Standard 203.07 Program and operate a VFD for acceleration, deceleration, and braking**
  - o Performance Indicators
    - Program and Operate an AC VFD to accelerate a motor to its rated speed
    - Program and Operate an AC VFD to decelerate a motor to a stop
    - Program and Operate an AC VFD to provide S-Curve acceleration
    - Program and Operate an AC VFD to provide DC Injection braking to a motor
  - o Knowledge Indicators
    - Describe the operation of AC VFD ramping and how it is used
    - Describe how an AC VFD can accelerate a motor past its rated speed
    - Describe S-Curve acceleration and explain how it is used

C-204 Motor Control Troubleshooting 1

- **Standard 204.01 Troubleshoot motor control components**
  - Performance Indicators
    - Test motor control circuit components: indicator lamps, manual switches, control relays, motor contactors, and overload relays
    - Test the windings of a 3-phase motor with a digital multimeter
    - Test the windings of a control transformer with a digital multimeter
  - Knowledge Indicators
    - Describe the electric motor faults
    - Describe 3-phase motor starter faults
    - Describe manual switch faults
    - Describe control transformer faults
    - Describe types of in-circuit component tests
- **Standard 204.02 Use a clamp-on ammeter to measure motor current**
  - Performance Indicators
    - Use a clamp-on ammeter to measure AC current draw in a 3-phase circuit
  - Knowledge Indicators
    - Describe the operation of a clamp-on ammeter
- **Standard 204.03 Troubleshoot 2/3-wire motor control circuits**
  - Performance Indicators
    - Troubleshoot a 2-wire motor control system
    - Troubleshoot a 3-wire motor control system
  - Knowledge Indicators
    - Describe a 6-step troubleshooting sequence
    - Describe methods of systems level troubleshooting and give advantages of each
    - Describe methods used to analyze circuit signals
    - Describe how to insulate a bad component using the output-back and half-split troubleshooting methods
    - Describe faults, symptoms, and causes of 2 and 3-wire motor control circuits
- **Standard 204.04 Troubleshoot reversing motor control circuits**
  - Performance Indicators
    - Troubleshoot a reversing motor control circuit
    - Troubleshoot a motor control circuit that has manual and automatic modes
  - Knowledge Indicators
    - Describe faults, symptoms, and causes of reversing motor control circuits
- **Standard 204.05 Troubleshoot motor control circuits with automatic input devices**
  - Performance Indicators
    - Test an automatic input switch
    - Troubleshoot a motor control circuit with automatic input devices
    - Troubleshoot a motor control sequence control circuit
  - Knowledge Indicators

- Describe how to test an automatic input device with a multimeter
- Describe automatic input switch faults
- Describe how to troubleshoot a sequence circuit
- **Standard 204.06 Troubleshoot timer control circuits**
  - Performance Indicators
    - Test a timer relay
    - Troubleshoot an On-Delay timer circuit
    - Troubleshoot an Off-Delay timer circuit
  - Knowledge Indicators
    - Describe the methods used to test a timer relay
- **Standard 204.07 Troubleshoot an AC VFD motor control system**
  - Performance Indicators:
    - Troubleshoot an AC VFD motor control system
    - Use status and diagnostic indicators to troubleshoot a VFD system
  - Knowledge Indicators:
    - Describe types of VFD processor faults
    - Describe a VFD systems troubleshooting process

C-207 Programmable Controller Systems 1

- **Standard 207.01 Start up and shut down a PLC system**
  - Performance Indicators:
    - Power up and perform a normal shutdown of a PLC system
    - Identify the parts of a PLC
  - Knowledge Indicators:
    - Describe the basic operation of a programmable controller (PLC)
    - Describe the component functions of a PLC
    - Describe the operation of the PLC power supply circuit
- **Standard 207.02 Configure an Ethernet/IP Driver**
  - Performance Indicators:
    - Configure an Ethernet/IP Driver to permit PLC to PC communications
  - Knowledge Indicators:
    - Describe the function of Ethernet/IP driver software
- **Standard 207.03 Transfer programs between a PLC / PC via point-to-point Ethernet**
  - Performance Indicators:
    - Connect and configure a point-to-point PLC Ethernet network
    - Download a PLC project from a PC via point-to-point Ethernet
    - Upload a PLC project to a PC via point-to-point Ethernet
  - Knowledge Indicators:
    - Describe the basic operation of a point-to-point Ethernet network
    - Describe the Ethernet IP address system for point-to-point
    - Describe the basic operation of PLC programming software
- **Standard 207.04 Transfer programs between a PLC / PC via USB serial**
  - Performance Indicators:
    - Connect and configure a point-to-point PLC serial network
    - Download a PLC project from a PC via point-to-point USB serial
    - Upload a PLC project to a PC via point-to-point USB serial
  - Knowledge Indicators:
    - Describe the basic operation of USB serial communications
    - Describe the USB configuration using PLC programming software
- **Standard 207.05 Operate and monitor a PLC**
  - Performance Indicators:
    - Change PLC operation mode to Run or Program
    - Monitor PLC status using I/O indicators and software
  - Knowledge Indicators:
    - Describe the functions of PLC operation modes
- **Standard 207.06 Connect, configure, and operate an HMI panel with Ethernet**
  - Performance Indicators:
    - Connect and configure HMI panel with Ethernet network
    - Download a project to an HMI panel via an Ethernet network
    - Operate a basic HMI panel project with Ethernet network

- o Knowledge Indicators:
  - ▪ Describe the operation of a Human Machine Interface (HMI) panel
  - ▪ Describe basic functions of an HMI panel project
- **Standard 207.07 Configure PLC discrete I/O**
  - o Performance Indicators:
    - ▪ Configure PLC discrete I/O
    - ▪ Identify a discrete I/O terminal given a tag
  - o Knowledge Indicators:
    - ▪ Describe the memory organization of a typical PLC
    - ▪ Describe types of discrete PLC I/O modules
    - ▪ Describe how discrete I/O devices are interfaced to a PLC
    - ▪ Describe the format of PLC instruction and I/O addresses
    - ▪ Interpret a tag
- **Standard 207.08 Program and operate a basic PLC logic program**
  - o Performance Indicators:
    - ▪ Interpret a basic PLC ladder logic program
    - ▪ Interpret a basic PLC I/O diagram
    - ▪ Interpret a basic PLC power diagram
    - ▪ Design and test a basic PLC ladder program
  - o Knowledge Indicators:
    - ▪ Describe operation of a basic PLC logic instructions: normally-open, normally-closed, output coil, internal coils, timers, and up/down counters
    - ▪ Describe the symbolic, absolute discrete I/O address system
- **Standard 207.09 Create a PLC project**
  - o Performance Indicators:
    - ▪ Create a PLC project
    - ▪ Enter and operate a PLC logic program
    - ▪ Edit a PLC project
  - o Knowledge Indicators:
    - ▪ Describe the elements of a PLC project
- **Standard 207.10 Program and operate a PLC logic program that uses comparison instructions**
  - o Performance Indicators:
    - ▪ Interpret a PLC logic program that uses comparison instructions
    - ▪ Enter and operate a PLC logic program that uses comparison instructions
    - ▪ Interpret the operation a PLC logic program that uses comparison instructions
  - o Knowledge Indicators:
    - ▪ Describe the operation of PLC comparison instructions
- **Standard 207.11 Program and operate a PLC project that uses math instructions**
  - o Performance Indicators:
    - ▪ Interpret a PLC logic program that uses basic math instructions: Add, Subtract, Divide, and Multiply
    - ▪ Enter and operate a PLC program that uses basic math instructions
    - ▪ Interpret a PLC logic program that uses a Compute instruction
    - ▪ Enter and operate a PLC program that uses a Compute instruction

- Design and test a PLC program that uses math instructions
  - o Knowledge Indicators:
    - Describe operation and applications of basic PLC math instructions
    - Describe operation and applications of PLC Compute instruction
- **Standard 207.12 Program and operate a PLC motor control sequence program**
  - o Performance Indicators:
    - Interpret the operation of PLC motor control sequence program
    - Design and test operation of a PLC motor control sequence program
  - o Knowledge Indicators:
    - Describe the operation of a seal-in logic program
    - Describe the operation of a PLC-controlled motor control circuit
    - Describe the operation of a reversing motor control
- **Standard 207.13 Program and operate a basic PLC sequence program**
  - o Performance Indicators:
    - Interpret the operation of an event-driven 2-step PLC sequence program
    - Interpret the operation of a time-driven 2-step PLC sequence program
    - Design and test a basic event-driven PLC sequence program
    - Design and test a time-driven PLC sequence program
  - o Knowledge Indicators:
    - Describe the operation of an event-driven PLC sequence program
    - Describe the operation of a time-driven PLC sequence program

C-208 Programmable Controller Troubleshooting 1

- **Standard 208.01 Use status and diagnostic indicators to troubleshoot a PLC**
  - Performance Indicators:
    - Use status and diagnostic indicators to troubleshoot a PLC
  - Knowledge Indicators:
    - Describe two levels of troubleshooting and give an application of each
    - Describe types of PLC faults
- **Standard 208.02 Troubleshoot PLC inputs and outputs**
  - Performance Indicators:
    - Force on a PLC output
    - Troubleshoot PLC inputs and outputs
  - Knowledge Indicators:
    - Describe the function/applications of forcing outputs
    - Describe types of input/output module and field device faults
    - Describe methods of troubleshooting inputs and outputs
- **Standard 208.03 Troubleshoot PLC power distribution system**
  - Performance Indicators:
    - Troubleshoot power distribution faults
  - Knowledge Indicators:
    - Describe the operation of a PLC power distribution system
    - Describe types of power distribution faults
    - Describe methods of troubleshooting power distribution faults
- **Standard 208.04 Troubleshoot a PLC processor**
  - Performance Indicators:
    - Troubleshoot a PLC processor
  - Knowledge Indicators:
    - Describe types of processor faults
    - Describe methods of troubleshooting processor faults
- **Standard 208.05 Troubleshoot a PLC system with discrete I/O**
  - Performance Indicators:
    - Troubleshoot a PLC system with discrete I/O
  - Knowledge Indicators:
    - Describe methods of systems troubleshooting
    - Describe a 6-step PLC systems troubleshooting process
- **Standard 208.06 Program and operate a multi-step PLC sequence program**
  - Performance Indicators:
    - Interpret the operation of a multi-step event-driven PLC sequence program
    - Interpret the operation of a multi-step time-driven PLC sequence program
    - Design and test a PLC multi-step PLC sequence program
  - Knowledge Indicators:
    - Describe the operation of a multi-step event-driven and time-driven PLC sequence programs

- Describes types of PLC documentation: truth table, sequence of operation
- Describe how to interpret a multi-step PLC sequence program
- **Standard 208.07 Troubleshoot a multi-step PLC sequence program**
  - Performance Indicators:
    - Troubleshoot a multi-step PLC sequence program with event-driven and time-driven steps
  - Knowledge Indicators:
    - Describe how to troubleshoot a PLC sequence programs