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MOD 69 - INTRODUCTION TO RESIDENTIAL WIRING

- 7041-112-130 Electrical Supply Systems and Installations
  - Describe the three parts of an electrical supply system.
  - Describe typical voltages in an electrical supply system.
  - Describe how electrical wiring information is conveyed to the electrician using symbols and how specifications are used.
  - Describe the agencies that are responsible for establishing electrical codes and standards.

- 7041-112-160 Electrical Symbols and Conductors
  - Describe outlets and recognize their symbols.
  - Describe switches and recognize their symbols.
  - Describe conductors and recognize their symbols.
  - Recognize miscellaneous symbols.
  - Describe conductors and their sizes and types.
  - Describe the types of conductor insulation.
  - Describe conductor color code.

- 7041-112-190 Electrical Wiring Systems and Boxes
  - Describe how power is brought into a house and how the protection devices are used.
  - Describe two and three conductor wiring methods.
  - Describe sheathing and conduits and how they are used.
  - Describe electrical boxes and how they are used.
  - Describe how boxes are installed.
  - Describe how boxes are wired for outlets, switches, and connections.

- 7041-112-220 Electrical Switches, Interrupters, and Suppressors
  - Describe standard 1-pole switch wiring.
  - Describe three-way switch wiring.
  - Describe four-way switch wiring.
  - Describe 2-pole switch wiring.
  - Describe Ground Fault Circuit Interrupters (GFCI).
  - Describe Immersion Detection Circuit Interrupters (IDCI).
  - Describe Transient Voltage Surge Suppressors (TVSS).
  - Describe Isolated Ground Receptacles (IG).

- 7041-112-250 Recessed Lighting and Ballast
  - Describe the voltages used for residential lighting and the factors to consider before installation.
  - Describe recessed lighting installation.
  - Describe ballasts.
  - Describe ballast installation.

- 7041-112-280 Branch Circuits and Conductor Sizing
  - Describe how the number of branch circuits is determined.
  - Describe how the number of outlets per branch circuit is determined.
  - Use NEC Table 310-16 to determine allowable amperage of conductors.
  - Describe the de-rating factors and restrictions on amperage for NEC Table 310-16.

- 7041-112-920 Introduction to Residential Wiring Post-Test (Theory)

MOD 70 - ROOM BRANCH CIRCUITS

- 7041-114-130 Bedroom and Master Bedroom Circuits
  - Describe the methods used to group outlets.
MOD 70 - ROOM BRANCH CIRCUITS (cont.)

7041-114-130 Bedroom and Master Bedroom Circuits (cont.)
• Describe the general wiring methods for bedrooms and how receptacles are placed.
• Describe how lighting fixtures are used in closets to meet NEC requirements.
• Describe the general wiring methods for master bedrooms.
• Describe the use of two circuit receptacles.
• Describe NEC requirements for paddle fans.

7041-114-160 Bathroom, Hallway, Front Porch, and Entry Circuits
• Define a bathroom according to the NEC.
• Describe the wiring of receptacles in bathrooms.
• Describe the lighting requirements in bathrooms.
• Describe equipment grounding requirements in bathrooms.
• Describe hallway circuits including three-way switches.
• Describe front porch and entry.

7041-114-190 Kitchen, Dining, and Living Room Circuits
• Describe receptacle requirements for small appliance circuits in kitchens, dining rooms, breakfast rooms, and pantries.
• Describe split circuit applications used in kitchens.
• Describe lighting requirements in dining rooms.
• Describe equipment grounding requirements in dining rooms.
• Describe receptacle requirements in living rooms.
• Describe lighting requirements in living rooms.
• Describe the use of track lighting and dimmer controls used in living rooms.

7041-114-220 Laundry, Study, Rear Entry, and Attic Circuits
• Describe receptacle and lighting requirements for laundry rooms.
• Describe electric dryer connection methods to include circuit sizing.
• Describe electric dryer frame grounding requirements.
• Describe receptacle and lighting requirements for study rooms to include valance lighting and the use of surge protectors.
• Describe receptacle and lighting requirements for rear entries.
• Describe receptacle and lighting requirements for attics (including crawl spaces, rooftops, and equipment rooms).

7041-114-250 Family Room and Garage Circuits
• Describe receptacle and lighting requirements for family rooms.
• Describe the use and precautions for multi-wire circuits.
• Describe receptacle and lighting requirements for garage circuits.
• Describe the use and NEC regulations for outdoor outlets and wiring.

7041-114-280 Workshop and Basement Circuits
• Describe receptacle and lighting requirements for workshops.
• Describe the use of multi-outlet assemblies.
• Describe receptacle and lighting requirements for basements.

7041-114-920 Room Branch Circuits Post-Test (Theory)

MOD 71 - SPECIAL PURPOSE BRANCH CIRCUITS

7041-116-130 Water Pump and Water Heater Circuits
• Describe the operation of jet pumps and submersible pumps.
• Describe wiring for jet pumps and submersible pumps.
MOD 71 - SPECIAL PURPOSE BRANCH CIRCUITS (cont.)

7041-116-130 Water Pump and Water Heater Circuits (cont.)
- Describe conductor and overcurrent device sizing for jet pumps and submersible pumps.
- Describe the operation of water heaters.
- Describe wiring for water heaters.
- Describe conductor and overcurrent device sizing for water heaters.

7041-116-160 Large Kitchen Appliance Circuits
- Describe the operation of ovens and stoves.
- Describe the wiring of ovens and stoves.
- Describe conductor and overcurrent device sizing for ovens and stoves.
- Describe the operation of food waste disposers and dishwashers.
- Describe the wiring for food waste disposers and dishwashers.
- Describe conductor and overcurrent device sizing for food waste disposers and dishwashers.

7041-116-190 Vent Fans and Hydromassage Tub Circuits
- Describe vent fan operation.
- Describe the wiring of vent fans.
- Describe conductor and overcurrent device sizing for vent fans.
- Describe hydromassage tub operation.
- Describe the wiring for hydromassage tubs.
- Describe conductor and overcurrent device sizing for hydromassage tubs.

7041-116-220 Electric Heating and Air Conditioning
- Describe the operation of electric heaters.
- Describe the wiring of electric heating systems.
- Describe the operation of air conditioner systems.
- Describe the wiring of air conditioner systems.

7041-116-250 Oil and Gas Heating & Heat and Smoke Detectors
- Describe the operation of oil and gas heaters.
- Describe the wiring of oil and gas heater systems.
- Describe the operation of heat/smoke detectors.
- Describe the wiring of heat/smoke detector systems.

7041-116-280 Television and Telephone Systems
- Identify the different types of television signal sources.
- Describe the wiring of television systems.
- Understand the needs of telephone wiring.
- Describe the wiring of telephone systems.

7041-116-310 Service Entrance Equipment and Calculations
- Understand the needs for service entrance equipment.
- Describe the wiring of service entrance equipment.
- Understand the purpose of service entrance calculations.
- Perform service entrance calculations.

7041-116-340 Swimming Pool and Spa Wiring
- Understand the dangers of wiring swimming pool equipment.
- Describe the wiring of swimming pool equipment.
- Understand the danger of wiring spa equipment.
- Describe the wiring of spa equipment.

7041-116-920 Special Purpose Branch Circuits Post-Test (Theory)
MOD 72 - INTRODUCTION TO BASIC SYSTEMS

7211-112-130 Systems Familiarization ............................... ST-101 Set
  • Describe component thinking.
  • Describe systems thinking.
  • Compare component thinking to systems thinking.
  • Define structure, interconnectivity, and behavior.
  • Define input, process, and output.
  • Use systems thinking approach on a trailer with electric brakes connected to an automotive vehicle.
  • Show how to reduce a system to the subprocesses and modules used to produce certain outputs within the output function.
    ◦ Set up a system.
    ◦ Follow setup instructions.
    ◦ Initialize, align, and operate a system.
    ◦ Perform a system E-Stop.
    ◦ Perform a system restart.
    ◦ Perform a system shutdown.

7211-112-160 Systems Safety ........................................... ST-101 Set
  • Define a hazard.
  • Identify a hazard as physical, chemical, ergonomic, radiation, psychological, or biological.
  • Perform a safety risk assessment.
  • Apply the hierarchy of risk controls.
  • Select the correct fire extinguisher to put out a class A, B, C, D, and combination fires.
  • Read emergency evacuation route diagrams.
  • Practice standard safety rules while working around and with electricity.
  • Correlate OSHA safety code colors used in manufacturing to situations and devices.
  • Read material safety data sheets (MSDS).
  • Implement the 5-point eye safety checklist.
  • Recognize the hazards of confined spaces.

7211-112-190 Multimeter Familiarization .............................. ST-101 Set
  • Define a digital multimeter’s purpose.
  • Identify quantities measured with a digital multimeter.
  • Identify the sections of a digital multimeter.
  • List the IEC Measurement Categories.
  • List safe measurement techniques.
    ◦ Set up a DMM to measure DC and AC voltages.
    ◦ Measure and read DC and AC voltages.
    ◦ Apply safe voltage measurement techniques.
    ◦ Set up a DMM to measure resistance.
    ◦ Measure and read resistance.
    ◦ Set up a DMM to measure continuity.
    ◦ Measure and read continuity.
    ◦ Apply safe resistance and continuity measurement techniques.

7211-112-220 Oscilloscope Familiarization ........................... ST-101 Set
  • Define the purpose of an oscilloscope.
  • Identify quantities measured with an oscilloscope.
  • Identify the sections of an oscilloscope.
  • Set up an oscilloscope.
MOD 72 - INTRODUCTION TO BASIC SYSTEMS (cont.)

7211-112-220 Oscilloscope Familiarization (cont.)
- Zero a trace.
- Perform probe compensation.
- Use an oscilloscope to measure waveforms for determining DC voltage, AC voltage (Vpk and Vpp), and period.
- Calculate frequency, Vrms, phase, and pulse width using an oscilloscope.
- Define and measure duty cycle.

7211-114-130 System Input and Output Functions ........................................ ST-101 Set
- Define the system input function.
- Define the system output function.
- Define system inputs.
- Define system outputs.
- Using HMI input controls, perform input functions on a motor system.
- Verify inputs using visual displays and a multimeter.
- Operate and observe the output functions on a motor system.
- Verify outputs using visual displays and a multimeter.

7211-114-160 Instrumentation ................................................................. ST-101 Set
- Define a sensor.
- Describe sensor applications.
- Identify sensor devices.
- Define an actuator.
- Describe actuator process conversion.
- Identify actuator devices.
- Describe what sensor(s) correspond to the function of an actuator.
- Trace sensor and actuator connections using a composite diagram.
- Verify normal operation of a position sensor using displays, monitors, and a multimeter.

7211-114-190 System Process Function ..................................................... ST-101 Set
- Identify the system process function and process control.
- Define feedback loop.
- Describe the types and uses of feedback.
- Define and compare vicious cycle and virtuous cycle.
- Describe the reaction of the process function to various system inputs.
- Use a block diagram to describe the sequence of actions that take place in a control loop.
- Define and compare open loop control and closed loop control.
- Describe the functions of hysteresis and deadband as they relate to process control.
- Identify logic (sequential) control and linear control.
- Define and compare PLCs and PACs.
- Operate and observe the process function of a motor system.
- Using HMI inputs, control the rotational characteristics of a motor system.
- Verify processes using system visual displays, an oscilloscope, and a multimeter.

7211-114-220 Systems Thinking Applications .............................................. ST-101 Set
- Use a vehicle cruise control system to explain how negative feedback controls a process to maintain proper speed of the vehicle.
- Use a 2-axis motor control system to explain how vertical motion can be combined with horizontal motion.
- Observe the operation of a motor system's process control to regulate the rotational power output of the system.
MOD 72 - INTRODUCTION TO BASIC SYSTEMS (cont.)
7211-114-220 Systems Thinking Applications (cont.)
   - Use HMI inputs to simulate motor loading.
   - Measure motor system signals with an oscilloscope.
   - Analyze the relationship of measured signals (digital pulses) and rpm of the motor system.
7211-116-160 System Maintenance and Diagnostics ................................. ST-101 Set
   - Recognize typical preventive, scheduled, and unscheduled maintenance routines.
   - Describe general inspection techniques for systems maintenance.
   - Recognize system unscheduled maintenance routines.
   - Describe when unscheduled maintenance is necessary.
   - Set up and initialize a system following a given procedure.
   - Perform a system operational check.
   - Show proper use of measurement devices.
   - Examine basic systems fault isolation procedures.
   - Demonstrate the ability to diagnose a defective subsystem using fault isolation procedures.
7211-116-190 System Malfunctions and Troubleshooting ......................... ST-101 Set
   - Examine the systems troubleshooting process.
   - Set up and initialize a system following a given procedure.
   - Validate system operation using sensors, displays, and monitoring devices.
   - Verify symptoms of subsystem malfunctions.
   - Use a digital multimeter and oscilloscope to take measurements.
   - Troubleshoot malfunctioning subsystems in a system.

MOD 73 - HOME ENERGY SYSTEMS
7231-112-130 Introduction to Renewable Energy Systems ........................... ES-101 Set
   - Express the need for renewable energy.
   - Explain the four interdependent elements of renewable energy systems.
   - Understand renewable energy sources.
   - Describe energy conversion technologies.
7231-112-160 Energy Sources and Site Surveys ................................. ES-101 Set
   - Describe renewable energy resources (wind, solar, hydroelectric, ocean wave, ocean tidal, ocean current, ocean thermal conversion, geothermal).
   - Illustrate energy resources (wind, solar).
   - Explain the use of a site survey.
   - Describe how to perform a site survey.
7231-114-130 Home Solar Energy System Fundamentals ............................. ES-101 Set
   - Explain home solar energy operation.
   - Describe solar resources and their uses for home energy.
   - Recognize safe home solar energy maintenance methods.
   - Recognize home solar energy common tools.
   - Read a home solar energy block diagram to identify the major subsystems.
   - Operate a home solar energy system using a block diagram.
   - Verify the operation of the home solar energy system using sensors, monitors and display devices.
   - Examine the operation of the home solar energy system.
7231-114-160 Home Wind Energy System Fundamentals ............................. ES-101 Set
   - Explain home wind energy operation.
MOD 73 - HOME ENERGY SYSTEMS (cont.)

7231-114-160 Home Wind Energy System Fundamentals (cont.)
- Describe the effects of wind speed and wind obstructions.
- Describe tilt-up tower operation.
- Recognize safe home wind energy maintenance methods.
- Recognize home wind energy common tools.
- Read a home wind energy block diagram to identify the major subsystems.
- Operate a home wind energy system using a block diagram.
- Verify the operation of the home wind energy system using sensors, monitors and display devices.
- Examine the operation of a home wind energy system.

7231-114-190 Home Hybrid Energy System Fundamentals ........................................ ES-101 Set
- Explain home backup power generation.
- Explain home inverter and grid-tied interface operation.
- Describe hybrid home energy system integration.
- Recognize safe home hybrid energy maintenance methods.
- Recognize home hybrid energy common tools.
- Read a home hybrid energy block diagram to identify the major subsystems.
- Operate a home hybrid energy system using a block diagram.
- Verify the operation of the home hybrid energy system using sensors, monitors, and display devices.
- Examine the operation of each home hybrid energy subsystem.

7231-114-220 Home Energy System Maintenance and Diagnostics .......................... ES-101 Set
- Recognize typical home energy preventive, scheduled, and unscheduled maintenance routines.
- Describe general inspection techniques for home energy systems.
- Recognize unscheduled maintenance routines.
- Describe when unscheduled maintenance is necessary.
- Set up and initialize a home energy system following a given procedure.
- Perform a home energy operational check.
- Show proper use of measurement devices.
- Examine home energy system fault isolation procedures.
- Demonstrate the ability to diagnose a defective subsystem in a home energy system using fault isolation procedures.

7231-114-250 Home Energy System Malfunctions and Troubleshooting ................. ES-101 Set
- Examine the troubleshooting process for home energy systems.
- Describe the basic tools used to troubleshoot home energy systems.
- Set up and initialize a home energy system following a given procedure.
- Validate system operation using sensors, displays, and monitoring devices.
- Verify symptoms of home energy subsystem malfunctions.
- Use a digital multimeter to take measurements.
- Troubleshoot malfunctioning subsystems in a home energy system.

7231-114-920 Home Energy Systems Post-Test (Theory) ........................................ ---

MOD 74 - COMMERCIAL WIND ENERGY SYSTEMS

7231-112-130 Introduction to Renewable Energy Systems ........................................ ---
- Express the need for renewable energy.
MOD 74 - COMMERCIAL WIND ENERGY SYSTEMS (cont.)

7231-112-130 Introduction to Renewable Energy Systems (cont.)
- Explain the four interdependent elements of renewable energy systems.
- Understand renewable energy sources.
- Describe energy conversion technologies.

7231-112-160 Energy Sources and Site Surveys
- Describe renewable energy resources (wind, solar, hydroelectric, ocean wave, ocean tidal, ocean current, ocean thermal conversion, geothermal).
- Illustrate energy resources (wind, solar).
- Explain the use of a site survey.
- Describe how to perform a site survey.

7231-116-130 Wind Turbine System Fundamentals
- Describe the types of wind turbines (HAWT and VAWT).
- Describe the differences between commercial and residential wind generation.
- Recognize safe wind turbine maintenance methods.
- Explain commercial wind power subsystem operation (generator, gearing, cooling, control, yaw, pitch, brake).
- Read a wind turbine block diagram to identify major subsystems.
- Set up and initialize a wind turbine system following a given procedure.
- Operate a wind turbine system using a block diagram.
- Verify the operation of a wind turbine system using sensors, monitors, and display devices.
- Examine the operation of each wind turbine subsystem.

7231-116-160 3-Phase Power Fundamentals
- Describe 3-phase power.
- Describe the operation of an AC generator.
- Describe the operation of inverters.
- Describe the difference between 50 Hz and 60 Hz power.
- Read a wind turbine block diagram.
- Operate a wind turbine system using a block diagram.
- Verify the presence of 3-phase power using an oscilloscope.

7231-116-190 Wind Turbine System Maintenance and Diagnostics
- Recognize wind turbine preventive/scheduled and unscheduled maintenance routines.
- Describe physical inspection techniques for a wind turbine system.
- Recognize unscheduled maintenance routines.
- Describe when unscheduled maintenance is necessary.
- Set up and initialize a wind turbine system following a given procedure.
- Perform a wind turbine system operational check.
- Show proper use of measurement devices.
- Examine wind turbine system fault isolation procedures.
- Demonstrate the ability to diagnose a defective subsystem in a wind turbine system using fault isolation procedures.

7231-116-220 Wind Turbine System Malfunctions and Troubleshooting
- Examine the troubleshooting process for wind turbine systems.
- Describe the basic tools used to troubleshoot commercial wind turbine systems.
- Initialize a wind turbine system.
- Validate a wind turbine system operation.
- Recognize symptoms of wind turbine subsystem malfunctions.
- Use a digital multimeter and oscilloscope to take measurements.
MOD 74 - COMMERCIAL WIND ENERGY SYSTEMS (cont.)
7231-116-220 Wind Turbine System Malfunctions and Troubleshooting (cont.)
  - Identify a malfunctioning subsystem in a wind turbine power system.
7231-116-920 Commercial Wind Energy Systems Post-Test (Theory) .......................... --

MOD 75 - COMMERCIAL SOLAR ENERGY SYSTEMS
7231-112-130 Introduction to Renewable Energy Systems ................................. --
  - Express the need for renewable energy.
  - Explain the four interdependent elements of renewable energy systems.
  - Understand renewable energy sources.
  - Describe energy conversion technologies.
7231-112-160 Energy Sources and Site Surveys ................................................. --
  - Describe renewable energy resources (wind, solar, hydroelectric, ocean wave, ocean tidal, ocean current, ocean thermal conversion, geothermal).
  - Illustrate energy resources (wind, solar).
  - Explain the use of a site survey.
  - Describe how to perform a site survey.
7231-118-130 Solar Thermal System Fundamentals ............................................. --
  - Express the need for solar thermal power as a renewable energy.
  - Differentiate non-concentrating and concentrating thermal collectors.
  - Explain the three main classes of solar thermal collectors.
  - Examine solar pool heating systems.
  - Examine solar water heating systems.
  - Examine solar space heating systems.
  - Examine parabolic trough systems.
  - Examine solar dish (Stirling engine) systems.
  - Examine solar power tower systems.
  - Express the need for solar photovoltaic power as a renewable energy.
  - Explain the photovoltaic (PV) effect and construction.
  - Describe solar resources.
  - Describe general solar photovoltaic personal protective equipment.
  - Explain proper installation procedures.
  - Recognize safe installation and maintenance methods.
  - Recognize solar PV system common tools.
  - Read a solar photovoltaic system block diagram to identify the major subsystems.
  - Set up and initialize a solar PV system following a given procedure.
  - Operate a solar photovoltaic system using a block diagram.
  - Verify the operation of a solar photovoltaic system using sensors, monitors, and display devices.
  - Examine the operation of each solar photovoltaic subsystem.
7231-118-190 Solar Photovoltaic System Maintenance and Diagnostics ............... ES-101 Set
  - Recognize solar photovoltaic preventive/scheduled and unscheduled maintenance routines.
  - Describe physical inspection techniques for solar photovoltaic systems.
  - Recognize unscheduled maintenance routines.
  - Describe when unscheduled maintenance is necessary.
  - Set up and initialize a solar PV system following a given procedure.
MOD 75 - COMMERCIAL SOLAR ENERGY SYSTEMS (cont.)

7231-118-190  Solar Photovoltaic System Maintenance and Diagnostics (cont.)
- Perform a solar photovoltaic system operational check.
- Show proper use of measurement devices.
- Examine solar photovoltaic system fault isolation procedures.
- Demonstrate the ability to diagnose a defective subsystem in a solar photovoltaic system using fault isolation procedures.

7231-118-220  Solar Photovoltaic System Malfunctions and Troubleshooting  
- Examine the troubleshooting process for solar photovoltaic systems.
- Describe the basic tools used to troubleshoot solar photovoltaic systems.
- Set up and initialize a solar PV system following a given procedure.
- Validate system operation using sensors, displays, and monitoring devices.
- Verify symptoms of solar photovoltaic subsystem malfunctions.
- Use a digital multimeter and oscilloscope to take measurements.
- Troubleshoot malfunctioning subsystems in a solar photovoltaic system.

7231-118-920  Commercial Solar Energy Systems Post-Test (Theory)  

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