

**ELECTRICITY 1, 2, 3, 4**  
**COURSE CODES: 6287, 6288, 6289, 6290**

**PROGRAM DESCRIPTION:** The Electricity program prepares students to be career-ready in residential and commercial electrical installation. Students in this program learn to install residential, commercial, and industrial wiring systems. Upon completion of this program, proficient students will be able to demonstrate knowledge and skills in electricity with emphasis on safety, tools, and equipment. Standards are aligned to the NCCER® or Residential Academy Electrical certification.

Provided a student takes Introduction to Construction and scores 70% on all assessments (00101-8-15), he or she does not have to repeat the NCCER® Core modules in Electricity.

**OBJECTIVE:** Given the necessary equipment, supplies, and facilities, the student will complete all of the following core standards successfully.

**CREDITS:** 1 (120 hours), 2 (240 hours) units per course code

**PREREQUISITE(S):** Algebra 1

**RECOMMENDED GRADE LEVEL:** 9 - 12

**COMPUTER ACCESS REQUIRED:** 1 Computer per student with Internet access

**RECOMMENDED MAXIMUM ENROLLMENT:** 16

**RESOURCES:** Instructional Materials

**PREREQUISITE:**

**NCCER® CORE MODULES**

**MODULE A. BUILD YOUR FUTURE IN CONSTRUCTION**

**Proficient construction professionals demonstrate basic safety. The following accountability criteria are considered essential for students in all the Construction programs of study.**

1. Define construction and summarize the current and future outlook for jobs.
2. Identify some of construction's more prominent contributions in history.
3. Recognize and describe how construction careers make a difference in the community.
4. Describe the financial and professional benefits of pursuing a construction career.
5. Describe industry sectors and the progression path for construction careers.
6. Identify different construction careers and the types of skills they require.
7. Explain the benefits of career and technical education programs.
8. Describe the advantages of craft training programs and their relationship with apprenticeships.
9. Summarize the path to a construction career through community colleges and universities.

10. No performance tasks.

## **MODULE B. SAFETY**

**Proficient construction professionals demonstrate basic safety knowledge. The following accountability criteria are considered essential for students in all the Construction programs of study.**

1. Identify the responsibilities and personal characteristics of a professional craftsperson.
2. Describe the safe work requirements for elevated work.
3. Identify and explain how to avoid struck-by and caught-in-between hazards.
4. Explain the appropriate safety precautions around common job-site hazards.
5. Demonstrate the use and care of appropriate personal protective equipment (PPE).
6. Identify and describe other specific job-site safety hazards.
7. Follow safe procedures for lifting heavy objects.
8. Describe safe behavior on and around ladders and scaffolds.
9. Explain the importance of the Hazard Communication Standard (HazCom) requirement and Safety Data Sheets (SDS)
10. Describe fire prevention and firefighting techniques.
11. Define safe work procedures around electrical hazards.
12. Complete 10-hour OSHA course/assessment and receive card. (Optional)
13. Complete Performance Tasks.

## **MODULE C. CONSTRUCTION MATH**

**Proficient construction professionals demonstrate basic math. The following accountability criteria are considered essential for students in all the Construction programs of study.**

1. Add, subtract, multiply, and divide whole numbers, with and without a calculator.
2. Use a standard ruler and a metric ruler to measure.
3. Add, subtract, multiply, and divide fractions.
4. Add, subtract, multiply, and divide decimals, with and without a calculator.
5. Convert decimals to percent and percent to decimals.
6. Convert fractions to decimals and decimals to fractions.
7. Explain what the metric system is and how it is important in the construction trade.
8. Recognize and use metric units of length, weight, volume, and temperature.
9. Recognize some of the basic shapes used in the construction industry and apply basic geometry to measure them.
10. No performance tasks.

## **MODULE D. INTRODUCTION TO HAND TOOLS**

**Proficient construction professionals demonstrate how to safely use various hand tools. The following accountability criteria are considered essential for students in all the Construction programs of study.**

1. Recognize and identify various types of basic hand tools used in the construction trade.
2. Identify and describe how to use various types of measurement and layout tools.
3. Identify and explain how to use various types of cutting and shaping tools.
4. Use these tools safely.
5. Describe the basic procedures for taking care of these tools.
6. Complete Performance Tasks

## **MODULE E. INTRODUCTION TO POWER TOOLS**

**Proficient construction professionals demonstrate how to safely use power tools. The following accountability criteria are considered essential for students in all the Construction programs of study.**

1. Identify and explain how to use various types of power drills and impact wrenches used in the construction trade.
2. Identify and explain how to use various types of power saws.
3. Identify and explain how to use various grinders and grinder attachments.
4. Identify and explain how to use miscellaneous power tools.
5. Use power tools safely.
6. Explain how to maintain power tools properly.
7. Complete Performance Tasks

## **MODULE F. INTRODUCTION TO CONSTRUCTION DRAWINGS/RECOMMEND BLUEPRINT READING**

**Proficient construction professionals demonstrate knowledge and the use of blueprints/construction drawings. The following accountability criteria are considered essential for students in all of the Construction programs of study.**

1. Identify and describe various types of construction drawings, including their fundamental components and features.
2. Recognize and identify basic blueprint terms, components, and symbols.
3. Relate information on blueprints to actual locations on the print.
4. Recognize different classifications of drawings.
5. Interpret and use drawing dimensions.
6. Complete Performance Tasks.

## **MODULE G. BASIC RIGGING (OPTIONAL)**

**Proficient construction professionals demonstrate how to use basic rigging. The following accountability criteria are considered essential for students in all of the Construction programs of study.**

1. Explain how ropes, chains, hoists, loaders, and cranes are used to move material and equipment from one location to another on a job site.
2. Describe inspection techniques and load-handling safety practices.
3. Explain the American National Standards Institute (ANSI) hand signals.
4. Complete Performance Tasks

## **MODULE H. BASIC COMMUNICATION SKILLS**

**Proficient construction professionals demonstrate appropriate communication. The following accountability criteria are considered essential for students in all of the Construction programs of study.**

1. Describe the communication, listening and speaking processes and their relationship to job performance.
2. Describe good reading and writing skills and their relationship to job performance
3. Demonstrate telephone and e-communication skills necessary in the workplace.
4. Complete Performance Tasks.

## **MODULE I. BASIC EMPLOYABILITY SKILLS**

**Proficient construction professionals demonstrate appropriate workplace. The following accountability criteria are considered essential for students in all of the Construction programs of study.**

1. Describe the opportunities in the construction business and how an individual enters the construction workforce.
2. Explain the importance of critical thinking and how to solve problems in the workplace.
3. Explain the importance of social skills and identify ways good social skills are applied in the construction trade.
4. Describe computer systems and their industry applications.
5. Explain interpersonal relationship skills, self-presentation, and key workplace issues such as sexual harassment, stress, and substance abuse.
6. No performance tasks.

## **MODULE J. MATERIALS HANDLING**

**Proficient construction professionals demonstrate appropriate skills handling materials. The following accountability criteria are considered essential for students in all of the Construction programs of study.**

1. Describe the hazards associated with handling materials and provides techniques to avoid both injury and property damage.
2. Complete Performance Tasks.

### **ELECTRICITY LEVEL 1**

#### **A. ORIENTATION TO ELECTRICAL TRADE**

**Proficient electrical professionals demonstrate knowledge of the industry and relevant professional development. The following accountability criteria are considered essential for students in the Electrical program of study.**

1. Identify various career paths and opportunities in the electrical trade.
2. Identify the skills, responsibilities, and characteristics needed to be a successful electrician.
3. Describe various types of training in the electrical field.
4. List department of labor (DOL) requirements for apprenticeship.
5. Describe the typical components in a residential, commercial, and industrial wiring system.
6. Identify employee and employer responsibilities.

#### **B. ELECTRICAL SAFETY**

**Proficient electricians demonstrate appropriate knowledge and skills in electrical safety. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Analyze the effects of electrical shock on the human body.
2. Verify that circuits are de-energized.
3. Use PPE to reduce the risk of injury.
4. Identify OSHA requirements for protective equipment.
5. Apply OSHA requirements in the workplace.
6. Select and use protective equipment.
7. Discuss the purpose of NFPA 70E®.
8. Identify the safety hazards associated with ladders, scaffolds, and lift equipment.
9. Avoid back injuries by practicing proper lifting techniques.
10. Demonstrate basic tool safety.
11. Identify confined-space entry procedures.
12. Work safely with dangerous materials.
13. Select and use appropriate fall protection.
14. Demonstrate performance tasks.

## **C. INTRODUCTION TO ELECTRICAL CIRCUITS**

**Proficient electricians demonstrate appropriate knowledge of electrical circuits. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify and describe hand tools commonly used by electrical workers.
2. Identify the components of an atom.
3. Compare the atomic structures of conductors and insulators.
4. Identify the role of magnetism in electrical devices.
5. Identify the basic components in a power distribution system.
6. Define terms related to electricity, e.g., current, voltage, resistance.
7. Use Ohm's law to solve for unknown circuit values.
8. Identify the symbol for a resistor and determine its value based on color codes.
9. Distinguish between series and parallel circuits.
10. Identify the instruments used to measure circuit values.
11. Calculate electrical power.
12. Demonstrate performance tasks.

## **D. ELECTRICAL THEORY**

**Proficient electricians understand electrical theory. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify resistances in series and parallel.
2. Simplify series-parallel circuits.
3. Apply Ohm's law to various types of circuits.
4. Apply Kirchhoff's laws to various types of circuits.
5. Use Kirchhoff's current law.
6. Use Kirchhoff's voltage law.

## **E. INTRODUCTION TO NATIONAL ELECTRICAL CODE® (NEC)**

**Proficient electricians understand the significance of the National Electrical Code®. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Trace the history of the NEC®.
2. Identify the roles of other organizations, e.g., UL, CSA.
3. Identify the chapters in the NEC®.
4. Use the NEC® to find specific installation requirements.
5. Demonstrate performance tasks.

## **F. DEVICE BOXES**

**Proficient electricians demonstrate knowledge and installation of device boxes. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify, size, and install boxes and their applications.
2. Size and install pull and junction boxes.
3. Demonstrate performance tasks.

## **G. HAND BENDING**

**Proficient electricians demonstrate knowledge and installation of device boxes. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Select and use hand bending equipment.
2. Use geometry to make a bend.
3. Make 90° bends.
4. Make offset bends.
5. Make back-to-back 90 degree bends.
6. Make 3-bend and 4-bend saddles.
7. Cut, ream, and thread conduit.
8. Cut conduit using a hacksaw and a pipe cutter.
9. Cut and join PVC conduit.
10. Demonstrate performance tasks.

## **H. RACEWAYS AND FITTINGS**

**Proficient electricians demonstrate appropriate knowledge and skills for installing raceways and fittings. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify types of conduit and their applications.
2. Properly bond conduit for use as a ground path.
3. Make conduit-to-box connections.
4. Identify raceway supports.
5. Identify installation requirements for various construction methods.
6. Select and install
  - a. tie wraps and screws
  - b. hammer-driven pins and studs
  - c. masonry and hollow-wall anchors
  - d. epoxy anchoring systems
7. Identify the safety requirements for stud-type guns.
8. Identify types of wireways and their components.
9. Install wireway supports.
10. Identify and install specialty raceways.

11. Identify cable tray types and fittings.
12. Install cable tray supports.
13. Demonstrate performance tasks.

## **I. CONDUCTORS AND CABLES**

**Proficient electricians demonstrate appropriate knowledge and skills for installing conductors and cables. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify wire sizes.
2. Determine conductor ampacities.
3. Identify conductor materials and insulation.
4. Identify fixture wiring.
5. Identify cable types and applications.
6. Identify instrumentation control wiring.
7. Install conductors using fish tape.
8. Install conductors using pulling equipment. (optional)
9. Demonstrate performance tasks.

## **J. BASIC ELECTRICAL CONSTRUCTION DRAWINGS**

**Proficient electricians demonstrate appropriate knowledge and skills for interpreting electrical drawings, equipment schedules, and specifications. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Read and interpret information found on a set of drawings (e.g., site plan, title box, electrical, mechanical).
2. Interpret drafting lines.
3. Use an architect's scale.
4. Use an engineer's scale.
5. Use a metric scale.
6. Interpret electrical symbols.
7. Create a materials estimate using a set of electrical drawings.
8. Identify fixtures in a lighting floor plan.
9. Read block and schematic diagrams.
10. Interpret written specifications.
11. Demonstrate performance tasks.



## **K. RESIDENTIAL ELECTRICAL SERVICES**

**Proficient electricians demonstrate appropriate knowledge and skills for installing residential electrical services. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Calculate the electric service load.
2. Apply demand factors.
3. Calculate appliance loads.
4. Size the load center.
5. Size grounding electrodes and the main bonding jumper for residential electrical systems.
6. Identify the service drop location and panelboard location of service-entrance equipment.
7. Identify wiring methods for various types of residences.
8. Select and install cable systems and raceways for various types of residences.
9. Complete the branch circuit layout for power and lighting.
10. Install outlet boxes.
11. Select and install receptacles and switches.
12. Install devices near residential swimming pools, spas, and hot tubs.
13. Demonstrate performance tasks

## **L. ELECTRICAL TEST EQUIPMENT**

**Proficient electricians demonstrate appropriate knowledge and skills for using electrical test equipment. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify the applications of a voltmeter, ohmmeter, ammeter, a multimeter, and other meters.
2. Select a meter with the correct category rating for an application.
3. Identify electrical test equipment safety hazards.
4. Demonstrate performance tasks.

## **ELECTRICITY LEVEL 2**

### **A. ALTERNATING CURRENT**

**Proficient electricians demonstrate appropriate knowledge and skills in working with AC currents as well as making power calculations as needed in their role. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Define the terminology of sine waves.
2. Define AC phase relationships.
3. Identify non sinusoidal waveforms.
4. Find unknown values in purely resistive AC circuits.

5. Find unknown values in inductive AC circuits.
6. Find unknown values in capacitive AC circuits.
7. Find unknown values in combination circuits.
8. Make power calculations in AC circuits.
9. Calculate true, apparent, and reactive power.
10. Use the power triangle to determine unknown values.
11. Identify the basic components in a transformer.
12. Identify transformer operating characteristics.
13. Calculate turns and voltage ratios.
14. Identify various types of transformers and their applications.

## **B. MOTORS: THEORY AND APPLICATION**

**Proficient electricians demonstrate appropriate knowledge and skills for installing and using AC and DC motors. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Describe how DC motors operate.
2. Identify types of DC motors.
3. Identify the NEC® requirements for motors.
4. Identify NEC® installation and motor protection requirements.
5. Describe how AC motors operate.
6. Identify three-phase, synchronous, and single-phase induction motors.
7. Identify the various types of AC and DC motors and how they operate.
8. Identify variable-speed drives and describe their operating characteristics.
9. Identify braking methods.
10. Identify motor enclosures, frame designations, and operating characteristics.
11. Identify motor operating characteristics using nameplate data.
12. Install the connections and terminal markings for AC motors.
13. Demonstrate the ability to install and wire motors.
14. Demonstrate performance tasks.

## **C. ELECTRIC LIGHTING**

**Proficient electricians demonstrate appropriate knowledge and skills for installing electric lighting. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Explain the relationship between human vision and light.
2. Identify how the human eye operates.
3. Identify the characteristics of light.
4. Identify and install lamps, ballasts, LED drivers, and different types of lighting fixtures.
5. Identify lighting fixtures and their applications.
6. Store and handle lamps and lighting fixtures.
7. Select occupancy/photosensors.
8. Use lighting timers.

9. Program energy management systems.
10. Demonstrate performance tasks.

#### **D. CONDUIT BENDING**

**Proficient electricians demonstrate appropriate knowledge and skills for calculating and making conduit bending. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify the NEC® requirements for conduit bends.
2. Identify the minimum radius requirements for various types of conduit.
3. Calculate the number of bends per run.
4. Use right-angle mathematics to find bend distances.
5. Use the circumference of a circle to determine bend distances.
6. Analyze mechanical bender chart for bending specifications.
7. Make mechanical bends.
8. Use electric and hydraulic conduit benders.
9. Install and bend PVC conduit.
10. Demonstrate performance tasks.

#### **E. PULL AND JUNCTION BOXES**

**Proficient electricians demonstrate appropriate knowledge and skills for installing pull and junction boxes. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Select pull and junction boxes.
2. Select and install fittings.
3. Size pull and junction boxes for systems over and under 1,000V.
4. Identify conduit bodies and other cast enclosures.
5. Select and install handholes.
6. Demonstrate performance tasks.

#### **F. CONDUCTOR INSTALLATIONS**

**Proficient electricians demonstrate appropriate knowledge and skills for installing conductors. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Plan the installation.
2. Identify a pulling location and set up the cable reels.
3. Prepare raceways for conductors.
4. Install a pull line.
5. Prepare the cable ends for pulling.
6. Select cable-pulling equipment.
7. Set up the feeding end.
8. Support conductors.

9. Pull cable in cable trays.
10. Identify cable limitations when pulling.
11. Calculate the allowable tension on pulling devices and conductors.
12. Calculate the sidewall loading.
13. Demonstrate performance tasks.

## **G. CABLE TRAY**

**Proficient electricians demonstrate appropriate knowledge and skills for installing cable trays. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Select cable tray fittings.
2. Identify cable tray supports.
3. Determine the load on supports.
4. Identify types of failure under load.
5. Identify installation requirements and NEC® specifications for number of conductors allowed in cable tray.
6. Identify de-rating factors for cable tray conductors.
7. Demonstrate performance tasks.

## **H. CONDUCTOR TERMINATIONS AND SPLICES**

**Proficient electricians demonstrate appropriate knowledge and skills for preparing cable ends for terminations and splices. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Strip and train small and large conductors.
2. Bend cable and train conductors.
3. Make wire connections.
4. Install various types of connectors.
5. Make aluminum connections.
6. Install control and signal cables.
7. Reinsulate electrical connections.
8. Tape electrical connections.
9. Install heat-shrink insulators.
10. Use motor connection kits.
11. Demonstrate performance tasks.

## **I. GROUNDING AND BONDING**

**Proficient electricians demonstrate appropriate knowledge and skills for appropriate grounding and bonding as required by NEC® Article 250. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify the purpose of grounding and bonding.
2. Identify the grounding requirements for various systems.

3. Identify service grounding methods.
4. Size and install a grounding electrode conductor.
5. Select other electrodes.
6. Size and select equipment grounding.
7. Size an equipment grounding conductor.
8. Ground an enclosure.
9. Bond service equipment.
10. Size the main bonding jumper.
11. Bond multiple service disconnects.
12. Bond enclosures and equipment.
13. Ground and bond separately derived systems.
14. Ground separately derived systems.
15. Install grounding at more than one building.
16. Test for effective grounds.
17. Measure earth resistance using the fall-of-potential method.
18. Complete a three-point test.
19. Demonstrate performance tasks.

## **J. CIRCUIT BREAKERS AND FUSES**

**Proficient electricians demonstrate appropriate knowledge and skills for installing circuit breakers, fuses, and overcurrent devices. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify the function of overcurrent protective devices.
2. Identify types of overcurrent conditions.
3. Identify NEC® requirements for overcurrent protective devices.
4. Size and select circuit breakers.
5. Identify circuit breaker components, types, and ratings.
6. Size and select fuses, fuse types, and markings
7. Coordinate the operation of overcurrent protective devices.
8. Demonstrate performance tasks.

## **K. CONTROL SYSTEMS AND FUNDAMENTAL CONCEPTS**

**Proficient electricians demonstrate appropriate knowledge and skills for installing various control systems. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify magnetic and mechanically held contactors.
2. Select lighting contactors.
3. Make forward and reverse motor contactor connections.
4. Select mechanically held contactors.
5. Select and troubleshoot relays.
6. Select control relays.
7. Select timers and timing relays.
8. Select solid-state relays.

9. Select overload relays.
10. Install low-voltage remote control switching systems.
11. Identify remote control switching system components and operating characteristics.
12. Plan and install a remote control switching system.
13. Demonstrate performance tasks.

### **LEVEL 3**

#### **A. LOAD CALCULATIONS – BRANCH AND FEEDER CIRCUITS**

**Proficient electricians demonstrate appropriate knowledge and skills for calculating branch circuit and feeder loads for residential and commercial applications per NEC® requirements. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Calculate branch circuit ratings.
2. Apply de-rating factors.
3. Calculate branch circuit ampacity.
4. Calculate receptacle loads.
5. Calculate small appliance loads.
6. Calculate laundry circuit loads.
7. Calculate cooking appliance loads.
8. Calculate water heater loads.
9. Calculate electric heating loads.
10. Calculate air conditioning loads.
11. Calculate the loads on multi-outlet assemblies.
12. Calculate show window loads.
13. Calculate sign loads.
14. Calculate loads for heavy-duty lamp holder outlets.
15. Calculate commercial kitchen equipment loads.
16. Calculate motor loads.
17. Calculate welder loads.
18. Demonstrate performance tasks.

#### **B. CONDUCTOR SELECTION AND CALCULATIONS**

**Proficient electricians demonstrate appropriate knowledge and skills for sizing and installing conductors for different applications. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify overcurrent protection for branch circuits and feeders.
2. Identify the properties of conductors.
3. Calculate wire sizes based on resistance.
4. Calculate conductor resistances.
5. Calculate voltage drops for various applications.

## **C. PRACTICAL APPLICATIONS OF LIGHTING**

**Proficient electricians demonstrate appropriate knowledge and skills for installing lamps and lighting systems. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Classify lighting by type of service and location.
2. Identify types of lighting fixtures.
3. Identify types of lighting for various applications.
4. Identify special-purpose wiring systems.
5. Select dimmer systems for various applications.
6. Demonstrate performance tasks.

## **D. HAZARDOUS LOCATIONS**

**Proficient electricians demonstrate appropriate NEC® classifications and requirements for hazardous locations. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify Class I locations.
2. Identify Class II locations.
3. Identify Class III locations.
4. Locate NEC® requirements for hazardous locations.
5. Identify sources of ignitions.
6. Select and install explosion-proof equipment and seals.
7. Demonstrate performance tasks.

## **E. OVERCURRENT PROTECTION**

**Proficient electricians demonstrate appropriate knowledge and skills for selecting circuit breakers and fuses for various applications. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify overload conditions.
2. Identify short circuit conditions.
3. Identify ground faults.
4. Identify arc faults.
5. Identify fuse ratings.
6. Identify types of fuses and their operating characteristics.
7. Identify fuse classes and applications.
8. Identify circuit breaker classifications.
9. Identify circuit breaker interrupting capacity ratings.
10. Select overcurrent devices for various applications.
11. Apply short circuit calculations.
12. Test and troubleshoot circuit breakers.
13. Test and troubleshoot fuses.

## **F. DISTRIBUTION EQUIPMENT**

**Proficient electricians demonstrate appropriate NEC® knowledge and skills for installing, grounding, and maintenance of switchboards and switchgear, as well ground fault relay testing. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Describe switchboards and switchgear, including NEC requirements for installation, grounding, and maintenance.
2. Describe the proper installation of distribution equipment.
3. Test and maintain distribution equipment.

## **G. TRANSFORMERS**

**Proficient electricians demonstrate appropriate knowledge and skills for installing various transformers, connections, and grounding requirements. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Describe construction, operations, and applications of various transformers.
2. Describe the NEC® requirements for the installation of connections, and grounding requirements of transformers.
3. Demonstrate performance tasks.

## **H. COMMERCIAL ELECTRICAL SERVICES**

**Proficient electricians demonstrate appropriate knowledge and skills for the components, installation, and NEC® requirements for commercial electrical services. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Describe the components, installation considerations, and NEC® requirements for commercial electrical services.
2. Demonstrate performance tasks.

## **I. MOTOR CALCULATIONS**

**Proficient electricians demonstrate appropriate knowledge and skills for calculating the size of conductors and overcurrent protection. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Calculate conductor ampacities for a typical motor control center.
2. Calculate conductor ampacities for other motor applications.
3. Size motor protective devices.
4. Demonstrate performance tasks.



## **J. MOTOR CONTROLS**

**Proficient electricians demonstrate appropriate knowledge and skills for installing motor controllers and control circuit pilot devices. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify electromechanical relays.
2. Identify magnetic contactors.
3. Identify types of motor overload protection.
4. Select NEMA magnetic contactors/motor starters.
5. Select IEC magnetic contactors/motor starters.
6. Identify contactor/motor starter accessories.
7. Identify control transformers.
8. Select motor enclosures.
9. Interpret installation diagrams.
10. Identify NEC® regulations for motor control circuits.
11. Connect motor controllers for specific applications.
12. Demonstrate performance tasks.

### **LEVEL 4 (ADVANCED ELECTRICITY)**

#### **A. LOAD CALCULATIONS – FEEDERS AND SERVICES**

**Proficient electricians demonstrate appropriate knowledge and skills for basic load calculations for residential and commercial applications. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Explain basic load calculations for residential and commercial including raceway fill, conductor de-rating, and voltage drop.
2. Demonstrate performance tasks.

#### **B. HEALTH CARE FACILITIES**

**Proficient electricians demonstrate appropriate knowledge and skills for installing electrical systems in health care facilities, including life safety and critical circuits. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Explain the installation of electrical systems in health care facilities, including the requirements for life safety and critical circuits.
2. Demonstrate performance tasks.

## **C. STANDBY AND EMERGENCY SYSTEMS**

**Proficient electricians demonstrate appropriate knowledge and skills for installing electric generators and storage batteries. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Explain the NEC® installation requirements for electric generators and storage batteries.
2. Demonstrate performance tasks.

## **D. BASIC ELECTRONIC THEORY**

**Proficient electricians demonstrate appropriate knowledge of the function and operation of basic electronic devices, including semiconductors, diodes, rectifiers, and transistors. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Explain the function and operation of basic electronic devices, including semiconductors, diodes, rectifiers, and transistors.
2. Demonstrate performance tasks.

## **E. FIRE ALARM SYSTEMS**

**Proficient electricians demonstrate appropriate knowledge and skills for installing fire alarm systems. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Explain the technologies, codes, and wiring approaches used to assemble a fire alarm system.
2. Explain installation and troubleshooting techniques.
3. Demonstrate performance tasks.

## **F. SPECIALTY TRANSFORMERS**

**Proficient electricians demonstrate appropriate knowledge and skills for installing various types of transformers. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify and describe various types of transformers.
2. Identify instrument transformers.
3. Define harmonics and explain how harmonic issues are identified and resolved.
4. Demonstrate performance tasks.

## **G. ADVANCE CONTROLS**

**Proficient electricians demonstrate advanced knowledge and skills for installing solid-state controls, reduced-voltage starts, and adjustable-frequency drives. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Describe the various types of relays used in motor control circuits.
2. Explain how reduced-voltage starting is accomplished.
3. Describe the types and uses of adjustable-frequency drives.
4. Describe motor braking methods.
5. Describe how to troubleshoot motor controls.
6. Demonstrate performance tasks.

## **H. HVAC CONTROLS**

**Proficient electricians demonstrate appropriate knowledge and skills for installing HVAC systems. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Describe the operating principles and major components of HVAC systems.
2. Identify the types of thermostats and their uses.
3. Identify and describe HVAC control systems and devices.
4. Identify the NEC® requirements that apply to HVAC systems.
5. Demonstrate performance tasks.

## **I. HEAT TRACING AND FREEZE PROTECTION**

**Proficient electricians demonstrate appropriate knowledge and skills for installing heat-tracing and freeze-protection systems. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Describe heat-tracing applications, components, controls, and selection/installation considerations related to piping.
2. Describe roof, gutter, and downspout de-icing systems and the relevant selection/installation considerations.
3. Describe snow-melting and anti-icing systems and the relevant selection/installation considerations.
4. Describe other electric heat-tracing and warming systems and the relevant selection/installation considerations.
5. Demonstrate performance tasks.

## **J. MOTOR OPERATION AND MAINTENANCE**

**Proficient electricians demonstrate appropriate knowledge and skills for motor cleaning, testing, and preventative maintenance. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify the factors that affect motor reliability and lifespan.
2. Describe maintenance and troubleshooting requirements for electric motors.
3. Describe the guidelines for installing and commissioning electric motors.
4. Demonstrate performance tasks.

## **K. MEDIUM-VOLTAGE TERMINATIONS/SPLICES**

**Proficient electricians demonstrate appropriate knowledge and skills for making splices and terminations. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Describe how to splice medium-voltage cable.
2. Describe termination classes and important considerations when creating terminations.
3. Define high-potential testing and explain how such testing is conducted.
4. Demonstrate performance tasks.

## **L. SPECIAL LOCATIONS**

**Proficient electricians demonstrate appropriate knowledge and skills for selecting and installing equipment, enclosures, and devices for special locations. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Identify and select equipment, components, and wiring methods for various special locations and applications.
2. Identify and select equipment, components, and wiring methods for marinas, boatyards, and bodies of water.
3. Identify and select equipment, components, and wiring methods for pools, spas, tubs, and fountains.
4. Demonstrate performance tasks.

## **M. FUNDAMENTALS OF CREW LEADERSHIP**

**Proficient electricians demonstrate appropriate knowledge and skills for managing crews, including leadership, safety, and project control. The following accountability criteria are considered essential for students in the Electricity program of study.**

1. Describe current issues and organizational structures in industry today.
2. Explain how to incorporate leadership skills into work habits, including communications, motivation, team building, problem-solving, and decision-making

- skills.
3. Identify a crew leader's typical safety responsibilities with respect to common safety issues, including awareness of safety regulations and the cost of accidents.
  4. Demonstrate a basic understanding of the planning process, scheduling, and cost and resource control.
  5. Analyze the skills and licensure procedures for advancement in the electrical profession.
  6. Demonstrate performance tasks.

*Student Organizations, Technology Knowledge, Personal Qualities and Skills, and Professional Knowledge are to be embedded in the course standards above.*

## **STUDENT ORGANIZATIONS**

**Proficient professionals know the academic subject matter, including professional development. The following accountability criteria are considered essential for students in any program of study.**

1. Identify the purpose and goals of a Career and Technology Student Organization (CTSO).
2. Explain how CTSOs are integral parts of specific clusters, majors, and/or courses.
3. Explain the benefits and responsibilities of being a member of a CTSO. List leadership opportunities that are available to students through participation in CTSO conferences, competitions, community service, philanthropy, and other activities.
4. Explain how participation in CTSOs can promote lifelong benefits in other professional and civic organizations.

## **TECHNOLOGY KNOWLEDGE**

**Proficient professionals know the academic subject matter, including the ethical use of technology. The following accountability criteria are considered essential for students in any program of study.**

1. Demonstrate proficiency and skills associated with the use of technologies that are common to a specific occupation.
2. Identify proper netiquette when using e-mail, social media, and other technologies for communication purposes.
3. Identify potential abuse and unethical uses of laptops, tablets, computers, and/or networks.
4. Explain the consequences of social, illegal, and unethical uses of technology (e.g., piracy; illegal downloading; cyberbullying; licensing infringement; inappropriate uses of software, hardware, and mobile devices in the work environment).
5. Discuss legal issues and the terms of use related to copyright laws, Creative Commons, fair use laws, and ethics pertaining to downloading of images, photographs, Creative Commons, documents, video, sounds, music, trademarks, and other elements for personal use.
6. Describe ethical and legal practices of safeguarding the confidentiality of business-related information.
7. Describe possible threats to a laptop, tablet, computer, and/or network and methods of avoiding attacks.

## **PERSONAL QUALITIES AND EMPLOYABILITY SKILLS**

**Proficient professionals know the academic subject matter, including positive work practices and interpersonal skills. The following accountability criteria are considered essential for students in any program of study.**

1. Demonstrate creativity and innovation.
2. Demonstrate critical thinking and problem-solving skills.
3. Demonstrate initiative and self-direction.
4. Demonstrate integrity.
5. Demonstrate work ethic.
6. Demonstrate conflict resolution skills.
7. Demonstrate listening and speaking skills.
8. Demonstrate respect for diversity.
9. Demonstrate customer service orientation.
10. Demonstrate teamwork.

## **PROFESSIONAL KNOWLEDGE**

**Proficient professionals know the academic subject matter, including positive work practices and interpersonal skills. The accountability criteria are considered essential for students in any program of study.**

1. Demonstrate global or “big picture” thinking.
2. Demonstrate career and life management skills and goal-making.
3. Demonstrate continuous learning and adaptability skills to changing job requirements.
4. Demonstrate time and resource management skills.
5. Demonstrates information literacy skills.
6. Demonstrates information security skills.
7. Demonstrates information technology skills.
8. Demonstrates knowledge and use of job-specific tools and technologies.
9. Demonstrate job-specific mathematics skills.
10. Demonstrates professionalism in the workplace.
11. Demonstrates reading and writing skills.
12. Demonstrates workplace safety.