# Scope & Sequence

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| Course Name: Electrical Technology II **PEIMS Code:** 13005700 | | | **Course Credit:** 2.0  **Course Requirements:** This course is recommended for students in Grades 11-12.  **Prerequisites:** Electrical Technology I.  **Recommended Prerequisites:** Principles of Architecture and Principles of Construction. |
| **Course Description:** In Electrical Technology II, students will gain advanced knowledge and skills needed to enter the workforce as an electrician, a building maintenance technician, or a supervisor; prepare for a postsecondary degree in a specified field of construction or construction management; or pursue an approved apprenticeship program. Students will acquire knowledge and skills in safety, electrical theory, tools, codes, installation of electrical equipment, alternating current and direct current motors, conductor installation, installation of electrical services, and electric lighting installation. | | | |
| **NOTE:** This is a suggested scope and sequence for the course content. This content will work with any textbook or instructional materials. If locally adapted, make sure all TEKS are covered. | | | |
| **Total Number of Periods**  **Total Number of Minutes**  **Total Number of Hours** | 350 Periods  15,750 Minutes  262.5 Hours\* | \*Schedule calculations based on 175/180 calendar days. For 0.5 credit courses, schedule is calculated out of 88/90 days. Scope and sequence allows additional time for guest speakers, student presentations, field trips, remediation, extended learning activities, etc. | |
| **Unit Number, Title, and Brief Description** | **# of Class Periods\***  (assumes 45-minute periods)  Total minutes per unit | **TEKS Covered**  **130.58. (c) Knowledge and Skills** | |
| **Unit 1: Career Development**  Students will identify interests, abilities, aptitudes, values, and personality traits as they relate to career planning, to develop a keen understanding of the value and benefit of work, and to differentiate between jobs and careers. This unit will help students better understand the various career opportunities within the Architecture and Construction industry. Students will develop a career plan designed to achieve their career goals within this industry. Students will explore the job titles, job expectations, salaries, education needed and forecast for the industry. | 10 Periods   1. Minutes | (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:  (A) identify job opportunities with their accompanying job duties such as electrician, building maintenance technician, manager, and electrical engineer; and  (B) research careers along with the education, job skills, and experience required to achieve a career goal | |
| **Unit 2: Industry Regulations, Compliance, and Workplace Safety**  This unit will expose students to the important compliance, safety standards, and regulations that are implemented within this industry. Students will learn that such practices are in place to manage resources to minimize losses and liabilities to businesses in the industry. Students will determine the role of risk management in the construction industry including, but not limited to, discussions focusing on liability insurance, sanitation, OSHA and EPA regulations, emergency situations, building code, MSDS, and security issues. | 10 Periods  675 Minutes | (2) The student knows the issues associated with electrical hazards found on a jobsite. The student is expected to:  (A) demonstrate safe working procedures in a construction environment;  (B) explain the purpose of the Occupational Safety and Health Administration (OSHA) and how it promotes safety on the job;  (C) identify electrical hazards and how to avoid or minimize them in the workplace; and  (D) explain safety issues concerning lockout and tagout procedures, personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection | |
| **Unit 3: Contactors and Relays**  Students will also gain knowledge with a relay and how to wire a relay, using a timing relay to turn on a single light, and using a timing relay to turn on a run/stop light. | 30 Periods  1,350 Minutes | (12) The student knows the practical applications of contactors and relays. The student is expected to:  (A) describe the operating principles of contactors and relays;  (B) select contactors and relays for use in specific electrical systems;  (C) explain how mechanical contactors operate;  (D) explain how solid-state contactors operate;  (E) install contactors and relays according to National Electrical Code requirements;  (F) select and install contactors and relays for lighting control;  (G) describe how overload relays operate;  (H) connect a simple control circuit; and  (I) test control circuits | |
| **Unit 4: Motors**  Within this unit students gain knowledge understanding motor concepts including their main parts, control components, electromagnetic induction, speed, voltage, frequency, and torque. Students will compare and contrast between different types of motors and they will understand the theory behind permanent magnet motors, three-phase motors, and induction motors. Students will describe concepts such as flux interaction, commutation, the effect of multiple windings, armature’ reaction, compensation and CEMF, and how each of these factors effects motor operation. | 30 Periods  1,350 Minutes | (3) The student gains knowledge of alternating current and direct current motors with specific attention being given to main parts, circuits, and connections. The student is expected to:  (A) define terms such as ampacity, branch circuit, circuit breaker, controller, duty, full-load amps, ground fault circuit interrupter, interrupting rating, motor circuit switch, thermal protector, National Electrical Manufacturers Association design letter, non-automatic, overcurrent, overload, rated full-load speed, rated horsepower, remote control circuit, service factor, and thermal cutout;  (B) describe the various types of motor enclosures;  (C) describe how the rated voltage of a motor differs from the system voltage;  (D) describe the basic construction and components of a three-phase squirrel cage induction motor;  (E) explain the relationships among speed, frequency, and the number of poles in a three-phase induction motor;  (F) describe how torque is developed in an induction motor;  (G) explain how and why torque varies with rotor reactance and slip;  (H) define percent slip and speed regulation;  (I) explain how the direction of a three-phase motor is reversed;  (J) describe the component parts and operating characteristics of a three-phase wound-rotor induction motor;  (K) define torque, starting current, and armature reaction as they apply to direct current motors;  (L) explain how the direction of rotation of a direct current motor is changed;  (M) describe the design and characteristics of direct current shunt, series, and compound motors;  (N) describe dual-voltage motors and their applications;  (O) describe the methods for determining various motor connections; and  (P) describe general motor protection requirements as delineated by the National Electrical Code | |
| **Unit 5: Grounding and Bonding Electrical Systems**  During this unit students will learn concepts pertaining to grounding and bonding; that they are important elements of a building’s electrical wiring system and they each have different functions, but they work together to make the building’s electrical wiring safe. Students will understand basic grounding and bonding fundamentals pertaining to grounding electrode system and the grounding electrode conductor, along with the bonding and grounding enclosures and equipment. Students will explain the importance of ground fault protection equipment, special location requirements for grounding and bonding, and bring the student up to speed with the latest related NEC requirements. | 30 Periods  1,350 Minutes | (4) The student learns the purpose for grounding and bonding electrical systems. The student is expected to:  (A) explain the purpose of grounding and the scope of the National Electrical Code;  (B) distinguish between a short circuit and a ground fault;  (C) define the National Electrical Code ground-related terms;  (D) distinguish between system grounding and equipment grounding;  (E) use the National Electrical Code to size the grounding electrode conductor for various alternating current systems;  (F) explain the National Electrical Code requirements for the installation and physical protection of grounding electrode conductors;  (G) explain the function of the grounding electrode system and determine which grounding electrodes must be used;  (H) define electrodes and explain the resistance requirements for electrodes using the National Electrical Code;  (I) use the National Electrical Code to size the equipment grounding conductor for raceways and equipment;  (J) explain the function of the main bonding jumper and system bonding jumpers in the grounding system and size the bonding jumpers for various applications;  (K) size the main bonding jumper for a service using multiple service disconnecting means;  (L) explain the National Electrical Code requirements for bonding of enclosures and equipment;  (M) explain effective grounding and its importance in clearing ground faults and short circuits;  (N) explain the purposes of the grounded conductor neutral in operation of overcurrent devices;  (O) explain the National Electrical Code requirements for grounding separately derived systems, including transformers and generators;  (P) explain the National Electrical Code requirements for grounding at more than one building; and  (Q) explain the National Electrical Code grounding requirements for systems over 600 volts | |
| **Unit 6: Conduit**  Students will gain the knowledge regarding conduit bending, hand bending equipment, conduit bending geometry, bending a 90 degree elbow, making offset bends, making saddle bends, and joining metallic conduits utilizing proper tools and equipment. Students will also gain the knowledge related to cutting, reaming and threading metal conduit, non-metallic sheathed cable, and bending PVC conduit. Students will accurately use mathematical formulas to determine proper conduit bends. | 30 Periods  1,350 Minutes | (5) The student properly bends all sizes of conduit up to six inches. The student is expected to:  (A) describe the process of conduit bending using power tools;  (B) identify all parts of popular electric and hydraulic benders;  (C) avoid excessive waste when working with conduit systems;  (D) bend offsets, kicks, saddles, and segmented and parallel bends;  (E) explain the requirements for the National Electrical Code for bending conduit;  (F) compute the radius, degrees in bend, developed length, and gain for conduit up to six inches; and  (G) explain how to correct damaged conduit and modify existing bends | |
| **Unit 7: Outlet, Pull, and Junction Boxes**  Students will identify various types of metallic and non-metallic boxes and conduit bodies. Students will learn proper sizing of outlet and junction boxes including minimum dimensions of pull and junction boxes for conductors size #4 and larger will be discussed. Students will explain where boxes are required for specific electrical conductors. Students will identify the various types of boxes encountered in typical level 1 residential and small commercial installations, Students will calculate minimum size for outlet boxes and conduit bodies based on the number of conductors and devices installed Students will evaluate installations for code compliant mounting of boxes and conduit bodies per NEC regulations. | 30 Periods  1,350 Minutes | (6) The student learns to select and size outlet boxes, pull boxes, and junction boxes. The student is expected to:  (A) describe the different types of nonmetallic and metallic boxes;  (B) calculate the required box size for any number and size of conductors;  (C) explain the National Electrical Code regulations for volume required per conductor in outlet boxes;  (D) locate, install, and support boxes of all types;  (E) describe the National Electrical Code regulations governing pull and junction boxes;  (F) explain the radius rule when installing conductors in pull boxes;  (G) understand the National Electrical Code requirements for boxes supporting lighting fixtures;  (H) describe the purpose of conduit bodies and Type FS boxes;  (I) install the different types of fittings used in conjunction with boxes;  (J) describe the installation rules for boxes and fittings in hazardous areas;  (K) explain how boxes and fittings are selected and installed; and  (L) describe the various types of box supports | |
| **Unit 8: Cable Raceways**  Students will identify raceway fittings, body sizes, as well as seal fittings, fasteners and anchors to secure raceways. Students will demonstrate proper cable reel transportation and storage, as well as preparation techniques for cable pulling. Students will understand how to prevent damaging wires during cable pulls in raceways and cable trays by considering raceway/cable tray size, cable configuration, jamming potential, conductor clearance, sidewall bearing pressure, etc. | 30 Periods  1,350 Minutes | (7) The student knows transportation, storage, and setup of cable reels, methods of rigging, and procedures to complete cable pulls in raceways and cable trays. The student is expected to:  (A) describe the various methods of installing conductors in conduit;  (B) plan and set up for a cable pull;  (C) describe how cable reels are transported to the pulling site;  (D) set up reel stands and spindles for a wire-pulling installation;  (E) explain how mandrels, swabs, and brushes are used to prepare conduit for conductors;  (F) install a pull line for a cable-pulling operation;  (G) explain the operation of power fish tape systems;  (H) prepare the ends of conductors for pulling;  (I) describe the types of cable pullers;  (J) describe the process of high-force cable pulling;  (K) explain how to support conductors in vertical conduit runs;  (L) describe the installation of cables in cable trays;  (M) explain the importance of communication during a cable-pulling operation; and  (N) calculate the probable stress or tension in cable pulls | |
| **Unit 9: Cable Trays**  Students will identify and describe the components of a cable tray including base and side members as well as supportive hanging/securing hardware. Students will understand that cable tray wiring systems are the preferred wiring system when they are evaluated against equivalent conduit wiring systems in terms of safety, dependability, space and cost. Students will explain that in facilities where cable tray may be used as the equipment grounding conductor in accordance with NEC, the grounding equipment system components lend themselves to visual inspection as well as electrical continuity checks | 30 Periods  1,350 Minutes | (8) The student installs cable trays and modifies cable trays and cable. The student is expected to:  (A) describe the components that make up a cable tray assembly;  (B) explain the methods used to hang and secure a cable tray;  (C) describe how cable enters and exits cable trays;  (D) select the proper cable tray fitting for the situation;  (E) explain the National Electrical Manufacturers Association standards for cable tray installations;  (F) explain the National Electrical Code requirements for cable tray installations;  (G) select the required fittings to ensure equipment grounding continuity in cable tray systems;  (H) interpret electrical working drawings showing cable tray fittings;  (I) size a cable tray for the number and type of conductors contained in the system;  (J) select rollers and sheaves for pulling cable in specific cable tray situations; and  (K) designate the required locations of rollers and sheaves for a specific cable pull | |
| **Unit 10: Conductor Terminating and Splicing**  During this unit students will explore the implementation, performance and evaluation of conductor connections and terminations. Students will demonstrate reliable termination and connection processes, working to specifications, safe use of connection and termination tools, and evaluating termination and connection work. Students will understand the importance of proper methods of terminating conductors to having safe electrical installation. Students will explore and demonstrate techniques for the different types of mechanical conductor connection including splicing, crimping, and wire nuts. | 30 Periods  1,350 Minutes | (9) The student knows the methods of terminating and splicing conductors of all types and sizes and the preparation and taping of conductors. The student is expected to:  (A) describe how to make a good conductor termination;  (B) prepare cable ends for terminations and splices;  (C) install lugs and connector onto conductors;  (D) train cable at termination points;  (E) explain the role of the National Electrical Code in making cable terminations and splices;  (F) explain why mechanical stress should be avoided at cable termination points;  (G) describe the importance of using proper bolt torque when bolting lugs onto bus bars;  (H) describe crimping techniques;  (I) select the proper lug or connector for the job;  (J) describe splicing techniques; and  (K) explain how to use hand and power crimping tools | |
| **Unit 11: Single- and Three-Phase Services**  Students will compare and contrast single- and three-phase current and the types of services they support in different settings. Students will understand circuit loads and the number of circuits required for electrical projects. Students will demonstrate installation of disconnect switches, distribution panels, panel boards, overcurrent protection devices per NEC guidelines. | 30 Periods  1,350 Minutes | (10) The student installs single- and three-phase services, including metering equipment. The student is expected to:  (A) describe various types of electric services for commercial and industrial installations;  (B) read electrical drawings and diagrams describing service installation;  (C) calculate and select service-entrance equipment;  (D) explain the role of the National Electrical Code in service installations;  (E) install main disconnect switches, panel boards, and overcurrent protection devices;  (F) identify the circuit loads, number of circuits required, and installation requirements for distribution panels;  (G) explain the types and purposes of service grounding;  (H) explain the purpose and required locations of ground fault circuit interrupters;  (I) describe single-phase service connections; and  (J) describe both wye-phase and delta-connected three-phase services | |
| **Unit 12: Fuses and Circuit Breakers**  Students will learn how fuses, circuit breakers, and ground fault circuit interrupters (GFCI) provide overcurrent protection in electrical circuits. Students understand overcurrent protection overview, disconnect switch coordination, fuses and circuit breakers, dual element time delay fuse, non time delay fuses, cartridge fuses, plug fuses, and testing fuses. Students will also learn about circuit breakers, thermal magnetic circuit breakers, circuit breaker coordination, HACR circuit breakers, and low voltage lighting systems. Students will use technical vocabulary when describing the functionality of single-element and time-delay fuses as well as with thermal and magnetic circuit breakers. Students will focus on understanding, interpreting, analyzing and knowing how to correctly use electrical formulas, units of measure, mathematics concepts, and science principles in order to solve problems. | 30 Periods  1,350 Minutes | (11) The student knows the practical application of fuses and circuit breakers. The student is expected to:  (A) explain the necessity of overcurrent protection devices in electrical circuits;  (B) define the terms associated with fuses and circuit breakers;  (C) describe the operation of a circuit breaker;  (D) select the most suitable overcurrent device for the application;  (E) describe the operation of single-element and time-delay fuses;  (F) explain how ground fault circuit interrupters can save lives;  (G) calculate short circuit currents; and  (H) describe troubleshooting and maintenance techniques for overcurrent devices | |
| **Unit 13: Principles of Lighting**  Students will differentiate between different types of electrical lighting fixtures including lamps, surface mounted, recessed, suspended and track-mounted. Students will compare and contrast the different types of lamps consumers can install in their electrical fixtures such as incandescent, halogen, fluorescent, light-emitting diode (LED), and high-intensity discharge an understanding of installing a variety of fixtures. Students will demonstrate the proper, safe installation of various electrical fixtures. | 30 Periods  1,350 Minutes | (13) The student learns the basic principles of human vision and the characteristics of light. The student is expected to:  (A) explain how the human eye works;  (B) describe the characteristics of light;  (C) recognize the different kinds of lamps and explain the advantages and disadvantages of each type, including incandescent, halogen, fluorescent, and high-intensity discharge;  (D) select and install lamps into lighting fixtures; and  (E) recognize and install various types of lighting fixtures, including surface mounted, recessed, suspended, and track-mounted units | |