CareerClusters™ PATHWAYS TO COLLEGE & CAREER READINESS
Architecture & Construction

Learning that works for Colorado CTE®

Colorado CTE Course – Scope and Sequence

Course Name	Electrical Construction II	Course Details	Credit= 1.0-2.0
		Course = 0.50 Carnegie Unit Credit	Prerequisite: Electrical Construction I CTE Credential: Architecture and Construction
Course Description	Continues practical applications of electrical theory and techniques used by licensed electricians. Exploration of OSHA's electrical safety-related work practices, and how they are applied to the work environment. Approaches to commercial and industrial building wiring in conformance with the current National Electrical Code and local codes using electric metallic tubing and other raceways.		
Note:	This is a suggested scope and sequence for the course content. The content will work with any textbook or instructional resource. If locally adapted, make sure all essential knowledge and skills are covered.		
SCED Identification #	17102	Schedule calculation based on 60 calendar days of a 90-day semester. Scope and sequence allows for additional time for guest speakers, student presentations, field trips, remediation, or other content topics.	

All courses taught in an approved CTE program must include Essential Skills embedded into the course content. The Essential Skills Framework for this course can be found at https://www.cde.state.co.us/standardsandinstruction/essentialskills

Instructional Unit Topic	Suggested Length of Instruction	CTE or Academic Standard Alignment	Competency / Performance Indicator	Outcome / Measurement	CTSO Integration
Career Development		Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans.	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	Update materials from coursework to add to the student's portfolio. Continually reflect on coursework experiences and revise and refine the career plan generated in prior courses. Include photographs or illustrations and written descriptions of sequential progress in construction projects.	

			technician, manager, and electrical engineer; and (B) research careers along with the education, job skills, and experience required to achieve a career goal.		
Safety		Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the Building and Construction Trades sector workplace environment. Interpret policies, procedures, and regulations for the workplace environment, including employer and employee responsibilities.	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.		
AC/DC Motors		Describe AC circuits and apply scientific principles to the operation of motors.	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) understand terminology associated with AC/DC motors and operation; (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;	Identify and define AC waveforms and phase relationships. Determine unknown values in AC circuits including resistive, inductive, capacitive and combination circuits. Perform AC circuit calculations: true power, apparent power, reactive power, power factor, and power triangle to solve for unknown values. 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	

			(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	circuit, service factor, and thermal cutout. Compare and contrast alternating current (AC) and direct current (DC) motors and describe their operating characteristics. Identify variable-speed drives and describe their operating characteristics. Identify motor enclosures, frame designations, and operating characteristics. Identify the connections and terminal markings for AC motors. Identify the National Electrical Code requirements for motors.	

			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; (P) describe general motor protection requirements as delineated by the National Electrical Code; and (Q) demonstrate applications of Ohm's law to solve AC/DC calculations.		
Grounding and Bonding		Understand and apply grounding and bond for electrical systems according to the NEC Article 250 requirements.	The student learns the purpose for grounding and bonding electrical systems. The student is expected to: (A) explain the purpose of grounding and the	Compare and contrast grounding requirements for various electrical systems. Include information on grounding methods, size and selection of grounding electrode conductor.	

			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;	Explain the process for grounding an enclosure. Demonstrate a three-point test and explain its purpose. Install two lengths of Type NM cable in a switch box using Type NM cable clamps: • Strip the ends of the cable to conform with National Electrical Code requirements. • Secure the cable in the switch box and tighten the cable clamps. • Connect and secure the equipment grounding conductors according to NEC requirements, and secure to the switch box with either a ground clip or a grounding screw.	

			(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.		
Conduit		Understand how the regulatory requirements for electrical construction apply to conduit. Demonstrate how to calculate and make conduit bends using mechanical, hydraulic, and electric benders.	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;	Identify the NEC requirements for conduit bends and describe the process for bending conduit using a mechanical bender. Demonstrate use of electric and hydraulic benders. Calculate the number of bends per run for an	

			(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.	application scenario and calculate bend distances. Demonstrate how to clear obstructions using offsets and saddles. Demonstrate PVC joining procedures.	
Electrical Boxes		Identify electrical boxes and fittings used in electrical systems.	The student learns to select and size outlet boxes, pull boxes, and junction boxes. The student is expected to:	Identify pull and junction boxes and fittings. Demonstrate how to select, install, and support pull and junction boxes for systems over and under 1,000V.	

			(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.		
Cable Pulling		Demonstrate how to set up and complete a cable-pulling operation for an electrical system.	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;	Identify the steps to install cable in conduit systems including: Installation planning, identifying pulling location and set up of cable reels, preparation of raceways, installing a pull line, preparing the cable ends, and selecting appropriate equipment. Explain the limitations to cable when pulling. Identify ways a technician can calculate for tension and loading.	

			(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;	Demonstrate cable pulling in a raceway system.	

			(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.		
Cable Trays		Understand the process for installation of electrical system cable trays.	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	Generate a list of materials for a cable tray layout. List all the components required, including the fasteners required to complete the system. Explain the methods to hang and secure cable trays. Describe how to determine load on supports and identify common failures.	

			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.		

Terminations and Splicing		Understand the methods for preparing terminations and splices of electrical cable.	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 connectors 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	Describe tools and techniques for stripping and training conductors. Explain why a good connection is important. Terminate conductors using selected crimp-type and mechanical-type terminals and connectors. Demonstrate how to reinsulate electrical connections using electrical tape, heat shrink insulators and motor connection kits. Explain the uses for each type. Explain why mechanical stress should be avoided at cable termination points.	

			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.		
Service Installation		Understand how to calculate branch circuit and feeder loads for residential and commercial applications.	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;	Explain how to calculate branch circuit and feeder loads for residential and commercial applications. Explain how derating factor are applied. Demonstrate how to calculate the service load for a sample residence. Explain how to apply demand factors. Explain how to calculate appliance loads. Demonstrate how to size the load center, including GFCIs and AFCIs. Identify installation considerations for commercial services. Identify service	

			(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.	components and calculate commercial circuit load requirements. Demonstrate how to locate NEC requirements for commercial services. Install service-entrance equipment. Explain how to size the main bonding jumper for a sample residence. Describe the installation methods for equipment grounding systems. Explain how to identify the service drop location. Describe how to select the panelboard location.	
Fuses and Circuit Breakers		Understand the operating principles of circuit breakers	The student knows the practical application of	Explain the function of overcurrent protective	

		and fuses in electrical systems.	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	devices. Identify the NEC requirements for overcurrent protective devices. Explain how circuit breakers work in electrical systems. Identify the circuit breaker components. Explain how circuit breakers are rated. Describe how to identify fuse types and markings. Describe the operation of single-element and time-delay fuses. Identify the following on one or more circuit breaker(s) and fuse(s): • Number of poles • Load rating • Voltage rating • Amperage interrupting rating	

			maintenance techniques for overcurrent devices.		
Contractors and Relays		Understand the operating principles of contactors and relays, including both mechanical and solid-state devices.	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;	Describe how to select lighting contactors. Explain how to make forward and reverse motor contactor connections. Describe how to select mechanically held contactors. Compare and contrast relays: • control relays • timers and timer relays • solid-state relays • overload relays Install low-voltage remote control switching systems. Identify remote control switching system components and operating characteristics. Plan and install a remote control switching system.	

			(H) connect a simple control circuit; and (I) test control circuits.		
Light Processing and Fixtures		Understand how the human eye process light to see. Use knowledge of lighting to select and install a variety of lighting fixtures.	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,	Explain the relationship between human vision and light. Identify and install lamps and ballasts. Select and install lighting fixtures for various applications. Select lighting controls, timers, and sensors for various applications.	

			suspended, and track-mounted units.		