

Colorado CTE Course – Scope and Sequence

Course Name	Electrical Construction		Course Details	Credit = 1.0 Prerequisite= Principles of Construction or Construction Technology CTE Credential= CTE Architecture and Construction		
			Course = 0.50 Carnegie Unit Credit			
Course Description	Electrical Construction covers 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. This course also includes exploration of OSHA’s electrical safety-related work practices and how they are applied to the work environment. Students will acquire knowledge and skills in safety, electrical theory, tools, codes, installation of electrical equipment, and the reading of electrical drawings, schematics, and specifications.					
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 Exploration		Develop an education and career plan aligned with personal goals. 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 technician, manager, and electrical engineer; and	Research the roles of electricians and the training and education requirements needed for licensure. Analyze the student’s current ICAP and discuss how it aligns with various training opportunities (apprenticeship, union and non-union jobs, military options, and postsecondary education and training.)	Updates to ICAP. SkillsUSA Personal Skills SkillsUSA 4 Pillars SkillsUSA Construction Electrical Wiring Contest	

			(B) research career pathways, including education, job skills, and experience required to achieve that pathway.		
Safety		Identify safety hazards on a jobsite and demonstrate practices for safe working. Be informed of laws/acts pertaining to the Occupational Safety and Health Administration (OSHA).	The student identifies 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; (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; and (E) identify and select the proper tools and	Identify safety hazards on a jobsite and demonstrate practices for safe working. Accurately read, interpret, and demonstrate safety rules, including but not limited to rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to distinguish between the rules and explain why certain rules apply. Recognize and employ universal construction signs and symbols such as colors, flags, stakes, and hand signals that apply to construction workplace situations. Research and evaluate construction company safety plans from local industry. Explain the need for jobsite security to prevent liability. Drawing from examples, create and implement a jobsite safety program in the class to ensure safe practices	

			<p>accessories, critique the readiness of the tools, use the tools to accomplish the desired tasks, and then return the tools and accessories to their proper storage.</p>	<p>and procedures including jobsite security procedures. Report out on the proper safety precautions when operating tools and equipment, including the steps to inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational, Safety & Health Administration (OSHA) regulations. Demonstrate safety procedures when operating tools and equipment. Describe hazards involved when working with electricity and determine procedures to safeguard against them in the workplace, including ensuring power load balance, adhering to the appropriate use of ground-fault circuit interrupters (GFCIs) when working with power tools, and performing lockout/tagout procedures.</p>	
Conduit		<p>Install conduit typical of residential construction and pull conductors through</p>	<p>The student learns conduit bending and installation. The student is expected to:</p>	<p>Demonstrate techniques to hand bend conduit including:</p> <ul style="list-style-type: none"> • Applying geometrical principles (use 	

		conduit as required by the NEC.	<p>(A) identify the methods of hand bending conduit;</p> <p>(B) identify the various methods used to install conduit;</p> <p>(C) use mathematical formulas to determine conduit bends;</p> <p>(D) make 90 degree bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender; and</p> <p>(E) cut, ream, and thread conduit.</p>	<p>trigonometric ratios of right triangles to determine the offset angle of an offset bend and use the calculation to accurately create the bend.)</p> <ul style="list-style-type: none"> • Make 90 degree bends, back-to-back bends, offsets, kicks, and saddle bends <p>Demonstrate how to cut, ream, and thread conduit using hacksaws, pipe cutters, and ream tools. Demonstrate the steps to cut and join PVC conduit.</p>	
Hardware and Device Boxes		Understand common electrical industry practices and demonstrate skills necessary to complete electrical construction tasks in accordance with accepted industry standards.	<p>The student gains knowledge of the hardware and systems used by an electrician to mount and support boxes, receptacles, and other electrical components. The student is expected to:</p> <p>(A) identify and explain the use of threaded fasteners;</p> <p>(B) identify and explain the use of non-threaded fasteners;</p> <p>(C) identify and explain the use of anchors;</p>	Distinguish among the various types of device boxes, such as metallic and nonmetallic device boxes. For a variety of given residential and/or commercial applications, select appropriate device boxes according to drawings, specifications, and code requirements. Steps should include identifying the proper box type and size; and determining the minimum size pull or junction box for conduit entering and exiting (both for a straight pull and at an angle).	

			<p>(D) demonstrate the correct applications for fasteners and anchors; and</p> <p>(E) install fasteners and anchors.</p>	<p>Install typical devices, junction boxes, and panels using appropriate hardware and tools.</p> <ul style="list-style-type: none"> • Identify the appropriate box type and size for a given application • Select the minimum size pull or junction box based on the application • Select and install using appropriate hardware and be able to justify your selection 	
<p>Electrical Concepts</p>		<p>Apply the appropriate mathematical calculations used in the construction trades.</p> <p>Apply Ohm’s Law to calculate resistance, current flow, and voltage in series, parallel, and combination circuits.</p>	<p>The student learns the electrical concepts used in Ohm's law applied to direct current and series parallel circuits and understands series parallel circuits, resistive circuits, Kirchhoff's voltage and current laws, and circuit analysis. The student is expected to:</p> <p>(A) recognize what atoms are and what atoms are composed of;</p> <p>(B) define voltage and identify the ways in which it can be produced;</p>	<p>Describe the structure of an atom and compare and contrast the structures of conductors and insulators. Define common industry terms:</p> <ul style="list-style-type: none"> • Current • Voltage • Resistance • Magnetism • Power distribution system (and components) <p>Explain how electrician’s use Kirchhoff’s current and voltage laws to perform resistive circuit calculations. Explain the difference between parallel and series</p>	

			<p>(C) explain the difference between conductors and insulators; (D) define the units of measurement used to measure the properties of electricity; (E) explain how voltage, current, and resistance are related to each other; (F) calculate an unknown value using the formula for Ohm's law; (G) explain the different types of meters used to measure voltage, current, and resistance; (H) calculate the amount of power used by a circuit using the power formula; (I) explain the basic characteristics of a series, parallel, and combined series-parallel circuit; (J) calculate, using Kirchhoff's current law, the total current in parallel and series-parallel circuits; and (K) find the total amount of resistance in a series, parallel, or combined series-parallel circuit.</p>	<p>circuits and how to identify resistance in each. Define the units of measurements used in the electrical trades and the equipment that is used to measure those values. Calculate the amount of power used by a circuit and explain ways to make the circuit more efficient.</p>	
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<p>Testing Equipment</p>		<p>Use electrical equipment to inspect and test construction wiring systems.</p>	<p>The student gains knowledge in selecting, using, and safely maintaining common electrical test equipment. The student is expected to:</p> <p>(A) explain how to operate test equipment such as ammeter, ohmmeter, volt-ohm-multimeter, continuity tester, and voltage tester;</p> <p>(B) explain how to read specific test equipment and convert from one scale to another when using specified test equipment;</p> <p>(C) explain the importance of proper meter polarity; and</p> <p>(D) explain the difference between digital and analog meters.</p>	<p>Identify various types of testing equipment:</p> <ul style="list-style-type: none"> • Voltmeter • Ohmmeter • Ammeter • Multimeter • Continuity tester • Voltage tester <p>Distinguish among the various types and uses of electrical test equipment by rating category. Determine the appropriate test equipment for a given situation and environment and the procedures necessary for safe use. Utilizing test equipment such as a voltmeter, inspect and test an electrical wiring system for compliance according to drawings, specifications, and code requirements. Determine whether or not an electrical circuit is “live.”</p>	
<p>Electrical Code</p>		<p>Identify local, district, state, and federal regulatory agencies, entities, laws, and regulations related to the Building and Construction Trades industry sector.</p>	<p>The student uses the National Electrical Code and local code applications. The student is expected to:</p> <p>(A) explain the purpose and history of the National Electrical Code;</p>	<p>Locate and assess requirements for performing electrical work including local, state, and national requirements. Interpret electrical codes, and determine inspection procedures and other applicable portions of the law.</p>	

			<p>(B) describe the layout of and explain how to navigate the National Electrical Code; (C) describe the purpose of the National Electrical Manufacturers Association and National Fire Protection Association; and (D) investigate local code applications and local regulatory agencies.</p>	<p>Visit the Colorado Department of Regulatory Agency's Licensing Board's website and analyze its policies and requirements. Explain how such policies impact local construction businesses. Describe the purpose and layout of the National Electrical Code (NEC). Create a chart to illustrate what is and is not covered by the NEC, citing evidence from NEC Article 90. Navigate, read, and interpret the NEC to determine requirements for a given electrical installation. For example, interpret the NEC to compare and contrast the box requirements for a device box to support a wall receptacle with those for a box to support a lighting fixture.</p>	
<p>Raceways, Wireways, and Ducts</p>		<p>Understand the types and applications of raceways, wireways and ducts in the construction electrical industry.</p>	<p>The student learns the types and applications of raceways, wireways, and ducts. The student is expected to: (A) describe various types of cable trays and raceways;</p>	<p>Explain the function of raceway systems, including acting as a grounding conductor. Distinguish among the various types of raceways, fittings, and conduit bodies available for raceway systems. Analyze a given environment and select the appropriate</p>	

			<p>(B) identify and select various types and sizes of raceways;</p> <p>(C) identify and select various types and sizes of cable raceways;</p> <p>(D) identify and select various types of raceway fittings;</p> <p>(E) identify various methods used to install raceways;</p> <p>(F) demonstrate knowledge of National Electrical Code raceway requirements;</p> <p>(G) describe procedures for installing raceways and boxes on masonry surfaces, metal stud systems, wood-framed systems, and drywall surfaces; and</p> <p>(H) recognize safety precautions that must be followed when working with boxes and raceways.</p>	<p>materials and installation methods for a raceway system, citing evidence from textbooks and codes. For example, recommend the appropriate raceway materials and installation method for a wood frame building of given parameters, drawing on evidence from codes such as the National Electrical Code (NEC).</p> <p>Outline the methods and procedures used to install various raceway systems, including terminating conduit. Accurately connect conduit to a box according to code requirements, explaining the need for a proper connection based on grounding requirements and protection of the wires.</p> <p>Apply the appropriate tools and procedures to install flexible raceway systems.</p>	
Wiring		<p>Understand the principle of conduction as applied to construction electrical industry.</p> <p>Determine the allowable ampacity of conductors for a variety of given construction electrical applications.</p>	<p>The student learns the types and applications of conductors and wiring techniques. The student is expected to:</p> <p>(A) demonstrate the various wire sizes using a wire in accordance with</p>	<p>Read and interpret the NEC and other instructional texts to determine the allowable ampacity of conductors for a variety of given applications. Include the insulation and jacket material, conductor size and type, number of</p>	

			<p>American Wire Gauge standards; (B) identify insulation and jacket types according to conditions and applications; (C) describe voltage ratings of conductors and cables; (D) read and identify markings on conductors and cables; (E) use the tables in the National Electrical Code to determine the ampacity of a conductor; (F) state the purpose of stranded wire; (G) state the purpose of compressed conductors; (H) describe the different materials from which conductors are made; (I) describe the different types of conductor insulation; (J) describe the color coding of insulation; (K) describe instrumentation control wiring; (L) describe the equipment required for pulling wire through conduit;</p>	<p>conductors, temperature rating, and voltage rating of each. Describe possible consequences of improper conductor selection or installation, citing evidence from resources such as textbooks or trade journals. Describe the proper methods and procedures for installing conductors in a raceway system, noting potential hazards that exist when conductors are installed incorrectly. Employ tools and procedures to safely install conductors in a raceway system and verify the installation is performed according to code requirements.</p>	
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			(M) describe the procedure for pulling wire through conduit; (N) install conductors in conduit; and (O) pull conductors in a conduit system.		
Electrical Diagrams		Interpret and apply information from technical drawings, schedules, and specifications used in the construction trades. Identify the elements used in technical drawings, including types of lines, symbols, details, and views. Identify plumbing, electrical, and mechanical symbols and other abbreviations used in construction drawings.	The student learns electrical symbols and their use in design drawings. Additionally, students learn to interpret schematics, one-line diagrams, and wiring diagrams. The student is expected to: (A) explain the basic layout of a design drawing; (B) describe the information included in the title block of a drawing; (C) identify common symbols and the various types of lines used on drawings; (D) understand the use of architect's and engineer's scales; (E) interpret electrical drawings such as site plans, floor plans, and detail drawings;	Read and interpret electrical drawings and specifications, including detail drawings and equipment schedules, to create a list of materials needed for a given electrical project. For example, analyze a lighting plan, light fixture schedule, and specifications for a residence to determine the materials needed to install the lighting system. Explain the relationship between construction drawings and specifications. For example, describe how both the construction drawings and specifications provide information about the raceway system indicated for a given building. Examine construction drawings and specifications to determine the requirements for a raceway system in a given building. Describe processes by which construction professionals	

			(F) read equipment schedules found on electrical drawings; and (G) describe the type of information included in electrical specifications.	obtain clarification from architects regarding construction documents, such as by the use of requests for information (RFI's). Write a request for information (RFI) as would a construction professional to an architect to request clarification for a detail of the construction documents, such as the selection of a product.	
Commercial Electrical Devices		Understand commercial applications of construction electrical devices, including industrial construction and maintenance.	The student learns the electrical devices and wiring techniques used in commercial and industrial construction and maintenance. The student is expected to: (A) identify and state the functions and ratings of special switches such as single-pole, double-pole, three-way, four-way, dimmer, and safety switches; (B) explain National Electrical Manufacturers Association classifications as they relate to switches and enclosures; (C) explain the National Electrical Building Code requirements concerning wiring devices;	Identify routine maintenance procedures that should be performed on electrical systems for a given building. Create a timeline of recommended maintenance procedures for a client, justifying why each procedure is necessary by highlighting its preventive or cost-efficient characteristics. For example, create a schedule of tests to ensure emergency alarms are operating properly. Research and present on key differences between commercial and residential electrical code. Identify and explain the application of common commercial devices: <ul style="list-style-type: none"> • Wiring • Switches 	

			<p>(D) identify and state the functions and ratings of wiring devices such as straight blade, twist lock, and pin and sleeve receptacles;</p> <p>(E) identify and define receptacle terminals and disconnects;</p> <p>(F) identify and define ground fault circuit interrupters;</p> <p>(G) explain the box mounting requirements in the National Building Code;</p> <p>(H) use appropriate tools and connectors to strip and splice wires together;</p> <p>(I) identify and state the functions of limit switches and relays; and</p> <p>(J) identify and state the function of switchgear.</p>	<ul style="list-style-type: none"> • Receptacles • Terminals • Disconnects • GFCI <p>Explain basic commercial box mounting requirements and where to find/locate additional code information.</p>	
Residential Electrical Devices		Demonstrate skills necessary to complete an electrical system in a single-family residence in accordance with accepted industry standards.	<p>The student learns the electrical devices and wiring techniques used in residential construction maintenance. The student is expected to:</p> <p>(A) describe how to determine electric service requirements for dwellings;</p>	<p>Evaluate and recommend proper electrical hardware for a residential building. For example, for a residential dwelling with a given floor plan and schedule of major appliances, determine the size of the electrical service by referring to the National Electrical Code and local code to select the service-entrance</p>	

			<p>(B) explain the grounding requirements of a residential electric service;</p> <p>(C) calculate and select service-entrance equipment;</p> <p>(D) select the proper wiring methods for various types of residences;</p> <p>(E) explain the role of the National Electrical Code in residential wiring;</p> <p>(F) compute branch circuit loads and explain their installation requirements;</p> <p>(G) explain the types and purposes of equipment grounding conductors;</p> <p>(H) explain the purpose of ground-fault circuit interrupters and tell where they must be installed;</p> <p>(I) determine the size of outlet boxes and select the proper type for different wiring methods;</p> <p>(J) describe rules for installing electric space heating and heating, ventilating, and air conditioning equipment;</p>	<p>equipment, such as conductors, panelboard, and protective devices. Steps should include: calculating the load for lighting, small appliances, and large appliances; and determining the number of branch circuits required. Describe the installation rules pertaining to dedicated circuits as applied to various equipment such as ranges, dryers, and HVAC systems.</p>	
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			<p>(K) describe the installation rules for electrical systems around swimming pools, spas, and hot tubs;</p> <p>(L) describe the installation and control of lighting fixtures; and</p> <p>(M) explain how wiring devices are selected and installed.</p>		
Electrical Industry		<p>Understand current practices within the Construction Electrical Industry. Research past, present, and projected technological advances as they impact a particular Construction pathway.</p>	<p>Understand and apply current practices used within the construction electrical industry. Student is expected to:</p> <p>(A) identify new technology being used in the industry;</p> <p>(B) identify resources for maintaining industry-specific technical skills and knowledge; and</p> <p>(C) investigate local construction electrical industry business practices.</p>	<p>Research a new technology recently developed for the Electrical industry. Write persuasively to convince an employer how the use of the technology could benefit the company, citing evidence from resources. For example, describe how a new power tool could improve efficiency for a technician. Consult a variety of sources to describe alternatives to traditional project delivery methods, such as the design-build and construction management-related methods, distinguishing among the roles and relationships of various construction personnel in each scenario.</p>	

