

## Colorado CTE Course – Scope and Sequence

| Course Name                                                                                                                                                                                                                                                                                                                        | Mechanical, Electrical, and Plumbing Systems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                  | Course Details                                                                                                                                                                                                                           | Credit = 1.0 (Semester A and B)<br>Prerequisite: (Suggested) Principles of Construction                                                                                                                                                                                                   |                            |
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| Course Description                                                                                                                                                                                                                                                                                                                 | Mechanical, Electrical, and Plumbing Systems prepares students for electrical, plumbing, and HVAC careers by introducing students to the physical principles of these systems and the fundamental skills needed to work with them. Upon completion of this course, proficient students will be able to follow safety procedures and use tools to perform basic operations with electrical circuits, as well as demonstrate understanding in fundamental concepts of electricity theory (i.e. Ohm’s Law). Students will be able to apply proper tools and procedures to perform basic operations with plastic piping, including measuring, cutting, and joining pipe. Furthermore, students will be able to apply mathematics concepts to solve HVAC, electrical, and plumbing problems. This course is intended to provide an introduction and lay a solid foundation for those students entering the construction or craft skilled areas. The course provides a strong knowledge of construction safety, construction mathematics, and common hand and power tools. This course also provides communication and occupation skills to assist the student in obtaining and maintaining employment. |                                                                                                                                                                                                                  |                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                           |                            |
| 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 #                                                                                                                                                                                                                                                                                                              | 13102                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 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 <a href="https://www.cde.state.co.us/standardsandinstruction/essentialskills">https://www.cde.state.co.us/standardsandinstruction/essentialskills</a> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                  |                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                           |                            |
| Instructional Unit Topic                                                                                                                                                                                                                                                                                                           | Suggested Length of Instruction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | CTE or Academic Standard Alignment                                                                                                                                                                               | Competency / Performance Indicator                                                                                                                                                                                                       | Outcome / Measurement                                                                                                                                                                                                                                                                     | CTSO Integration           |
| Safety                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Incorporate safety procedures when operating tools and equipment. Comply with regulations and applicable codes to establish and manage a legal and safe workplace/jobsite.                                       | Identify safety hazards on a jobsite and demonstrate practices for safe working. Accurately read, interpret, and demonstrate adherence to safety rules, including but not limited to rules pertaining to electrical safety, Occupational | Demonstrate safe procedures to move materials by planning the movement, properly lifting, stacking, and storing materials, and selecting proper materials-handling equipment. Perform a hazard assessment for a given task, such as working on a ladder to install electrical components. | SkillsUSA Workplace skills |

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|                            |  |                                                                                                                                                                                                                | <p>Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Maintain safety records and demonstrate adherence to industry-standard practices regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety to protect all personnel and equipment.</p> | <ul style="list-style-type: none"> <li>Explain the steps necessary to safely perform the task, outlining steps to take in case of an emergency.</li> </ul> <p>Locate material safety data sheets (MSDS), explain their function and how to interpret the information presented. Read and discuss information on OSHA, EPA and other safety regulations. Pass safety inspections and comply with regulations at all times.</p>                                                                                           |                                                                     |
| <b>Tools and Equipment</b> |  | <p>Demonstrate the construction crafts required for each phase of a given project. Safely use and maintain appropriate tools, machinery, equipment and resources to accomplish construction project goals.</p> | <p>Apply tools and equipment found in the electrical, plumbing and HVAC trades.</p>                                                                                                                                                                                                                                               | <p>Select appropriate supplies for a simple electrical installation and repair: conduit, boxes, clamps, conductor, wiring, wire stripper, multimeter, pliers, etc.</p> <p>Select appropriate tools and supplies required for a basic plumbing installation and repair: tongue-and-groove pliers, basin wrench, compression sleeve puller, pipe wrench, adjustable wrench, propane torch, flux, hacksaw, metal file, tube cutter, plunger/auger, etc.</p> <p>Select appropriate tools and suppliers for a basic HVAC</p> | <p>SkillsUSA<br/>Technical Skills<br/>Grounded in<br/>Academics</p> |

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|                           |  |                                                                                                                                    |                                                                                                                        | <p>installation and repair:<br/>cordless drill, cordless saw,<br/>tape measure, screwdrivers,<br/>hammer, drill bits,<br/>shears/snips, PVC cutter, caulk<br/>gun, etc.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                              |
| <b>Career Exploration</b> |  | <p>Evaluate a wide range of<br/>career pathway<br/>opportunities for success in<br/>architecture and<br/>construction careers.</p> | <p>Compare and contrast<br/>career opportunities<br/>within the HVAC,<br/>electrical, and plumbing<br/>industries.</p> | <p>Produce a chart or other<br/>graphic comparing the skills,<br/>responsibilities, and personal<br/>characteristics of successful<br/>professionals in each of the<br/>three industries.<br/>Research and create a<br/>personnel profile or a mock<br/>job description for one of<br/>these professionals, including<br/>skills and characteristics<br/>during a typical day on the job<br/>Explain what an<br/>apprenticeship is, referencing<br/>data from the U.S.<br/>Department of Labor and<br/>other sources. Write<br/>persuasively to describe the<br/>benefits of the apprenticeship<br/>approach of on-the-job<br/>training paired with related<br/>training for individuals seeking<br/>construction careers. Use a<br/>variety of sources to gather<br/>data, cite each source, and<br/>briefly describe why the<br/>chosen source is reliable.<br/>Research apprenticeships and<br/>postsecondary institutions<br/>(technical colleges,</p> | <p>Updates to<br/>ICAP<br/>SkillsUSA<br/>Personal Skills</p> |

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|                             |  |                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                 | community colleges, and four-year universities) in Colorado and other states that offer construction-related programs. Write an informative paper or develop an infographic identifying entry requirements for a specific apprenticeship or postsecondary program of study, and the secondary courses that will prepare students to be successful in the program.                                               |                                 |
| <b>Trades Relationships</b> |  | Use effective communication skills and strategies (listening, speaking, reading, writing and graphic communications) to work with clients and colleagues. Understand the integral systems that impact the design of buildings and structures. | Examine how the roles and responsibilities among construction trades and professions work in relationship to completing a project. Identify the purpose of building codes and the roles of various entities or individuals in their use and application to complete a project. Describe how electricians, plumbers, and HVAC technicians coordinate work with other construction personnel to complete a project, including submitting bids for | Create a graphic which Explains inspection procedures used to enforce building codes during the construction of a residential or commercial building, outlining the roles and responsibilities of the building inspector and the contractor and the intervals at which inspections are performed. Present a best practice communication model to be used on the job-site involving multiple trades specialties. | SkillsUSA Teamworks Competition |

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|                                                                        |  |                                                                              | subcontracted work and requesting clarification through an RFI (request for information) process.                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                               |
| <b>Math Applications for HVAC, Electrical and Plumbing Professions</b> |  | Apply mathematics concepts to solve HVAC, electrical, and plumbing problems. | <p>The student understands basic construction mathematics for use in electrical, plumbing and HVAC trades. The student is expected to:</p> <p>Perform conversions between the metric system and the English system and among units within the metric system. Calculate the square and square root of numbers. Solve algebraic equations. Calculate values associated with angles and triangles.</p> | <p>Apply mathematics concepts to solve HVAC, electrical, and plumbing problems, distinguishing which principles apply to a given problem. Concepts should include, but are not limited to:</p> <p>Concepts from Fundamentals of Construction:</p> <ol style="list-style-type: none"> <li>Operating with whole numbers, fractions, and decimals.</li> <li>Performing conversions between fractions, decimals, and percentages. For example, convert a decimal to a fraction to prepare a unit for measurement on a fractional scale to the precision of 1/16 of an inch.</li> <li>Working with units such as feet, inches, meters, centimeters, and millimeters, and determining appropriate units for a given construction task. For example, determine how many pieces of 2 ft. 4 in. PVC pipe may be cut from a 10 ft. piece and how much pipe will be left over.</li> <li>Calculating the area of two-dimensional spaces.</li> </ol> | <p>SkillsUSA Technical Skills Grounded in Academics SkillsUSA Applied Mathematics Contest</p> |

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|                           |  |                                                                                    |                                                                                                                                                                                                                                                                                     | <p>Calculating surface area and volume for three-dimensional objects employing related geometric terminology.</p> <p>e. Performing proportionate reasoning to estimate quantities.</p> <p>f. Using basic rules of right triangles, such as the Pythagorean Theorem, to find missing lengths.</p> <p>Additional Concepts:</p> <p>g. Performing conversions between the metric system and the English system and among units within the metric system.</p> <p>h. Calculating the square and square root of numbers.</p> <p>i. Solving algebraic equations.</p> <p>j. Calculating values associated with angles and triangles.</p> |                                                                                                                                                           |
| <b>Electrical Systems</b> |  | Understand and apply practices and procedures required to maintain jobsite safety. | Describe how different levels of electrical shock affect the human body. Apply knowledge of electrical theory to electrical circuits and components. Compare and contrast the instruments used to measure voltage, resistance, and current. Apply Ohm's law and Kirchhoff's laws to | <p>Research current OSHA standards and other regulations specific to job-site electrical safety to identify methods and equipment to reduce the risk of injury due to electrical shock.</p> <p>Apply lockout/tagout procedures to ensure safe conditions for working on electrical systems.</p> <p>Explain the difference between conductors and insulators.</p>                                                                                                                                                                                                                                                                | <p>SkillsUSA</p> <p>Technical Skills</p> <p>Grounded in</p> <p>Academics</p> <p>SkillsUSA</p> <p>Electrical</p> <p>Contest; Team</p> <p>Works Contest</p> |

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|  |  |  | <p>solving given problems in electrical circuits.</p> <p>Understand the difference between resistive and inductive loads in electrical circuits and explain how physical laws apply.</p> <p>Apply knowledge of basic electrical circuits to a residential wiring system.</p> <p>Analyze the composition and properties of conductors.</p> <p>Determine the procedures necessary to safely replace or install electrical devices in a device box, such as a light fixture, receptacle, or switch.</p> | <p>Demonstrate understanding of the layout and operation of electrical circuits (series, parallel, and series-parallel circuits).</p> <p>Define voltage, resistance, current, and the units of measure associated with each.</p> <p>Describe the relationship between voltage, resistance, and current as defined by Ohm's law.</p> <p>Present a solution to an electrical challenge that explains the cause and relationship effect of Ohm's Law and Kirchoff's Law on:</p> <ul style="list-style-type: none"> <li>• Voltage</li> <li>• Current</li> <li>• Resistance</li> <li>• Voltage drop</li> </ul> <p>In a written or oral presentation, explain a simple residential electrical wiring plan to a peer, accurately describing the name and function of each component, how the components work together, and the impact of the physical laws on the circuit.</p> <p>Apply knowledge about conductors and electrical lockout/tagout procedures to safely complete installations of a device in a device box.</p> |  |
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| <b>Plumbing Systems</b> |  | <p>Understand the relationship of safety in the plumbing occupation to public and private health concerns. Apply scientific principles to common plumbing applications.</p> <p>Understand technical relationships between plumbing systems and the collection and movement of water and waste-water in buildings.</p> | <p>Examine safety considerations specific to plumbers by identifying possible hazards on a job site.</p> <p>Determine common requirements found in plumbing codes and explain why the codes are necessary; include the importance of proper plumbing on human health.</p> <p>Describe the movement of potable water and waste within the plumbing systems of a building, drawing distinctions between water supply systems and drain, waste, and vent systems.</p> | <p>In a written or oral presentation, explain how to work safely in and around confined spaces and trenches. Construct a model to explain how physical principles such as gravity and pressure apply within plumbing systems, and how they contribute to the proper functioning and efficiency of the system.</p> <ul style="list-style-type: none"> <li>• Illustrate why an understanding of these physical principles is important to a plumbing professional in the design, installation, maintenance, and repair of plumbing systems.</li> </ul> <p>Examine a health or safety issue involved with plumbing. Write an explanatory text to illustrate the problem and describe how it can be prevented or remedied with proper plumbing applications.</p> | <p>SkillsUSA Technical Skills Grounded in Academics SkillsUSA Plumbing Contest; Team Works Contest</p> |
| <b>Piping</b>           |  | <p>Demonstrate the construction crafts required for each phase of a given project.</p>                                                                                                                                                                                                                                | <p>Analyze the parts of a pipe fitting including the face, center, and back. Determine fitting allowances by using</p>                                                                                                                                                                                                                                                                                                                                             | <p>Create a list of the items needed for a specific plumbing installation. Describe the factors influencing the decision to use various piping</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <p>SkillsUSA Technical Skills Grounded in Academics</p>                                                |

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|                     |  | <p>Safely use and maintain appropriate tools, machinery, equipment and resources to accomplish construction project goals.</p> | <p>measuring and calculating techniques and by consulting manufacturer's tables. Calculate the length of pipe needed for a given application by implementing common pipe measuring techniques.</p> <p>Compare and contrast the material properties and uses of the various types of plastic piping, including storing and handling, safety issues, and types of fitting and hanging equipment.</p> <p>Apply appropriate plastic piping in plumbing systems and HVAC systems.</p> <p>Employ tools and procedures to safely measure, cut, ream, and join plastic piping and fittings.</p> | <p>materials and tools in a residence and demonstrate the ability to use the correct materials, tools, and PPE.</p>                                                                                                                                            | <p>SkillsUSA Plumbing Contest; Team Works Contest</p>                          |
| <b>HVAC Systems</b> |  | <p>Understand and apply practices and procedures required to maintain jobsite safety.</p>                                      | <p>Examine safety considerations specific to HVAC technicians by identifying possible hazards on a job site.</p> <p>Describe the basic components included in an HVAC system and identify key information</p>                                                                                                                                                                                                                                                                                                                                                                           | <p>Analyze the regulations that impact the work of HVAC technicians, such as the Clean Air Act and EPA guidelines. Create an informational artifact summarizing these regulations to an individual contemplating starting an HVAC business, explaining key</p> | <p>SkillsUSA Technical Skills Grounded in Academics SkillsUSA HVAC Contest</p> |

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|                                                 |  |                                                                                                      | <p>from blueprints, manuals, and manufacturers' specifications.</p> <p>Understand the fundamental concepts of heating and combustion, including describing the processes by which heat is transferred.</p>                                    | <p>considerations and citing resources that the future business owner can consult.</p> <p>Create an artifact which describes the negative consequences that can arise due to a poorly functioning or improperly installed HVAC system.</p> <p>Relate the types of heat transfer to the various heating systems used within a building.</p> <p>Conduct a mock energy audit. Citing the principles of heat transfer, propose strategies the homeowner could use to conserve energy in the home.</p> |  |
| <b>Construction Drawings and Specifications</b> |  | <p>Read, interpret, and use technical drawings, documents, and specifications to plan a project.</p> | <p>Inspect and interpret a full set of construction drawings and specifications for a construction project including civil, architectural, structural, mechanical, plumbing, electrical, and fire protection drawings and specifications.</p> | <p>Identify elements and symbols of blueprints and drawings. Explain the relationship between different types of drawing and the importance of cross-referencing different types of drawings with one another and cross-referencing drawings with specifications.</p>                                                                                                                                                                                                                             |  |
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## Academic Standards Alignment

Colorado CTE courses are required to integrate academic and essential skills into course content. The following academic standards have been identified as aligned to this course and should be integrated throughout instruction.

[CO CTE Academic Standards Resources](#) (Rubrics, integration strategies, etc) [CDE Colorado Academic Standards Online](#) (Online standards lookup tool)

## **Reading, Writing, & Communicating**

### **Standard 1: Oral Expression and Listening**

- **Prepared Graduate 1:** Collaborate effectively as group members or leaders who listen actively and respectfully; pose thoughtful questions, acknowledge the ideas of others; and contribute ideas to further the group's attainment of an objective.
- **Prepared Graduate 2:** Deliver effective oral presentations for varied audiences and varied purposes.

### **Standard 2: Reading for All Purposes**

- **Prepared Graduate 4:** Read a wide range of informational texts to build knowledge and to better understand the human experience.
- **Prepared Graduate 5:** Understand how language functions in different contexts, command a variety of word-learning strategies to assist comprehension, and make effective choices for meaning or style when writing and speaking.

### **Standard 3: Writing and Composition**

- **Prepared Graduate 8:** Craft narratives using techniques specific to the genre.
- **Prepared Graduate 9:** Demonstrate mastery of their own writing process with clear, coherent, and error-free polished products.

### **Standard 4: Research Inquiry and Design**

- **Prepared Graduate 10:** Gather information from a variety of sources; analyze and evaluate its quality and relevance; and use it ethically to answer complex questions.

*Note: Mathematics and Science standards will be added in the future. Visit the [Colorado Academic Standards](#) page for the most current version.*