

## Colorado CTE Course – Scope and Sequence

<b>Course Name</b>	<b>HVAC Technology II</b>		<b>Course Details</b>	<b>Credit = 1.0-2.0</b>	
			<b>Course = 0.50 Carnegie Unit Credit</b>	<b>Prerequisite: HVAC Technology I</b>	
				<b>CTE Credential: CTE Manufacturing or CTE Architecture and Construction</b>	
<b>Course Description</b>	In Heating, Ventilation, and Air Conditioning (HVAC) and Refrigeration Technology II, students will gain advanced knowledge and skills needed to enter the industry as HVAC and refrigeration technicians or building maintenance technicians or supervisors, 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, use of tools, codes, installation of commercial HVAC equipment, heat pumps, troubleshooting techniques, various duct systems, and maintenance practices.				
<b>Note:</b>	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 #	17055	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>					
<b>Instructional Unit Topic</b>	<b>Suggested Length of Instruction</b>	<b>CTE or Academic Standard Alignment</b>	<b>Competency / Performance Indicator</b>	<b>Outcome / Measurement</b>	<b>CTSO Integration</b>
<b>Career Development</b>		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 in occupations such as HVAC technician, building maintenance technician	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.	

			<p>or manager, and electrical engineer; and</p> <p>(B) research career pathways along with the education, job skills, and experience required to achieve a career goal.</p>		
<b>Commercial Air Systems</b>		<p>Describe the basic components and concepts of heating, air-conditioning, and refrigeration commercial systems.</p> <p>Explain the major functions of a building-management system.</p>	<p>The student learns the principles of commercial air systems. The student is expected to:</p> <p>(A) identify the differences between types of commercial air systems;</p> <p>(B) identify the type of building in which a particular type of system is used; and</p> <p>(C) explain the typical range of capacities for a commercial air system.</p>		
<b>Vent Systems</b>		<p>Demonstrate a practical knowledge of combustion heating systems.</p> <p>Determine the suitable application, and analyze the proper functioning, of gas valves and regulators.</p>	<p>The student knows the principles of venting fossil-fuel furnaces and the proper methods for selecting and installing vent systems for gas-fired</p>		

			<p>heating equipment. The student is expected to:</p> <p>(A) describe the principles of combustion and explain complete and incomplete combustion;</p> <p>(B) describe the content of flue gas and explain how it is vented;</p> <p>(C) identify the components of a furnace vent system;</p> <p>(D) describe how to select and install a vent system;</p> <p>(E) perform the adjustments necessary to achieve proper combustion in a gas furnace;</p> <p>(F) describe the techniques for venting different types of furnaces;</p> <p>(G) explain the various draft control devices used with natural-draft furnaces;</p>		
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			<p>(H) calculate the size of a vent required for a given application; and</p> <p>(I) adjust a thermostat heat anticipator.</p>		
<b>Hydronic Systems</b>		<p>Understand how hydronic systems are used to transfer heat.</p> <p>Identify the components of hydronic systems and understand their operational functions.</p>	<p>The student gains knowledge of hot water heating systems, focusing on safe operation of the low-pressure boiler and piping systems commonly used in residential applications. The student is expected to:</p> <p>(A) explain the terms and concepts used when working with hot-water heating;</p> <p>(B) identify the major components of hot-water heating;</p> <p>(C) explain the purpose of each component of hot-water heating;</p> <p>(D) demonstrate the safety precautions used when working with hot-water systems;</p>		

			<p>(E) demonstrate how to operate selected hot-water systems;</p> <p>(F) demonstrate how to safely perform selected operating procedures on low-pressure systems;</p> <p>(G) identify the common piping configurations used with hot-water heating;</p> <p>(H) explain how to read the pressure across a water system circulating pump;</p> <p>(I) calculate heating water flow rates; and</p> <p>(J) select a pump for a given application.</p>		
<p><b>Humidity Control</b></p>		<p>Demonstrate practical knowledge of systems designed to improve air quality.</p> <p>Define relative, specific, and absolute humidity.</p> <p>Compare and contrast the benefits of air-filtration, air-handling, and ventilation systems.</p>	<p>The student learns the basic principles, processes, and devices used to control humidity and air clean-lines as well as devices used to conserve energy in HVAC systems. The student is expected to:</p>		

			<p>(A) explain why it is important to control humidity in a building;</p> <p>(B) recognize the various kinds of humidifiers used with HVAC systems and explain why each is used;</p> <p>(C) demonstrate how to install and service the humidifiers used in HVAC systems;</p> <p>(D) recognize the kinds of air filters used with HVAC systems and explain why each is used;</p> <p>(E) demonstrate how to install and service the filters used in HVAC systems;</p> <p>(F) use a manometer or differential pressure gauge to measure the friction loss of an air filter;</p> <p>(G) identify accessories commonly used with air conditioning systems to improve indoor air quality and reduce energy cost and explain the function of each, including humidity</p>		
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			<p>control devices, air filtration devices, and energy conservation devices; and</p> <p>(H) demonstrate or describe how to clean an electronic air cleaner.</p>		
<b>Refrigerant</b>		<p>Locate and explain the uses of refrigerant flow accessories.</p>	<p>The student gains the knowledge and skills in the handling of refrigerant and equipment servicing procedures to service HVAC systems in an environmentally safe manner. The student is expected to:</p> <p>(A) identify the common types of leak detectors and explain how each is used;</p> <p>(B) perform leak detection tests using selected methods;</p> <p>(C) identify the service equipment used for evacuating a system and explain why each item of equipment is used;</p>		

			<p>(D) perform system evacuation and dehydration;</p> <p>(E) identify the service equipment used for recovering refrigerant from a system and for recycling the recovered refrigerant and explain why each item of equipment is used;</p> <p>(F) perform a refrigerant recovery;</p> <p>(G) evacuate a system to a deep vacuum;</p> <p>(H) identify the service equipment used for charging refrigerant into a system and explain why each item of equipment is used;</p> <p>(I) use nitrogen to purge a system; and</p> <p>(J) charge refrigerant into a system using various methods, including weight, superheat, sub-cooling, and charging pressure chart.</p>		
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<p><b>Transformers</b></p>		<p>Understand how transformers operate and identify various types of transformers used in HVAC systems.</p> <p>Understand electrical theory applications for HVAC systems and components.</p>	<p>The student gains knowledge of transformers, single-phase and three-phase power distribution, capacitors, theory and operation of induction motors, and instruments and techniques used in testing alternating current circuits and components. The student is expected to:</p> <p>(A) describe the operation of various types of transformers;</p> <p>(B) explain how alternating current is developed and draw a sine wave;</p> <p>(C) identify single-phase and three-phase wiring arrangements;</p> <p>(D) explain how phase shift occurs in inductors and capacitors;</p> <p>(E) describe the types of capacitors and their applications;</p> <p>(F) explain the operation of single-phase and</p>	<p>Explain how transformers operate and identify various types of transformers used in HVAC systems. (Identify various forms of single-phase and three-phase transformers.)</p> <p>Explain how AC power is generated and how it is used.</p>	
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			<p>three-phase induction motors;</p> <p>(G) identify the various types of single-phase motors and their applications;</p> <p>(H) state and demonstrate the safety precautions that must be followed when working with electrical equipment; and</p> <p>(I) test alternating current components, including capacitors, transformers, and motors.</p>		
<p><b>Solid-State Electronics</b></p>		<p>Identify and explain the operations of electrical control systems and their components.</p>	<p>The student learns the theory of solid-state electronics as well as the operation, use, and testing of the various electronic components used in HVAC equipment. The student is expected to:</p> <p>(A) explain the theory of electronics and semiconductors;</p> <p>(B) explain how various semiconductor devices</p>		

			<p>such as diodes, light emitting diodes, and photo diodes work and how the devices are used in power and control circuits;</p> <p>(C) identify different types of resistors and explain how their resistance values can be determined;</p> <p>(D) describe the operation and function of thermistors and cad cells;</p> <p>(E) test semiconductor components; and</p> <p>(F) identify the connectors on a personal computer.</p>		
<p><b>Thermostats and System Controls</b></p>		<p>Troubleshoot electrical control systems, motors, and their components.</p> <p>Describe the operation and function of different types of electromechanical thermostats.</p>	<p>The student learns the operation, testing, and adjustment of conventional and electronic thermostats as well as the operation of common electrical, electronic, and pneumatic circuits used to control HVAC systems. The student is expected to:</p>		

			<p>(A) explain the function of a thermostat in an HVAC system;</p> <p>(B) describe different types of thermostats and explain how the thermostats are used;</p> <p>(C) demonstrate the correct installation and adjustment of a thermostat;</p> <p>(D) explain the principles applicable to all control systems;</p> <p>(E) identify the various types of electromechanical, electronic, and pneumatic HVAC controls and explain their function and operation;</p> <p>(F) describe a systematic approach for electrical troubleshooting of HVAC equipment and components;</p> <p>(G) recognize and use equipment manufacturers' troubleshooting aids to</p>		
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			<p>troubleshoot HVAC equipment;</p> <p>(H) demonstrate how to isolate electrical problems to faulty power distribution, load, or control circuits;</p> <p>(I) identify the service instruments needed to troubleshoot HVAC electrical equipment;</p> <p>(J) make electrical troubleshooting checks and measurements on circuits and components common to all HVAC equipment; and</p> <p>(K) isolate and correct malfunctions in a cooling system control circuit.</p>		
<p><b>Troubleshooting Gas Heating Systems</b></p>		<p>Demonstrate the skills necessary to service, maintain, and repair heating, air-conditioning, and refrigeration system components and accessories.</p> <p>Analyze, troubleshoot, and correct mechanical problems in a heating, air-conditioning, and refrigeration system.</p>	<p>The student learns the tools, instruments, and techniques used in troubleshooting gas heating appliances, including how to isolate and correct faults. The student is expected to:</p>		

			<p>(A) describe the operating sequence for gas heating equipment;</p> <p>(B) interpret control circuit diagrams for gas heating systems;</p> <p>(C) describe the operation of various types of burner ignition methods;</p> <p>(D) identify the tools and instruments used when troubleshooting gas heating systems;</p> <p>(E) demonstrate using the tools and instruments required for troubleshooting gas heating systems; and</p> <p>(F) isolate and correct malfunctions in gas heating systems.</p>		
<p><b>Troubleshooting Cooling Systems</b></p>		<p>Demonstrate the skills necessary to service, maintain, and repair heating, air-conditioning, and refrigeration system components and accessories.</p>	<p>The student learns the techniques and equipment used in troubleshooting cooling equipment and analyzing system temperatures and pressures in order to</p>		

		<p>Analyze, troubleshoot, and correct mechanical problems in a heating, air-conditioning, and refrigeration system.</p>	<p>isolate faults. The student is expected to:</p> <p>(A) describe a systematic approach for troubleshooting cooling systems and components;</p> <p>(B) isolate problems to electrical and mechanical functions in cooling systems;</p> <p>(C) recognize and use equipment manufacturers' troubleshooting aids to troubleshoot cooling systems;</p> <p>(D) identify and use the service instruments needed to troubleshoot cooling systems;</p> <p>(E) troubleshoot selected problems in cooling equipment; and</p> <p>(F) state the safety precautions associated with cooling troubleshooting.</p>		
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<p><b>Reverse-cycle Heating</b></p>		<p>Understand the operation of heat pump systems.</p>	<p>The student learns the principles of reverse-cycle heating, the operation of various types of heat pumps, and the mechanisms of heat pump control circuits and learns to install and service heat pumps. The student is expected to:</p> <p>(A) describe the principles of reverse-cycle heating;</p> <p>(B) identify heat pumps by type and general classification;</p> <p>(C) describe various types of geothermal water loops and their application;</p> <p>(D) list the components of heat pump systems;</p> <p>(E) describe the role and operation of electric heat in common heat pump systems;</p> <p>(F) describe common heat pump ratings such as coefficient of performance, heating season performance</p>	<p>Explain how heat pumps can extract heat from air and water.</p> <p>Describe common heat pump ratings such as coefficient of performance, heating season performance factor, and seasonal energy efficiency ratio. Explain how these are determined.</p> <p>Describe the operation of heat pump systems and the principles of reverse-cycle heating.</p> <p>Describe sources of supplemental and/or emergency heat used in heat pump systems.</p> <p>Describe the operation of electric heating equipment commonly used with heat pumps.</p>	
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			<p>factor, and seasonal energy efficiency ratio;</p> <p>(G) demonstrate heat pump installation and service procedures;</p> <p>(H) identify and install refrigerant circuit accessories commonly associated with heat pumps;</p> <p>(I) analyze a heat pump control circuit; and</p> <p>(J) isolate and correct malfunctions in a heat pump.</p>		
<p><b>Fasteners, Gaskets, Seals and Lubricants</b></p>		<p>Identify and describe common gaskets, packing materials, seals, and bearings used in HVAC equipment.</p>	<p>The student selects the application and installation of various types of fasteners, gaskets, seals, and lubricants as well as the installation and adjustment of different types of belt drives, bearings, and couplings. The student is expected to:</p>		

			<p>(A) identify, explain, and install threaded and non-threaded fasteners;</p> <p>(B) identify, remove, and install types of gaskets, packings, and seals;</p> <p>(C) identify types of lubricants and explain their uses;</p> <p>(D) use lubrication equipment to lubricate motor bearings;</p> <p>(E) identify the types of belt drives, explain their uses, and demonstrate procedures used to install or adjust them;</p> <p>(F) identify and explain types of couplings;</p> <p>(G) demonstrate procedures used to remove, install, and align couplings;</p> <p>(H) identify types of bearings and explain their uses;</p> <p>(I) explain causes of bearing failures;</p>		
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			<p>(J) demonstrate procedures used to remove and install bearings;</p> <p>(K) perform preventive maintenance inspection and cleaning procedures; and</p> <p>(L) list ways to develop and maintain good customer relations.</p>		
<b>Sheet metal work</b>		<p>Understand the application of sheet metal in the fabrication of ductwork of HVAC systems.</p> <p>Describe the processes to join and install sheet metal duct.</p>	<p>The student demonstrates how to lay out, fabricate, install, and join sheet metal ductwork. The student is expected to:</p> <p>(A) identify and describe the types of sheet metal;</p> <p>(B) define properties of steel and aluminum alloys;</p> <p>(C) describe a layout method and perform proper cutting;</p> <p>(D) join sheet metal duct sections using proper seams and connectors;</p>		

			<p>(E) describe proper hanging and support methods for sheet metal ductwork;</p> <p>(F) describe thermal and acoustic insulation principles;</p> <p>(G) select, apply, and seal the proper insulation for sheet metal ductwork;</p> <p>(H) describe guidelines for installing components such as register, diffusers, grilles, dampers, access doors, and zoning accessories; and</p> <p>(I) install takeoffs and attach flexible duct to a sheet metal duct.</p>		
<b>Fiberglass Ductwork</b>		Describe the standards and application considerations related to fiberglass duct.	The student gains the knowledge and skills to lay out, fabricate, install, join, attach, and support fiberglass ductwork and fittings. The student is expected to:		

			<p>(A) identify types of fiberglass duct, including flexible duct;</p> <p>(B) describe fiberglass duct layout and some basic fabrication methods;</p> <p>(C) describe the various closure methods for sealing fiberglass duct;</p> <p>(D) fabricate selected duct modules and fittings using the appropriate tools;</p> <p>(E) describe hanging and support methods for fiberglass duct;</p> <p>(F) describe how to repair major and minor damage to fiberglass duct; and</p> <p>(G) install takeoffs and attach flexible duct to a fiberglass duct.</p>		
