Tennessee CTE

Mechanical, Electrical, & Plumbing Systems

Safety 1

1 **Safety Hazards and Rules: 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 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. Perform a hazard assessment for a given task, such as working on a ladder to install electrical components. Explain the steps necessary to safely perform the task, outlining steps to take in case of an emergency.** 1.1

2 **Safety Practices: Continue to 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. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational Safety & Health Administration (OSHA) regulations. Incorporate safety procedures when operating tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete safety test with 100 percent accuracy.** 1.2

3 **Materials Safety: Follow procedures to work safely around materials. Adhere to responsibilities for employees in material safety as outlined by the Hazard Communication Standard (HazCom), such as locating and interpreting material safety data sheets (MSDS). Demonstrate safe procedures to move materials by planning the movement, properly lifting, stacking, and storing materials, and selecting proper materialshandling equipment.** 1.3

Tools & Equipment 2

1 **Tools: For each of the systems covered in this course, identify and select the proper tools and 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. For example, demonstrate the ability to safely use a deburring tool to ream a pipe end and effectively clean and store the tool.** 2.1

Career Exploration 3

1 **Career Opportunities: Compare and contrast career opportunities within the HVAC, electrical, and plumbing industries. Building on career exploration conducted in Fundamentals of Construction, produce a chart or other graphic comparing the skills, responsibilities, and personal characteristics of successful professionals in each of the three industries. Drawing on the research, create a**

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personnel profile or a mock job description for one of these professionals, citing the use of skills and characteristics during a typical day on the job. 3.1

2 **Apprenticeship: Explain what an apprenticeship is, referencing data from the U.S. Department of Labor and other sources. Describe the benefits of the apprenticeship approach of on-the-job training paired with related training for individuals seeking construction careers.** 3.2

3 **Postsecondary Opportunities: Research apprenticeships and postsecondary institutions (colleges of applied technology, community colleges, and four-year universities) in Tennessee and other states that offer construction-related programs. Identify the 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.** 3.3

Construction Industry Principles 4

1 **Construction Trades on the Project: Examine how the roles and responsibilities among construction trades and professions work in relationship to completing a project. Describe how electricians, plumbers, and HVAC technicians coordinate work with other construction personnel to complete a project, including submitting bids for subcontracted work and requesting clarification through a RFI (request for information) process.** 4.1

2 **Building Code Enforcement: Explain 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.** 4.2

Construction Math 5

1 **Use Math: 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: Concepts from Fundamentals of Construction:** 5.1

a Operating with whole numbers, fractions, and decimals. 5.1.A

b 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. 5.1.B

c 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. 5.1.C

d Calculating the area of two-dimensional spaces. Calculating surface area and volume for three-dimensional objects employing related geometric terminology. 5.1.D

e Performing proportionate reasoning to estimate quantities. 5.1.E

Using basic rules of right triangles, such as the Pythagorean Theorem, to find missing lengths. 5.1.F

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Additional Concepts:

g Performing conversions between the metric system and the English system and among units within the metric system. 5.1.G

h Calculating the square and square root of numbers. 5.1.H

i Solving algebraic equations. 5.1.I

j Calculating values associated with angles and triangles. 5.1.J

Electrical Systems 6

1 **Electrical Shock Prevention: Describe how different levels of electrical shock affect the human body. 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. Drawing on evidence from textbooks and OSHA standards, apply lockout/tagout procedures to ensure safe conditions for working on electrical systems. For example, perform a lockout/tagout on a circuit breaker.** 6.1

2 **Electrical Circuits and Materials: Examine basic electrical circuits and components. Explain the difference between conductors and insulators. Demonstrate understanding of the layout and operation of electrical circuits (series, parallel, and series-parallel circuits). Define voltage, resistance, current, and the units of measure associated with each. Describe the relationship between voltage, resistance, and current as defined by Ohm's law. Compare and contrast the instruments used to measure voltage, resistance, and current.** 6.2

3 **Voltage and Current: Apply Ohm's law and Kirchhoff's laws to solving given problems in electrical circuits. Defend the solution using supporting evidence that explains the cause and effect relationship between the laws and each of the following:** 6.3

a Voltage 6.3.A

b Current 6.3.B

c Resistance 6.3.C

d Voltage drop 6.3.D

For example, use Ohm's law to calculate the current flow of a circuit for an electric dryer with a given voltage and resistance.

4 **Electrical Components: Building on knowledge of basic electrical circuits, examine a residential wiring system and explain the layout and the basic function of each component in the system (i.e. service entrance, electric meter, service entrance panel, subpanel, circuit breakers, switches, receptacles, and conductors). Distinguish between branch circuits and feeder circuits. Describe the difference between resistive and inductive loads in electrical circuits and explain how physical laws apply. Study a residential wiring plan and identify common electrical symbols used. Explain a simple residential electrical wiring plan, accurately describing the name and function of each component, how the components work together, and the impact of the physical laws on the circuit.** 6.4

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	5	**Conductors: Analyze the composition and properties of conductors. Explain how the markings on a conductor relate to the physical properties of the conductor, including the insulation and jacket material, conductor size and type, number of conductors, temperature rating, voltage rating, and permitted uses of the conductor. Inspect electrical charts and tables to determine the ampacity of a given conductor and to draw conclusions about the relationships among the physical properties of a conductor, such as size and ampacity. Explain how color coding is used to distinguish among conductor purposes. Interpret the meaning of color and markings on conductors.** 6.5
	6	**Replace Devices: Determine the procedures necessary to safely replace or install electrical devices in a device box, such as a light fixture, receptacle, or switch. Draw on resources such as the device manufacturer's instructions and other instructional texts to determine the tools, steps, and safety procedures involved. Apply knowledge about conductors and electrical lockout/tagout procedures to safely complete installations of a device in a device box. Steps should include using test equipment to verify the power is off and connecting conductors to the proper terminals. For example, install a single-pole switch in a device box.** 6.6
Plumbing Systems 7	1	**Plumbing Safety: Examine safety considerations specific to plumbers by identifying possible hazards on a job site. Explain how to work safely in and around confined spaces and trenches, as a journeyman plumber would to a plumber's helper.** 7.1
	2	**Plumbing System: 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. 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. Illustrate why an understanding of these physical principles is important to a plumbing professional in the design, installation, maintenance, and repair of plumbing systems.** 7.2
	3	**Plumbing Codes: Determine common requirements found in plumbing codes and explain why the codes are necessary; include the importance of proper plumbing on human health. Examine a health or safety issue involved with plumbing then illustrate the problem and describe how it can be prevented or remedied with proper plumbing applications.** 7.3
Piping 8	1	**Pipe Fittings: Analyze the parts of a pipe fitting including the face, center, and back. Determine fitting allowances by using 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.** 8.1
	2	**Plastic Piping: 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. Analyze the use of plastic piping in plumbing systems and HVAC systems. Describe the factors influencing the**

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		decision to use plastic piping in a residence. Demonstrate the ability to select the correct materials, tools, and PPE to complete plastic piping projects by creating a list of the items needed for a specific installation. For example, for a residential bathroom sink drain, create a basic list of the materials, tools, and equipment needed to install the drain. 8.2
	3	Use Plastic Piping: Employ tools and procedures to safely measure, cut, ream, and join plastic piping and fittings. For example, accurately measure PVC pipe, use a miter box and handsaw to cut pieces of pipe, ream and chamfer the ends, and join the pipe using solvent cement. 8.3
Heating, Ventilation, and Air Conditioning Systems (HVAC) 9	1	HVAC Safety: Examine safety considerations specific to HVAC technicians by identifying possible hazards on a job site. Analyze the regulations that impact the work of HVAC technicians, such as the Clean Air Act and EPA guidelines. Summarize these regulations to an individual contemplating starting an HVAC business, explaining key considerations and citing resources that the future business owner can consult. 9.1
	2	HVAC System: Describe the basic components included in an HVAC system, outlining the purposes of each, citing textual resources such as blueprints, manuals, and manufacturers' specifications. Drawing on this evidence, describe the impact of a well-tuned HVAC system on building energy efficiency as well as on human health and well-being. Similarly, describe the negative consequences that can arise due to a poorly functioning or improperly installed HVAC system. 9.2
	3	Heating: Explain the fundamental concepts of heating and combustion, including describing the processes by which heat is transferred. Illustrate the differences in heat transfer by conduction, convection, and radiation by performing experiments. Record observations, citing evidence that heat is being transferred, identifying the heat source, noting the direction heat is moving, and determining the type of heat transfer taking place. 9.3
	4	Heat Transfer: Relate the types of heat transfer to the various heating systems used within a building. Examine the basic layout of a heating system within a building, such as a single-family residence, and note the movement of heat, identifying areas of heat loss and heat gain. Citing the principles of heat transfer, propose strategies the homeowner could use to conserve energy in the home. 9.4
Construction Drawings & Specifications 10	1	Drawings and Specifications: 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. Read and interpret different drawing types including plan view drawings, elevation view drawings, section drawings, detail drawings, and schedules. 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. For example, explain how a floor plan, elevation, and detail drawing may all be used to inform the reader about the location of a given building component, such as a lighting fixture. 10.1

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Business and Project Management 11	1	**Communication: Describe strategies used to promote collaboration, trust, and clear communication among internal and external parties on a job site. Practice effective verbal, nonverbal, written, and electronic communication skills for working with colleagues, employers, clients, and other personnel while demonstrating the ability to: listen attentively, speak courteously and respectfully, resolve obstacles in construction, and respond to criticism. For example, assume the roles of a construction business owner and a potential client, listen to the needs of a potential client, and respond to the potential client by email; explain the services provided by the company and the next steps needed to begin the project. Other role playing could include a construction business owner and a potential subcontractor.** 11.1
	2	**Reports: Log daily activities completed during a project. Document important facts concisely in a personal daily report as would a technician to a supervisor including daily progress, equipment and materials used, personnel involved, and other occurrences.** 11.2
Portfolio 12	1	**Portfolio: Update materials from coursework to add to the portfolio started in Fundamentals of Construction. Continually reflect on coursework experiences and revise and refine the career plan generated in the prior course. Include photographs or illustrations and written descriptions of sequential progress in construction projects.** 12.1