

# Course Outline

Building and Construction Trades

REVISED: July/2021

**Job Title**  
HVAC Technician

**Career Pathway:**  
Mechanical Systems Installation  
and Repair

**Industry Sector:**  
Building and Construction Trades

**O\*NET-SOC CODE:**  
49-9021.00

**CBEDS Title:**  
Heating, Ventilation, and Air  
Conditioning (HVAC) Systems

**CBEDS No.:**  
5516

**72-85-65**

**HVAC/2**

**Credits:** 15

**Hours:** 180

**Course Description:**

This competency-based course is the second in a sequence of three designed for heating, ventilating, and airconditioning (HVAC) technology. Instruction includes orientation and safety, resource management review, electricity, basic electrical wiring and motor selection, thermodynamics review, ventilation systems, refrigeration systems, commercial refrigeration systems, refrigeration troubleshooting, and employability skills review. The competencies in this course are aligned with the California High School Academic Content Standards and the California Career Technical Education Model Curriculum Standards.

**Prerequisites:**

Enrollment requires completion of the HVAC/1 (72-85-60) course.

**NOTE:** For Perkins purposes this course has been designated as a **concentrator** course.

This course cannot be repeated once a student receives a Certificate of Completion.



## **COURSE OUTLINE COMPETENCY-BASED COMPONENTS**

A course outline reflects the essential intent and content of the course described. Acceptable course outlines have six components. (Education Code Section 52506). Course outlines for all apportionment classes, including those in jails, state hospitals, and convalescent hospitals, contain the six required elements:

(EC 52504; 5CCR 10508 [b]; Adult Education Handbook for California [1977], Section 100)

### **COURSE OUTLINE COMPONENTS**

### **LOCATION**

#### **GOALS AND PURPOSES**

Cover

The educational goals or purposes of every course are clearly stated and the class periods are devoted to instruction. The course should be broad enough in scope and should have sufficient educational worth to justify the expenditure of public funds.

The goals and purpose of a course are stated in the COURSE DESCRIPTION. Course descriptions state the major emphasis and content of a course, and are written to be understandable by a prospective student.

#### **PERFORMANCE OBJECTIVES OR COMPETENCIES**

pp. 7-15

Objectives should be delineated and described in terms of measurable results for the student and include the possible ways in which the objectives contribute to the student's acquisition of skills and competencies.

Performance Objectives are sequentially listed in the COMPETENCY-BASED COMPONENTS section of the course outline. Competency Areas are units of instruction based on related competencies. Competency Statements are competency area goals that together define the framework and purpose of a course. Competencies fall on a continuum between goals and performance objectives and denote the outcome of instruction.

Competency-based instruction tells a student before instruction what skills or knowledge they will demonstrate after instruction. Competency-based education provides instruction, which enables each student to attain individual goals as measured against pre-stated standards.

Competency-based instruction provides immediate and continual repetition and In competency-based education the curriculum, instruction, and assessment share common characteristics based on clearly stated competencies. Curriculum, instruction and assessment in competency-based education are: explicit, known, agreed upon, integrated, performance oriented, and adaptive.

**COURSE OUTLINE COMPETENCY-BASED COMPONENTS**  
**(continued)**

<b>COURSE OUTLINE COMPONENTS</b>	<b>LOCATION</b>
<p><b>INSTRUCTIONAL STRATEGIES</b></p> <p>Instructional techniques or methods could include laboratory techniques, lecture method, small-group discussion, grouping plans, and other strategies used in the classroom.</p> <p>Instructional strategies for this course are listed in the TEACHING STRATEGIES AND EVALUATION section of the course outline. Instructional strategies and activities for a course should be selected so that the overall teaching approach takes into account the instructional standards of a particular program, i.e., English as a Second Language, Programs for Adults with Disabilities.</p>	p. 17
<p><b>UNITS OF STUDY, WITH APPROXIMATE HOURS ALLOTTED FOR EACH UNIT</b></p> <p>The approximate time devoted to each instructional unit within the course, as well as the total hours for the course, is indicated. The time in class is consistent with the needs of the student, and the length of the class should be that it ensures the student will learn at an optimum level.</p> <p>Units of study, with approximate hours allotted for each unit are listed in the COMPETENCY AREA STATEMENT(S) of the course outline. The total hours of the course, including work-based learning hours (community classroom and cooperative vocational education) is listed on the cover of every CBE course outline. Each Competency Area listed within a CBE outline is assigned hours of instruction per unit.</p>	Cover pp. 7-15
<p><b>EVALUATION PROCEDURES</b></p> <p>The evaluation describes measurable evaluation criteria clearly within the reach of the student. The evaluation indicates anticipated improvement in performances as well as anticipated skills and competencies to be achieved.</p> <p>Evaluation procedures are detailed in the TEACHING STRATEGIES AND EVALUATION section of the course outline. Instructors monitor students' progress on a continuing basis, assessing students on attainment of objectives identified in the course outline through a variety of formal and informal tests (applied performance procedures, observations, and simulations), paper and pencil exams, and standardized tests.</p>	pp. 17
<p><b>REPETITION POLICY THAT PREVENTS PERPETUATION OF STUDENT ENROLLMENT</b></p> <p>After a student has completed all the objectives of the course, he or she should not be allowed to reenroll in the course. There is, therefore, a need for a statement about the conditions for possible repetition of a course to prevent perpetuation of students in a particular program for an indefinite period of time.</p>	Cover

## **ACKNOWLEDGMENTS**

Thanks to JUAN FIGUEROA, KHAM NGUYEN, and STEWART TADA for developing and editing this curriculum. Acknowledgment is also given to ERICA ROSARIO for designing the original artwork for the course covers.

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# **CALIFORNIA CAREER TECHNICAL EDUCATION MODEL CURRICULUM STANDARDS**

## **Building and Construction Trades Industry Sector**

### **Knowledge and Performance Anchor Standards**

#### **1.0 Academics**

Analyze and apply appropriate academic standards required for successful industry sector pathway completion leading to postsecondary education and employment. Refer to the Building and Construction Trades academic alignment matrix for identification of standards.

#### **2.0 Communications**

Acquire and accurately use Building and Construction Trades sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats.

#### **3.0 Career Planning and Management**

Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans.

#### **4.0 Technology**

Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Building and Construction Trades sector workplace environment.

#### **5.0 Problem Solving and Critical Thinking**

Conduct short, as well as more sustained, research to create alternative solutions to answer a question or solve a problem unique to the Building and Construction Trades sector using critical and creative thinking, logical reasoning, analysis, inquiry, and problem-solving techniques.

#### **6.0 Health and Safety**

Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the Building and Construction Trades sector workplace environment.

#### **7.0 Responsibility and Flexibility**

Initiate, and participate in, a range of collaborations demonstrating behaviors that reflect personal and professional responsibility, flexibility, and respect in the Building and Construction Trades sector workplace environment and community settings.

#### **8.0 Ethics and Legal Responsibilities**

Practice professional, ethical, and legal behavior, responding thoughtfully to diverse perspectives and resolving contradictions when possible, consistent with applicable laws, regulations, and organizational norms.

#### **9.0 Leadership and Teamwork**

Work with peers to promote divergent and creative perspectives, effective leadership, group dynamics, team and individual decision making, benefits of workforce diversity, and conflict resolution as practiced in the SkillsUSA career technical student organization.

#### **10.0 Technical Knowledge and Skills**

Apply essential technical knowledge and skills common to all pathways in the Building and Construction Trades sector, following procedures when carrying out experiments or performing technical tasks.

#### **11.0 Demonstration and Application**

Demonstrate and apply the knowledge and skills contained in the Building and Construction Trades anchor standards, pathway standards, and performance indicators in classroom, laboratory, and workplace settings, and through the SkillsUSA career technical student organizations.

## ***Building and Construction Trades Pathway Standards***

### **C. Mechanical Systems Installation and Repair Pathway**

The Mechanical Systems Installation and Repair pathway provides students with competencies fundamental for preparing for employment or advanced training in heating, ventilation, air-conditioning (HVAC) and appliance installation, maintenance, and repair. The pathway includes preparation for a Class C California License and EPA certification.

Sample occupations associated with this pathway:

- ◆ HVAC Installation and Maintenance Specialist
- ◆ Plumbing Installer
- ◆ Sheet Metal Fabricator
- ◆ Mechanical Engineer/Technician
- ◆ Mechanical Construction Field Manager

- C1.0 Demonstrate an understanding of the methods and devices used to improve air quality and comfort.
- C2.0 Describe the basic components and concepts of heating, air-conditioning, and refrigeration.
- C3.0 Demonstrate an understanding of the scientific theories and physical properties of heat and matter.
- C4.0 Analyze the effects and reactions of fluids, pressures, and temperatures on refrigerants.
- C5.0 Demonstrate skills necessary to fabricate and service the tubing, piping, and fittings utilized in accordance with accepted industry standards.
- C6.0 Demonstrate the skills necessary to service, maintain, and repair heating, air-conditioning, and refrigeration system components and accessories.
- C7.0 Demonstrate a practical knowledge of basic electricity and skills necessary to service and maintain the electrical components of heating, air-conditioning, and refrigeration equipment.
- C8.0 Troubleshoot electrical control systems, motors, and their components.
- C9.0 Demonstrate a practical knowledge of solid-state electronics.
- C10.0 Demonstrate a practical knowledge of combustion heating systems.
- C11.0 Demonstrate practical knowledge of systems designed to improve air quality.

**CBE**  
**Competency-Based Education**

**COMPETENCY-BASED COMPONENTS**  
**for the HVAC/2 Course**

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>A. ORIENTATION AND SAFETY</p> <p>Review, apply, and evaluate classroom and workplace policies and procedures used in accordance with federal, state, and local safety and environmental regulations.</p>	<ol style="list-style-type: none"> <li>1. Review the scope and purpose of the course.</li> <li>2. Review the overall course content as a part of the Linked Learning Initiative.</li> <li>3. Review classroom policies and procedures.</li> <li>4. Review the different occupations in the Energy and Utilities Industry Sector, which have an impact on the role of HVAC technicians.</li> <li>5. Review the opportunities available for promoting gender equity and the representation of non-traditional populations in the HVAC field.</li> <li>6. Review the purpose of the California Occupational Safety and Health Administration (Cal/OSHA) and its laws governing HVAC technicians.</li> <li>7. Review the impact of Environmental Protection Agency (EPA) legislation on the Energy and Utilities Industry Sector practices.</li> <li>8. Review and demonstrate the procedures for contacting proper authorities for the removal of hazardous materials based on the EPA standards.</li> <li>9. Review the National Electrical Code (NEC) and its role in safeguarding the work conditions of HVAC technicians.</li> <li>10. Review and demonstrate the use of the Safety Data Sheet (SDS) as it applies to the HVAC field.</li> <li>11. Review the role of the Leadership in Energy and Environmental Design (LEED) Green Building Rating System™, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), and National Association of Home Builders (NAHB) in increasing the use of green and sustainable technology in California.</li> <li>12. Review the federal, state and local Building and Safety Codes and their applications to the HVAC field.</li> <li>13. Review the provisions of the California Title 24 Energy Efficiency Standards (a.k.a. 2008 California Green Building Standards Code) as they relate to the Energy and Utilities Industry Sector.</li> <li>14. Review classroom and workplace first aid and emergency procedures based on the American Red Cross (ARC) standards.</li> <li>15. Review how each of the following insures a safe workplace:             <ol style="list-style-type: none"> <li>a. employees' rights as they apply to job safety</li> <li>b. employers' obligations as they apply to safety</li> </ol> </li> </ol>	<p><b>Career Ready Practice:</b> 1, 2, 3, 6, 11, 12</p> <p><b>CTE Anchor:</b> Communications: 2.1 Career Planning and Management: 3.6 Health and Safety: 6.1, 6.2, 6.4, 6.6, 6.9, 6.11 Ethics and Legal Responsibilities: 8.2, 8.3, 8.4 Leadership and Teamwork: 9.4, 9.6 Technical Knowledge and Skills: 10.1, 10.2</p> <p><b>CTE Pathway:</b> C1.7, C1.8, C1.9</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(2 hours)	<ul style="list-style-type: none"> <li>c. adherence to pressure vessel guidelines</li> <li>d. adherence to electrical shock hazard (NFPA 70E) prevention guidelines</li> <li>e. adherence to mechanical safety guidelines</li> <li>f. adherence to safe lifting guidelines</li> </ul> 16. Pass the safety test with 100% accuracy.	
<b>B. RESOURCE MANAGEMENT REVIEW</b>  Review, apply, and evaluate resource management principles and techniques applied in the HVAC field.	<ol style="list-style-type: none"> <li>1. Review the definitions of the following:               <ol style="list-style-type: none"> <li>a. resources</li> <li>b. management</li> <li>c. sustainability</li> </ol> </li> <li>2. Review the importance and list specific examples of effective management of the following resources in the HVAC field:               <ol style="list-style-type: none"> <li>a. time</li> <li>b. materials (including sustainable and green)</li> <li>c. personnel</li> </ol> </li> <li>3. Review the benefits of effective resource management in the HVAC field:               <ol style="list-style-type: none"> <li>a. profitability</li> <li>b. sustainability</li> <li>c. company growth</li> </ol> </li> <li>4. Review the economic benefits and liabilities of managing resources in an environmentally responsible way.</li> </ol>	<b>Career Ready Practice:</b> 1, 2, 3, 5, 7, 9  <b>CTE Anchor:</b> Communications: 2.1 Technology: 4.1 Problem Solving and Critical Thinking: 5.3 Health and Safety: 6.7, 6.11 Responsibility and Flexibility: 7.1, 7.3, 7.4, 7.6 Ethics and Legal Responsibilities: 8.1, 8.3, 8.4 Leadership and Teamwork: 9.2  <b>CTE Pathway:</b> C1.3, C4.8
<b>C. TRADE MATHEMATICS REVIEW</b>  Review, apply, and evaluate the mathematical requirements in the HVAC field.	<ol style="list-style-type: none"> <li>1. Review the practical applications of math in the HVAC field.</li> <li>2. Review and demonstrate problem-solving techniques involving whole number problems using arithmetic operations (addition, subtraction, multiplication, and division).</li> <li>3. Review and demonstrate problem-solving techniques involving:               <ol style="list-style-type: none"> <li>a. fraction problems using arithmetic operations</li> <li>b. decimal problems using addition, subtraction, multiplication, and division</li> </ol> </li> <li>4. Review and demonstrate techniques for changing:               <ol style="list-style-type: none"> <li>a. fractions to decimals</li> <li>b. decimals to fractions</li> </ol> </li> </ol>	<b>Career Ready Practice:</b> 1, 2, 3, 5  <b>CTE Anchor:</b> Communications: 2.1, 2.3



COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(10 hours)	<ol style="list-style-type: none"> <li>5. Review the English and metric systems of measuring length, weight, volume, capacity and temperature.</li> <li>6. Review and demonstrate English and metric measuring techniques of objects by using tools common to the trade.</li> <li>7. Review units in ascending and descending powers of ten.</li> <li>8. Calculate square roots of numbers.</li> <li>9. Review and demonstrate problem-solving techniques for               <ol style="list-style-type: none"> <li>a. geometric problems</li> <li>b. using percentages</li> <li>c. reading and interpreting graphs</li> <li>d. using a calculator</li> </ol> </li> </ol>	<p>Problem Solving and Critical Thinking: 5.1, 5.4</p> <p><b>CTE Pathway:</b> C1.5, C6.5</p>
<p>D. ELECTRICITY</p> <p>Understand, apply, and evaluate the generation and modification of electricity for HVAC systems.</p> <p>(15 hours)</p>	<ol style="list-style-type: none"> <li>1. Review the definitions of the following:           <ol style="list-style-type: none"> <li>a. matter</li> <li>b. atoms</li> <li>c. electrons</li> <li>d. molecules</li> <li>e. conductors</li> <li>f. insulators</li> <li>g. energy</li> <li>h. work</li> <li>i. electricity</li> <li>j. magnetism and polarity</li> <li>k. semiconductors</li> </ol> </li> <li>2. Differentiate AC from DC current.</li> <li>3. Differentiate uses of AC current from the uses of DC current.</li> <li>4. Describe the following:           <ol style="list-style-type: none"> <li>a. function of transformers</li> <li>b. electrical circuit types such as: series, parallel, and series/parallel</li> <li>c. schematic symbols</li> <li>d. three phase electrical power</li> <li>e. electrical color codes</li> <li>f. voltage changes</li> <li>g. voltage losses</li> </ol> </li> <li>5. Describe and demonstrate the following:           <ol style="list-style-type: none"> <li>a. using wiring diagrams to trace circuits</li> <li>b. electric power needs and uses in commercial air</li> </ol> </li> </ol>	<p><b>Career Ready Practice:</b> 1, 2, 3, 5, 10</p> <p><b>CTE Anchor:</b> Communications: 2.1 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3</p> <p><b>CTE Pathway:</b> C7.1, C7.2, C7.3, C7.4, C7.5</p>
<p>E. BASIC ELECTRICAL WIRING AND MOTOR SELECTION</p> <p>Understand, apply, and evaluate wiring principles and procedures approved by the National Electrical Code (NEC).</p>	<ol style="list-style-type: none"> <li>1. Define the terms common to electrical service installations:           <ol style="list-style-type: none"> <li>a. service drop</li> <li>b. weather head</li> <li>c. mast</li> <li>d. meter base</li> <li>e. disconnect</li> <li>f. panel</li> <li>g. ground</li> </ol> </li> <li>2. Identify and describe the features and functions of the following:</li> </ol>	<p><b>Career Ready Practice:</b> 1, 2, 3, 5</p> <p><b>CTE Anchor:</b> Communications: 2.1 Problem Solving</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(25 hours)	<ul style="list-style-type: none"> <li>a. tools and components common to the wiring trade</li> <li>b. commonly used wire sizes in the electrical trade</li> <li>c. amperage rating of wire size</li> <li>d. arrangement of electrical components and hardware in a typical utility-connected installation</li> <li>e. breaker panel components</li> </ul> <p>3. Describe the differences between:</p> <ul style="list-style-type: none"> <li>a. primary and secondary ground</li> <li>b. single-phase and three-phase service installations</li> <li>c. 24v to 240v circuits</li> </ul> <p>4. Describe and demonstrate the operation of the following main electrical components:</p> <ul style="list-style-type: none"> <li>a. inverter</li> <li>b. Ground Fault Circuit Interrupter (GFCI)</li> </ul> <p>5. Describe and demonstrate the following:</p> <ul style="list-style-type: none"> <li>a. electrical service wiring techniques</li> <li>b. wiring techniques for typical 120v and 240v residential circuits</li> <li>c. wiring techniques for typical 208v and 240v three phase commercial circuits</li> <li>d. wiring techniques for a sub-fed panel</li> </ul> <p>6. Define the terms common to motors:</p> <ul style="list-style-type: none"> <li>a. motor operation</li> <li>b. single-phase and three-phase motors</li> <li>c. split-phase, capacitor-start, permanent-split, capacitor, capacitor-start-capacitor-run, and shaded-pole motors</li> <li>d. motor controls and accessories</li> </ul> <p>7. Identify and describe the features and functions of the following:</p> <ul style="list-style-type: none"> <li>a. single-phase and three-phase motors</li> <li>b. split-phase, capacitor-start, permanent-split, capacitor, capacitor-start-capacitor-run, shaded-pole motors, and ECM motors</li> <li>c. motor controls and accessories</li> </ul> <p>8. Describe the following:</p> <ul style="list-style-type: none"> <li>a. efficiency versus cost in choosing electric motors</li> <li>b. motor control problems and their solutions</li> </ul> <p>9. Describe and demonstrate the following:</p> <ul style="list-style-type: none"> <li>a. schematic wiring diagrams for various types of electric motors</li> <li>b. troubleshooting motor problems</li> <li>c. improving motor efficiency</li> </ul>	<p>and Critical Thinking: 5.1, 5.2, 5.3, 5.4</p> <p><b>CTE Pathway:</b> C7.1, C7.2, C7.3, C7.4, C7.5, C7.6, C7.7, C8.1, C8.2, C8.6, C8.7, C8.8, C8.9, C8.10</p>
<p>F. THERMODYNAMICS REVIEW</p> <p>Review, apply, and evaluate the principles of matter and heat.</p>	<p>1. Review the following:</p> <ul style="list-style-type: none"> <li>a. thermodynamics</li> <li>b. potential energy</li> <li>c. kinetic energy</li> <li>d. heat</li> <li>e. temperature</li> <li>f. volume</li> <li>g. pressure</li> </ul>	<p><b>Career Ready Practice:</b> 1, 2, 3, 5</p> <p><b>CTE Anchor:</b></p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(5 hours)	<ul style="list-style-type: none"> <li>h. temperature measurement</li> <li>i. British Thermal Unit (BTU)</li> <li>j. Enthalpy</li> </ul> <ol style="list-style-type: none"> <li>2. Review and describe the features of the three states of matter: <ul style="list-style-type: none"> <li>a. solid</li> <li>b. liquid</li> <li>c. vapor</li> </ul> </li> <li>3. Review and describe the following heat transfer methods: <ul style="list-style-type: none"> <li>a. conduction</li> <li>b. convection (natural and forced)</li> <li>c. radiation</li> </ul> </li> <li>4. Review the following: <ul style="list-style-type: none"> <li>a. solidification</li> <li>b. liquefaction</li> <li>c. vaporization</li> <li>d. condensation</li> <li>e. sublimation</li> </ul> </li> <li>5. Review and describe the following: <ul style="list-style-type: none"> <li>a. Conservation: first law of thermodynamics</li> <li>b. Entropy: second law of thermodynamics</li> <li>c. Boyle's Law</li> </ul> </li> </ol>	<p>Communications: 2.1 Problem Solving and Critical Thinking: 5.1, 5.3</p> <p><b>CTE Pathway:</b> C1.1, C1.2, C1.4, C1.5, C3.3, C3.4, C3.5, C4.2, C4.3</p>
<p>G. VENTILATION SYSTEMS</p> <p>Understand, apply, and evaluate the operational techniques used for ventilation systems.</p>	<ol style="list-style-type: none"> <li>1. Define the following: <ul style="list-style-type: none"> <li>a. ventilation <ul style="list-style-type: none"> <li>i. mechanical ventilation</li> <li>ii. natural air ventilation</li> </ul> </li> <li>b. air ducting</li> <li>c. air volume / cubic feet per minute (CFM)</li> <li>d. air balancing</li> </ul> </li> <li>2. Describe the following uses of ventilation to prevent interior air stagnation: <ul style="list-style-type: none"> <li>a. removal of unpleasant smells</li> <li>b. removal of excessive moisture</li> <li>c. introduction of outside air</li> <li>d. keeping indoor air circulation</li> <li>e. carbon dioxide monitoring (CO2)</li> </ul> </li> <li>3. Review the following: <ul style="list-style-type: none"> <li>a. air discharge patterns</li> <li>b. air return patterns</li> <li>c. air flow patterns</li> <li>d. natural convection</li> <li>e. forced convection</li> </ul> </li> <li>4. Describe the following: <ul style="list-style-type: none"> <li>a. ways of making air flow</li> <li>b. duct system pressures: static, velocity, and total pressure</li> <li>c. calculation of air volume to motor size and electrical load</li> <li>d. a typical room air flow system</li> <li>e. noise considerations in choosing ducting</li> </ul> </li> </ol>	<p><b>Career Ready Practice:</b> 1, 2, 3, 4, 5</p> <p><b>CTE Anchor:</b> Communications: 2.1 Technology: 4.1, 4.3 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4 Health and Safety: 6.1, 6.6, 6.12 Technical Knowledge and Skills: 10.5</p> <p><b>CTE Pathway:</b> C1.5, C1.6, C1.7, C1.8, C2.4, C6.4, C6.5, C11.4, C11.5</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(30 hours)	<ul style="list-style-type: none"> <li>f. air distribution problems</li> <li>5. Identify and describe the features and functions of the following:               <ul style="list-style-type: none"> <li>a. air flow measuring instruments</li> <li>b. air control devices                   <ul style="list-style-type: none"> <li>i. registers</li> <li>ii. grilles</li> <li>iii. diffusers</li> <li>iv. dampers</li> <li>v. zoning systems</li> </ul> </li> <li>c. fan types</li> <li>d. electronic air cleaners</li> <li>e. electric heaters</li> </ul> </li> <li>6. Describe and demonstrate the following:               <ul style="list-style-type: none"> <li>a. drawing a typical air flow system, showing discharge, return and air flow patterns</li> <li>b. selection of fan size and style for various conditions</li> <li>c. calculation of the motor size required to change a system from one volume to another</li> <li>d. troubleshooting techniques for balancing, volume, noise, and other air distribution problems</li> </ul> </li> </ul>	
<p>H. REFRIGERATION SYSTEMS</p> <p>Understand, apply, and evaluate the operational techniques used for refrigeration systems.</p>	<ul style="list-style-type: none"> <li>1. Define the following:               <ul style="list-style-type: none"> <li>a. refrigeration</li> <li>b. refrigerant</li> <li>c. saturation</li> </ul> </li> <li>2. Identify and describe the features and functions of the following:               <ul style="list-style-type: none"> <li>a. cooling system components</li> <li>b. cooling system controls</li> <li>c. parts of the refrigeration cycle</li> <li>d. types of metering devices</li> <li>e. types of evaporators</li> <li>f. methods of compression</li> <li>g. types of compressors</li> <li>h. types of condensers</li> <li>i. refrigerants</li> </ul> </li> <li>3. Describe the proper transfer/recovery, charging, and storage of refrigerants.</li> <li>4. Describe the following:               <ul style="list-style-type: none"> <li>a. effects of pressurization on saturation points</li> <li>b. refrigeration cycle</li> <li>c. system compressor function</li> <li>d. evaporator function</li> <li>e. condenser function</li> <li>f. expansion valve operation</li> <li>g. thermostat operation</li> </ul> </li> <li>5. Describe and demonstrate the operation of the following:               <ul style="list-style-type: none"> <li>a. condenser</li> <li>b. liquid receiver</li> <li>c. dryer/filter</li> </ul> </li> </ul>	<p><b>Career Ready Practice:</b> 1, 2, 3, 4, 5, 10</p> <p><b>CTE Anchor:</b> Communications: 2.1 Technology: 4.1, 4.3 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4 Health and Safety: 6.1, 6.6, 6.11, 6.12 Technical Knowledge and Skills: 10.5 Demonstration and Application: 11.2</p> <p><b>CTE Pathway:</b> C1.2, C1.3, C2.1,</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(30 hours)	<ul style="list-style-type: none"> <li>d. accumulator</li> <li>e. suction filter</li> <li>f. oil separator</li> <li>g. head pressure control</li> <li>h. solenoid valve</li> <li>i. evaporator pressure regulator</li> <li>j. crankcase pressure regulator valve</li> <li>k. heat exchanger</li> <li>l. metering devices</li> <li>m. oil pressure regulator</li> </ul> <p>6. Identify and describe the features and functions of the following types of energy control systems:</p> <ul style="list-style-type: none"> <li>a. Electromechanical</li> <li>b. pneumatic</li> <li>c. direct digital controls (DDC)</li> <li>d. programmable logic controllers (PLC)</li> <li>e. internet of things (IOT)</li> </ul> <p>7. Describe and demonstrate installation and troubleshooting techniques used for:</p> <ul style="list-style-type: none"> <li>a. electromechanical control system</li> <li>b. pneumatic control system</li> <li>c. electronic control system</li> <li>d. programmable energy control system</li> </ul>	<p>C2.2, C2.3, C2.4, C3.1, C3.3, C4.1, C4.2, C4.5, C4.6, C4.7, C6.1, C6.2, C6.3, C6.4, C6.5, C6.6, C6.7, C6.8, C6.9, C6.10, C6.11, C7.6, C8.1, C8.2, C8.3</p>
<p>I. COMMERCIAL REFRIGERATION SYSTEMS</p> <p>Understand, apply, and evaluate the operational techniques for commercial refrigeration systems.</p>	<ul style="list-style-type: none"> <li>1. Define/identify the following: <ul style="list-style-type: none"> <li>a. commercial refrigeration</li> <li>b. marine refrigeration</li> <li>c. central station</li> <li>d. cooling towers</li> <li>e. cryogenic system</li> <li>f. ammonia</li> <li>g. ammonia system</li> <li>h. brine pumping systems</li> <li>i. shipboard piping system</li> <li>j. CO2 systems as a refrigerant</li> </ul> </li> <li>2. Describe the following: <ul style="list-style-type: none"> <li>a. commercial refrigeration applications</li> <li>b. marine refrigeration applications</li> <li>c. industrial applications of central station refrigeration units</li> <li>d. equipment and component design</li> <li>e. low temperature control systems</li> <li>f. electronic temperature controls</li> <li>g. function cooling towers</li> <li>h. cryogenic applications</li> <li>i. cryogenic compressor systems</li> </ul> </li> <li>3. Describe the following shipboard refrigeration issues: <ul style="list-style-type: none"> <li>a. power supplies</li> <li>b. ammonia refrigeration systems</li> <li>c. safe handling of ammonia</li> </ul> </li> </ul>	<p><b>Career Ready Practice:</b> 1, 2, 3, 5, 10</p> <p><b>CTE Anchor:</b> Communications: 2.1 Problem Solving and Critical Thinking: 5.1 Health and Safety: 6.1, 6.5, 6.6, 6.7, 6.8, 6.9, 6.11</p> <p><b>CTE Pathway:</b> C1.1, C1.2, C1.3, C1.4, C1.5, C1.6, C1.8, C2.1, C2.3, C3.1, C3.2, C4.1, C4.2, C4.3, C4.5, C4.6, C4.7, C4.8, C4.9</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(30 hours)	<ul style="list-style-type: none"> <li>d. effects of ammonia</li> <li>e. use of special equipment for ammonia systems</li> <li>f. brine pumping systems</li> <li>g. shipboard piping systems</li> <li>h. low temperature food storage</li> </ul>	
<p>J. REFRIGERATION TROUBLESHOOTING</p> <p>Understand, apply, and evaluate the troubleshooting techniques used for refrigeration systems.</p> <p>(30 hours)</p>	<ul style="list-style-type: none"> <li>1. Describe and demonstrate the following refrigeration troubleshooting techniques: <ul style="list-style-type: none"> <li>a. checking out a compressor electrically</li> <li>b. testing refrigerant temperature pressure</li> <li>c. performing a refrigerant-system change-out</li> <li>d. equipment-system interfacing</li> <li>e. installation of a dehydrator and evaluation of a system</li> </ul> </li> </ul>	<p><b>Career Ready Practice:</b> 1, 2, 3, 4, 5, 10, 11</p> <p><b>CTE Anchor:</b> Communications: 2.1 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4 Health and Safety: 6.1, 6.5, 6.6, 6.7, 6.8, 6.9, 6.11</p> <p><b>CTE Pathway:</b> C2.1, C2.4, C4.1, C4.3, C4.4, C4.5, C4.8, C6.2, C6.3, C6.4, C6.5, C6.7, C6.8, C6.9, C6.10, C6.11, C7.1, C7.4, C7.5, C7.6, C7.7, C8.1, C8.2, C8.3, C8.4, C8.6</p>
<p>K. EMPLOYABILITY SKILLS REVIEW</p> <p>Understand, apply, and evaluate the processes involved in seeking, gaining, and maintaining employment.</p>	<ul style="list-style-type: none"> <li>1. Review employer requirements for the following: <ul style="list-style-type: none"> <li>a. punctuality</li> <li>b. attendance</li> <li>c. attitude toward work</li> <li>d. quality of work</li> <li>e. teamwork</li> <li>f. timeliness</li> <li>g. communication skills</li> <li>h. computer skills and software applications</li> </ul> </li> <li>2. Update list of potential employers through traditional and internet sources.</li> <li>3. Review the role of electronic social networking in job search.</li> <li>4. Update sample résumés and cover letters.</li> <li>5. Review the importance of filling out a job application legibly, with accurate and complete information.</li> </ul>	<p><b>Career Ready Practice:</b> 1, 2, 3, 7</p> <p><b>CTE Anchor:</b> Communications: 2.1, 2.3, 2.4 Career Planning and Management: 3.1, 3.2, 3.3, 3.4 Responsibility and Flexibility: 7.4, 7.7</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(2 hours)	<ol style="list-style-type: none"> <li>6. Complete sample job application forms correctly.</li> <li>7. Review the importance of:               <ol style="list-style-type: none"> <li>a. enthusiasm on a job.</li> <li>b. appropriate appearance and hygiene on a job</li> <li>c. continuous upgrading of job skills</li> </ol> </li> <li>8. Review customer service as a method of building permanent relationships between the organization and the customer.</li> <li>9. Review and demonstrate appropriate interviewing techniques.</li> <li>10. Review the informational materials and resources needed to be successful in an interview.</li> <li>11. Update sample follow-up letters.</li> <li>12. Review and demonstrate appropriate follow-up procedures.</li> <li>13. State the important of:               <ol style="list-style-type: none"> <li>a. driving record</li> <li>b. Background check</li> <li>c. credit report</li> </ol> </li> </ol>	<p>Ethics and Legal Responsibilities: 8.4</p> <p>Leadership and Teamwork: 9.4</p> <p>Demonstration and Application: 11.1, 11.5</p> <p><b>CTE Pathway:</b> C1.2, C1.8, C1.9</p>

## ***SUGGESTED INSTRUCTIONAL MATERIALS and OTHER RESOURCES***

### **TEXTS AND SUPPLEMENTAL BOOKS**

Herman, Stephen L. and Bennie Sparkman. Electricity and Controls for HVAC/R, 6<sup>th</sup> Edition. Cengage Learning, 2009.

Raynes, Frank W. Heating Systems. Nabu Press, 2010.

Robertson, C.R. Fundamental Electrical and Electronic Principles. Elsevier Science and Technology, 2008.

Stanfield, Carter and David Skaves. Fundamentals of HVAC/R. Prentice Hall, 2009.

Ward, Ray. Domestic Central Heating Wiring Systems and Controls. Elsevier Science and Technology, 2005.

Johnson, Jim. HVACR Troubleshooting Fundamentals Electricity & Wiring Diagrams, Technical Training, 2019

John Tomczyk, Eugene Silberstein, Bill Whitman, Bill Johnson. Refrigeration and Air Conditioning Technology 8<sup>th</sup> Edition. Cengage Learning, 2019

### **RESOURCES**

Employer Advisory Board members

CTE Model Curriculum Standards

<http://www.cde.ca.gov/ci/ct/sf/documents/buildingconstruct.pdf>

### **COMPETENCY CHECKLIST**



## **TEACHING STRATEGIES and EVALUATION**

### **METHODS AND PROCEDURES**

- A. Lectures and discussions
- B. Multimedia presentations
- C. Demonstrations and participation
- D. Individualized instruction
- E. Peer teaching
- F. Role-playing
- G. Guest speakers
- H. Field trips and field study experiences
- I. Projects

### **EVALUATION**

SECTION A –Orientation and Safety– Pass the safety test with 100% accuracy.

SECTION B – Resource Management Review – Pass all assignments and exams on resource management review with a minimum score of 80% or higher.

SECTION C – Trade Mathematics Review – Pass all assignments and exams on trade mathematics review with a minimum score of 80% or higher.

SECTION D – Electricity – Pass all assignments and exams on electricity with a minimum score of 80% or higher.

SECTION E – Basic Electrical Wiring and Motor Selection – Pass all assignments and exams on basic electrical wiring and motor selection with a minimum score of 80% or higher.

SECTION F – Thermodynamics Review – Pass all assignments and exams on thermodynamics review with a minimum score of 80% or higher.

SECTION G – Ventilation Systems – Pass all assignments and exams on ventilation systems with a minimum score of 80% or higher.

SECTION H – Refrigeration Systems – Pass all assignments and exams on refrigeration systems with a minimum score of 80% or higher.

SECTION I – Commercial Refrigeration Systems – Pass all assignments and exams on commercial refrigeration systems with a minimum score of 80% or higher.

SECTION J – Refrigeration Troubleshooting – Pass all assignments and exams on refrigeration troubleshooting with a minimum score of 80% or higher.

SECTION K – Employability Skills Review – Pass all assignments and exams on employability skills review with a minimum score of 80% or higher.

## ***Standards for Career Ready Practice***

**1. Apply appropriate technical skills and academic knowledge.**

Career-ready individuals readily access and use the knowledge and skills acquired through experience and education. They make connections between abstract concepts with real-world applications and recognize the value of academic preparation for solving problems, communicating with others, calculating measures, and performing other work-related practices.

**2. Communicate clearly, effectively, and with reason.**

Career-ready individuals communicate thoughts, ideas, and action plans with clarity, using written, verbal, electronic, and/or visual methods. They are skilled at interacting with others: they are active listeners who speak clearly and with purpose, and they are comfortable with terminology that is common to workplace environments. Career-ready individuals consider the audience for their communication and prepare accordingly to ensure the desired outcome.

**3. Develop an education and career plan aligned with personal goals.**

Career-ready individuals take personal ownership of their educational and career goals and manage their individual plan to attain these goals. They recognize the value of each step in the educational and experiential process, and they understand that nearly all career paths require ongoing education and experience to adapt to practices, procedures, and expectations of an ever-changing work environment. They seek counselors, mentors, and other experts to assist in the planning and execution of education and career plans.

**4. Apply technology to enhance productivity.**

Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring and using new technology. They understand the inherent risks—personal and organizational—of technology applications, and they take actions to prevent or mitigate these risks.

**5. Utilize critical thinking to make sense of problems and persevere in solving them**

Career-ready individuals recognize problems in the workplace, understand the nature of the problems, and devise effective plans to solve the problems. They thoughtfully investigate the root cause of a problem prior to introducing solutions. They carefully consider options to solve a problem and, once agreed upon, follow through to ensure the problem is resolved.

**6. Practice personal health and understand financial literacy.**

Career-ready individuals understand the relationship between personal health and workplace performance. They contribute to their personal well-being through a healthy diet, regular exercise, and mental health activities. Career-ready individuals also understand that financial literacy leads to a secure future that enables career success.

**7. Act as a responsible citizen in the workplace and the community.**

Career-ready individuals understand the obligations and responsibilities of being a member of a community and demonstrate this understanding every day through their interactions with others. They are aware of the impacts of their decisions on others and the environment around them, and they think about the short-term and long-term consequences of their actions. They are reliable and consistent in going beyond minimum expectations and in participating in activities that serve the greater good.

**8. Model integrity, ethical leadership, and effective management.**

Career-ready individuals consistently act in ways that align with personal and community-held ideals and principles. They employ ethical behaviors and actions that positively influence others. They have a clear understanding of integrity and act on this understanding in every decision. They use a variety of means to positively impact the direction and actions of a team or organization, and they recognize the short-term and long-term effects that management's actions and attitudes can have on productivity, morale, and organizational culture.

**9. Work productively in teams while integrating cultural and global competence.**

Career-ready individuals contribute positively to every team, as both team leaders and team members. To avoid barriers to productive and positive interaction, they apply an awareness of cultural differences. They interact effectively and sensitively with all members of the team and find ways to increase the engagement and contribution of other members.

**10. Demonstrate creativity and innovation.**

Career-ready individuals recommend ideas that solve problems in new and different ways and contribute to the improvement of the organization. They consider unconventional ideas and suggestions by others as solutions to issues, tasks, or problems. They discern which ideas and suggestions may have the greatest value. They seek new methods, practices, and ideas from a variety of sources and apply those ideas to their own workplace practices.

**11. Employ valid and reliable research strategies.**

Career-ready individuals employ research practices to plan and carry out investigations, create solutions, and keep abreast of the most current findings related to workplace environments and practices. They use a reliable research process to search for new information and confirm the validity of sources when considering the use and adoption of external information or practices.

**12. Understand the environmental, societal, and economic impacts of decisions.**

Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact other people, organizations, the workplace, and the environment. They are aware of and utilize new technologies, understandings, procedures, and materials and adhere to regulations affecting the nature of their work. They are cognizant of impacts on the social condition, environment, workplace, and profitability of the organization.

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## Statement for Civil Rights

All educational and vocational opportunities are offered without regard to race, color, national origin, gender, or physical disability.

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