

# Course Outline

Building and Construction Trades

REVISED: August/2017

**Job Title**

Refrigeration Technician

**Career Pathway:**

Mechanical Systems Installation and Repair

**Industry Sector:**

Building and Construction Trades

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

49-9021.01

**CBEDS Title:**

Heating, Ventilation, and Air Conditioning (HVAC) Systems

**CBEDS No.:**

5516

**79-10-65**

## Refrigeration Technician: Service

**Credits:** 10

**Hours:** 120

**Course Description:**

This competency-based course is designed to provide training in the refrigeration and air conditioning trade. System fundamentals, troubleshooting and repair procedures are emphasized in practical terms. This course also includes instruction in employability skills. 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:**

None.

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

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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)**

**COURSE OUTLINE COMPONENTS**

**LOCATION**

**INSTRUCTIONAL STRATEGIES**

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Instructional techniques or methods could include laboratory techniques, lecture method, small-group discussion, grouping plans, and other strategies used in the classroom.

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.

**UNITS OF STUDY, WITH APPROXIMATE HOURS ALLOTTED FOR EACH UNIT**

Cover

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.

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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.

**EVALUATION PROCEDURES**

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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.

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.

**REPETITION POLICY THAT PREVENTS PERPETUATION OF STUDENT ENROLLMENT**

Cover

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.

## **ACKNOWLEDGMENTS**

Thanks to PAUL PIDOUX and MARCELA BAKER 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 Refrigeration Technician: Service Course**

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>A. ORIENTATION, EMPLOYABILITY SKILLS, AND SAFETY</p> <p>Understand trade and employment practices, trade opportunities, and rules of safety</p> <p>(6 hours)</p>	<ol style="list-style-type: none"> <li>1. List industry standards for employment.</li> <li>2. Identify wage scales and job classifications for the trade.</li> <li>3. Understand customer relations.</li> <li>4. Fill out a job application.</li> <li>5. Rehearse equipment care procedures.</li> <li>6. List procedures for safe handling of refrigerant and tools.</li> <li>7. List shop procedures for fire and earthquake safety.</li> <li>8. Pass safety test with 100% accuracy.</li> </ol>	<p><b>Career Ready Practice:</b> 1, 3, 6</p> <p><b>CTE Anchor:</b> Communications: 2.1, 2.2, 2.3, 2.4 Career Planning and Management: 3.4, 3.5 Health and Safety: 6.2, 6.11, 6.12 Technical Knowledge and Skills: 10.5</p> <p><b>CTE Pathway:</b> C4.8</p>
<p>B. THEORY OF REFRIGERATION</p> <p>Analyze the physical properties of refrigerant and system operation.</p> <p>(23 hours)</p>	<ol style="list-style-type: none"> <li>1. Understand force and pressure.</li> <li>2. Understand power and energy.</li> <li>3. Define temperature.</li> <li>4. Describe heat transfer.</li> <li>5. Describe the three states of water: solid, liquid, and vapor.</li> <li>6. Describe the effects of pressurization on boiling points and vapor points.</li> <li>7. Explain system cycle.</li> <li>8. List refrigerant characteristics.</li> <li>9. Describe system compression.</li> <li>10. Explain evaporator function.</li> <li>11. Explain condenser function.</li> <li>12. Understand expansion valve operation.</li> <li>13. Explain thermostat operation.</li> <li>14. Identify cooling system components.</li> <li>15. Identify cooling system controls.</li> <li>16. Identify heating system components, such as, furnaces.</li> <li>17. Identify heating system controls.</li> <li>18. Describe heating system operation for electric and gas.</li> </ol>	<p><b>Career Ready Practice:</b> 1, 3, 4, 5, 10</p> <p><b>CTE Anchor:</b> Problem Solving and Critical Thinking: 5.2, 5.3 Technical Knowledge and Skills: 10.1</p> <p><b>CTE Pathway:</b> C2.1, C2.2, C2.3, C3.2, C3.3, C3.4, C4.2, C4.3, C6.1, C6.3, C8.3, C10.2</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>C. ELECTRICAL</p> <p>Describe two types of electricity used in refrigeration and air conditioning systems.</p> <p>(23 hours)</p>	<ol style="list-style-type: none"> <li>1. Compare and contrast AC and DC current.</li> <li>2. Describe uses of AC and DC current.</li> <li>3. Describe function of transformers.</li> <li>4. Describe motor operation.</li> <li>5. Describe electrical circuit types, such as: series, parallel, and series/parallel.</li> <li>6. Use wiring diagrams to trace circuits.</li> <li>7. Identify schematic symbols.</li> <li>8. Describe the three phases of electrical power.</li> <li>9. Identify electrical color codes.</li> <li>10. Explain voltage changes.</li> <li>11. Explain voltage losses.</li> <li>12. Read schematic wiring diagrams for various types of electric motors.</li> <li>13. Describe motor controls and accessories.</li> <li>14. Describe various motor performance problems.</li> <li>15. Explain operation of electronic air cleaners.</li> <li>16. Explain operation of electric furnaces.</li> </ol>	<p><b>Career Ready Practice:</b> 1, 3, 4, 5, 10</p> <p><b>CTE Anchor:</b> Technical Knowledge and Skills: 10.1</p> <p><b>CTE Pathway:</b> C7.1, C7.3, C7.5, C8.6, C8.7, C11.5</p>
<p>D. AIR DISTRIBUTION</p> <p>Describe and understand a typical room air flow system.</p> <p>(6 hours)</p>	<ol style="list-style-type: none"> <li>1. Explain heat convection - natural and forced.</li> <li>2. Understand air discharge, return, and flow patterns.</li> <li>3. Describe air control devices, such as: registers, grilles, and diffusers.</li> <li>4. Describe air ducting and insulating.</li> <li>5. Calculate air volume to motor size and electrical load.</li> <li>6. Identify fan types and uses.</li> <li>7. Describe air distribution problems.</li> </ol>	<p><b>Career Ready Practice:</b> 1, 3, 5</p> <p><b>CTE Anchor:</b> Problem Solving and Critical Thinking: 5.2, 5.3 Technical Knowledge and Skills: 10.1</p> <p><b>CTE Pathway:</b> C1.4, C7.3, C9.4, C10.6, C10.7</p>
<p>E. METALWORKING</p> <p>Join and form metal ducting and tubing.</p>	<ol style="list-style-type: none"> <li>1. Demonstrate cutting and bending of tubing.</li> <li>2. Demonstrate brazing and soldering.</li> <li>3. Demonstrate welding.</li> <li>4. Demonstrate proper forming and joining of metal ducting.</li> </ol>	<p><b>Career Ready Practice:</b> 1, 3</p> <p><b>CTE Anchor:</b> Technical Knowledge and Skills: 10.2, 10.3</p>



COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(12 hours)		Demonstration and Application: 11.1, 11.2 <b>CTE Pathway:</b> C5.3, C5.7, C5.8, C5.9
F. LAB WORK  Perform service, diagnostics, and repair of refrigeration, heating, and air conditioning systems according to industry standards.          (50 Hours)	<ol style="list-style-type: none"> <li>1. Diagnose and repair cooling system problems.</li> <li>2. Perform service procedures on cooling system.</li> <li>3. Evacuate and dehydrate a refrigeration system.</li> <li>4. Adjust gas heating system as per manufacturer's specifications.</li> <li>5. Diagnose and repair gas heating systems in standard time.</li> <li>6. Diagnose and repair electric heating systems in standard time.</li> <li>7. Service system filters.</li> </ol>	<b>Career Ready Practice:</b> 1, 3, 5 <b>CTE Anchor:</b> Problem Solving and Critical Thinking: 5.2, 5.3 Technical Knowledge and Skills: 10.2, 10.3 Demonstration and Application: 11.1, 11.2 <b>CTE Pathway:</b> C6.10, C9.3, C10.7, C11.6

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

### **TEXTS AND SUPPLEMENTAL BOOKS**

Althouse, A.D., C.H. Turnquist, and A.F. Bacciano. Modern Refrigeration and Air Conditioning. Goodheart-Wilcox, 2004.

### **MULTIMEDIA**

Xerox Training Modules for:  
Control circuit troubleshooting  
Refrigeration cycle  
Refrigeration components

### **RESOURCES**

Employer Advisory Board members

CTE Model Curriculum Standards

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

[www.americangreenjobs.net](http://www.americangreenjobs.net)

<http://www.renewableenergyjobs.com/>

<http://careers.pennenergyjobs.com>

<http://www.cleantechrecruits.com>

### **COMPETENCY CHECKLIST**

## ***TEACHING STRATEGIES and EVALUATION***

### **METHODS AND PROCEDURES**

- A. Lectures and discussions
- B. Demonstrations
- C. Multimedia presentations
  - 1. charts
  - 2. films
  - 3. filmstrips
  - 4. slides
  - 5. overhead transparencies
- D. Lab and shop work

### **EVALUATION**

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

SECTION B – Theory of Refrigeration – Pass all assignments and exams on theory of refrigeration with a minimum score of 80% or higher.

SECTION C – Electrical – Pass all assignments and exams on electrical with a minimum score of 80% or higher.

SECTION D – Air Distribution – Pass all assignments and exams on air distribution with a minimum score of 80% or higher.

SECTION E –Metalworking – Pass all assignments and exams on metalworking with a minimum score of 80% or higher.

SECTION F – Lab Work – Pass all assignments and exams on lab work with a minimum score of 80% or higher.

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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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