

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

79-10-60

Refrigeration Technician (Fundamentals)

Credits: 10

Hours: 120

Course Description:

This competency-based course is designed to provide training in the refrigeration and air conditioning trade. Instruction includes basic knowledge of refrigeration and air conditioning mechanical theory, operation and maintenance, with emphasis on commercial aspects of refrigeration and air conditioning, including heating systems. 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 an **introductory/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. 7-10

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
<p>INSTRUCTIONAL STRATEGIES</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. 12
<p>UNITS OF STUDY, WITH APPROXIMATE HOURS ALLOTTED FOR EACH UNIT</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. 7-10
<p>EVALUATION PROCEDURES</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>	p. 12
<p>REPETITION POLICY THAT PREVENTS PERPETUATION OF STUDENT ENROLLMENT</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

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ANA MARTINEZ
Specialist
Career Technical Education

ROSARIO GALVAN
Administrator
Division of Adult and Career Education

APPROVED:

JOE STARK
Executive Director
Division of Adult and Career Education

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 (Fundamentals) 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"> 1. List the skills and knowledge required for an entry-level Stationary Engineer/Air Conditioning Service Technician. 2. Identify job classifications and wage scales in the air conditioning trade. 3. Describe some of today's current issues regarding air conditioning industry concerns and future ramifications. 4. Identify the many trade related organizations and publications which keep the skilled craftsman current with updated information. 5. Focus upon specific safety principles – fluids/tools/accessories/electrical. 6. List emergency procedures and practices for all classroom and lab instruction. 7. Pass safety test with 100% accuracy. 	<p>Career Ready Practice: 1, 3, 6</p> <p>CTE Anchor: Career Planning and Management: 3.3, 3.4, 3.5, 3.6 Health and Safety: 6.1, 6.7, 6.11 Leadership and Teamwork: 9.4 Technical Knowledge and Skills: 10.1</p> <p>CTE Pathway: C1.3, C1.7, C1.9</p>
<p>B. PRINCIPLES OF HEAT TRANSFER AND INTRODUCTION TO REFRIGERATION</p> <p>Understand the characteristics of basic heat transfer.</p> <p>(12 hours)</p>	<ol style="list-style-type: none"> 1. Explain the history of refrigeration. 2. Define matter and heat. 3. Distinguish between the three states of matter. 4. Describe the three methods of heat transfer. 5. Identify the three reference points of temperature. 6. Explain the difference between heat and temperature. 7. Explain the difference between latent heat and sensible heat. 8. Explain the relationship of pressures and fluids at different temperatures. 9. Define the classifications of refrigerants. 10. Describe the proper transfer and storage of refrigerants. 11. Explain the uses of different refrigerants. 	<p>Career Ready Practice: 1, 2, 3, 5, 10</p> <p>CTE Anchor: Career Planning and Management: 3.4 Technical Knowledge and Skills: 10.1</p> <p>CTE Pathway: C1.1, C3.2, C3.3, C3.4, C3.5, C4.2, C4.5, C4.8</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>C. REFRIGERATION CYCLE/ DIAGRAMS</p> <p>Understand the fundamental theories of the refrigeration cycle.</p> <p>(30 hours)</p>	<ol style="list-style-type: none"> 1. Explain the four parts of the refrigeration cycle. 2. Define types of metering devices. 3. Identify types of evaporators. 4. Identify types of compressors. 5. Explain the methods of compression. 6. Define the types of condensers. 7. Explain the operation performance of a condenser. 8. Identify the proper location of all accessories including: <ol style="list-style-type: none"> a. receivers b. dryer/filters c. accumulators d. suction filters e. oil separators f. head pressure control g. solenoid valves h. evaporator pressure regulator i. crankcase regulator valve j. heat exchangers k. metering controls 9. Explain the operation of the above listed accessories. 	<p>Career Ready Practice: 1, 3</p> <p>CTE Anchor: Problem Solving and Critical Thinking: 5.3 Technical Knowledge and Skills: 10.1</p> <p>CTE Pathway: C4.1, C6.1, C6.3, C6.4, C6.8, C6.9</p>
<p>D. CENTRAL STATION AIR CONDITIONING SYSTEMS</p> <p>Demonstrate the ability to analyze and troubleshoot listed systems.</p> <p>(15 hours)</p>	<ol style="list-style-type: none"> 1. Describe the function of the following components of central station systems: <ol style="list-style-type: none"> a. water chiller b. boiler c. air handler d. cooling tower e. walk-in cooler/freezer f. ice machines g. refrigerated containers h. heat pumps 	<p>Career Ready Practice: 1, 3, 5, 10</p> <p>CTE Anchor: Problem Solving and Critical Thinking: 5.3 Technical Knowledge and Skills: 10.1</p> <p>CTE Pathway: C6.10</p>
<p>E. ELECTRICAL CONTROLS/ COMPONENTS</p> <p>Identify and explain the proper use of motors and control systems.</p>	<ol style="list-style-type: none"> 1. Define watts, ohms, volts, and amps. 2. Define and compare single and multi-phase voltage and current. 3. Demonstrate proper use of the ohmmeter, ammeter, and voltmeter. 4. Size and test fuses and breakers. 5. Explain the operation and application of the: <ol style="list-style-type: none"> a. split phase motor b. three phase motor c. variable speed motor d. permanent split capacitor 	<p>Career Ready Practice: 1, 3, 4, 5, 10</p> <p>CTE Anchor: Problem Solving and Critical Thinking: 5.3, 5.4</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(40 hours)	<ol style="list-style-type: none"> 6. Demonstrate the proper use of testing equipment for motors. 7. Explain electrical circuits and controls. 8. Interpret detailed instructions for wiring circuits. 9. Draw electrical circuits that will conform to standard wiring procedures. 10. Wire actual electrical circuits from wiring diagrams. 11. Demonstrate use and understanding of basic electrical meters in the actual wiring and testing of circuits. 	<p>Technical Knowledge and Skills: 10.1, 10.3 Demonstration and Application: 11.1</p> <p>CTE Pathway: C7.1, C7.2, C7.3, C7.4, C7.5, C7.6, C7.7, C8.6, C8.7, C8.8, C8.9</p>
<p>F. HEATING AND CONTROLS</p> <p>Understand how to analyze and troubleshoot heating systems.</p> <p>(11 hours)</p>	<ol style="list-style-type: none"> 1. Identify and install heating and cooling thermostats. 2. Test a fan/limit control to identify set point of control. 3. Wire a complete heating system line and low voltage. 4. Test spark ignition modules. 5. Test and change a thermocouple flame sensor. 6. Differentiate between pilot proving devices. 	<p>Career Ready Practice: 1, 3, 8, 10</p> <p>CTE Anchor: Problem Solving and Critical Thinking: 5.3 Technical Knowledge and Skills: 10.1, 10.2, 10.3 Demonstration and Application: 11.1, 11.2</p> <p>CTE Pathway: C8.6, C9.5, C10.4</p>
<p>G. ENERGY CONTROL SYSTEMS</p> <p>Understand the fundamental operation of energy control systems.</p>	<ol style="list-style-type: none"> 1. Describe various ways of making air flow. 2. Identify types of energy control systems, including: <ol style="list-style-type: none"> a. electromechanical b. pneumatic c. electronic d. programmable 3. Describe operational sequences of energy type control systems. 4. Set up a programmable thermostat for heating/cooling. 	<p>Career Ready Practice: 1, 3</p> <p>CTE Anchor: Problem Solving and Critical Thinking: 5.3 Technical Knowledge and Skills: 10.1, 10.2, 10.3 Demonstration and Application: 11.1, 11.2</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(6 hours)		CTE Pathway: C8.1, C8.3, C9.1, C9.2, C9.5

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.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 – Principles of Heat Transfer and Introduction to Refrigeration – Pass all assignments and exams on principles of heat transfer and introduction to refrigeration with a minimum score of 80% or higher.

SECTION C – Refrigeration Cycle / Diagrams – Pass all assignments and exams on refrigeration cycle / diagrams with a minimum score of 80% or higher.

SECTION D – Central Station Air Conditioning Systems – Pass all assignments and exams on central station air conditioning systems with a minimum score of 80% or higher.

SECTION E –Electrical Controls / Components – Pass all assignments and exams on electrical controls / components with a minimum score of 80% or higher.

SECTION F – Heating and Controls – Pass all assignments and exams on heating and controls with a minimum score of 80% or higher.

SECTION G – Energy Control Systems – Pass all assignments and exams on energy control systems with a minimum score of 80% or higher.

Statement for Civil Rights

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