

Course Outline

Building and Construction Trades

REVISED: August/2017

Job Title

HVAC 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

72-85-70

HVAC/3

Credits: 15

Hours: 180

Course Description:

This competency-based course is the last in a sequence of three designed for heating, ventilating, and air-conditioning (HVAC) technology. It provides students with project-based experiences in air conditioning and integrated systems. Technical instruction includes an introduction, reviews of workplace safety policies and procedures, and employability skills, as well as introductory entrepreneurship. Emphasis is placed on cooling control systems, commercial air conditioning, integrated systems, and lab work focusing on the service, diagnostic, and repair techniques used in the HVAC industry. 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/2 (72-85-65) course.

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.

pp. 7-12

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

p. 14

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

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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/3 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"> 1. Review the scope and purpose of the course. 2. Review the overall course content as a part of the Linked Learning Initiative. 3. Review classroom policies and procedures. 4. Review the different occupations in the Energy and Utilities Industry Sector which have an impact on the role of HVAC technicians. 5. Review the opportunities available for promoting gender equity and the representation of non-traditional populations in the HVAC field. 6. Review the purpose of the California Occupational Safety and Health Administration (Cal/OSHA) and its laws governing HVAC technicians. 7. Review the impact of Environmental Protection Agency (EPA) legislation on the Energy and Utilities Industry Sector practices. 8. Review and demonstrate the procedures for contacting proper authorities for the removal of hazardous materials based on the EPA standards. 9. Review the National Electrical Code (NEC) and its role in safeguarding the work conditions of HVAC technicians. 10. Review and demonstrate the use of the Material Safety Data Sheet (MSDS) as it applies to the HVAC field. 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. 12. Review the City of Los Angeles Building and Safety Codes and their applications to the HVAC field. 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. 	<p>Career Ready Practice: 1, 3, 6, 11, 12</p> <p>CTE Anchor: 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>CTE Pathway: C1.7, C1.8, C1.9</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>C. COMMERCIAL AIR CONDITIONING</p> <p>Understand, apply, and evaluate the applications of commercial refrigeration and air conditioning.</p> <p>(35 hours)</p>	<ol style="list-style-type: none"> 1. Identify and describe the features and functions of the following: <ol style="list-style-type: none"> a. low temperature control systems b. standard air conditioning systems c. commercial air conditioning systems d. multi-zone systems e. central station air conditioning and controls 2. Describe and demonstrate the following: <ol style="list-style-type: none"> a. differences between standard air conditioning control systems and commercial air conditioning systems b. electric power needs and uses in commercial air c. commercial air flow applications 	<p>Career Ready Practice: 1, 3, 5, 10</p> <p>CTE Anchor: Communications: 2.1 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4</p> <p>CTE Pathway: C1.2, C1.3, C1.5, C2.1, C2.2, C2.3, C2.4, C3.2, C4.1, C8.1, C8.3, C8.7, C8.10, C9.4</p>
<p>D. INTEGRATED CONTROLS</p> <p>Understand, apply, and evaluate the operational techniques used for integrated systems.</p> <p>(35 hours)</p>	<ol style="list-style-type: none"> 1. Identify and describe the features and functions of the following: <ol style="list-style-type: none"> a. integrated systems b. pilot proving devices 2. Differentiate between pilot proving devices. 3. Describe and demonstrate the following: <ol style="list-style-type: none"> a. installation of heating and cooling thermostats b. testing of a fan/limit control to identify set point of control c. wiring a complete heating system line and low voltage d. testing spark ignition modules e. testing and changing a thermocouple flame sensor 	<p>Career Ready Practice: 1, 3, 4, 5, 10</p> <p>CTE Anchor: Communications: 2.1 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3 Health and Safety: 6.1, 6.6, 6.12</p> <p>CTE Pathway: C7.5, C7.6, C8.1, C8.2, C8.3, C8.4, C8.6, C9.1, C9.2, C9.3, C9.4, C9.5</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>E. LAB WORK</p> <p>Understand, apply, and evaluate the service, diagnostic, and repair techniques used for heating, ventilation, refrigeration, and air conditioning systems according to industry standards.</p> <p>(55 hours)</p>	<ol style="list-style-type: none"> 1. Describe and demonstrate the following: <ol style="list-style-type: none"> a. handling and working with pressure vessels b. electrical shock prevention procedures c. mechanical safety procedures d. lifting procedures e. procedures for emergency service calls f. service, diagnostic, and repair techniques for cooling systems g. evacuation and dehydration of a refrigeration system h. adjustment of a gas heating system per manufacturers' specifications i. service, diagnostic, and repair techniques for a gas heating system j. service, diagnostic, and repair techniques for heat pumps k. service procedures for system filters l. service, diagnostic, and repair techniques for commercial ice machines m. service, diagnostic, and repair techniques for walk-in refrigeration units n. service, diagnostic, and repair techniques for central station refrigeration units o. service, diagnostic, and repair techniques for cooling towers p. service, diagnostic, and repair techniques for various commercial air conditioning systems if applicable 	<p>Career Ready Practice: 1, 3, 4, 5, 6, 10</p> <p>CTE Anchor: Communications: 2.1 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4 Health and Safety: 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.11, 6.12 Technical Knowledge and Skills: 10.1, 10.2, 10.3, 10.5</p> <p>CTE Pathway: C2.1, C4.3, C4.4, C4.5, 4.7, C4.8, C4.9, C5.1, C5.2, C5.3, C5.4, C5.5, C5.6, C5.7, C5.8, C5.9, C6.2, C6.3, C6.4, C6.5, C6.7, C6.8, C6.9, C6.10, C6.11, C7.1, C7.6, C7.7, C8.2, C8.4, C8.9, C8.10, C9.4, C10.4, C10.6, C10.7</p>
<p>F. EMPLOYABILITY SKILLS REVIEW</p> <p>Understand, apply, and evaluate the processes involved in seeking, gaining, and maintaining</p>	<ol style="list-style-type: none"> 1. Review employer requirements for the following: <ol style="list-style-type: none"> a. punctuality b. attendance c. attitude toward work d. quality of work e. teamwork f. timeliness 	<p>Career Ready Practice: 1, 2, 3, 7</p> <p>CTE Anchor: Communications: 2.1, 2.3, 2.4</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>employment.</p> <p>(5 hours)</p>	<p>g. communication skills h. computer skills and software applications</p> <ol style="list-style-type: none"> 2. Update list of potential employers through traditional and internet sources. 3. Review the role of electronic social networking in job search. 4. Update sample résumés and cover letters. 5. Review the importance of filling out a job application legibly, with accurate and complete information. 6. Complete sample job application forms correctly. 7. Review the importance of enthusiasm on a job. 8. Review the importance of appropriate appearance on a job. 9. Review the importance of the continuous upgrading of job skills. 10. Review customer service as a method of building permanent relationships between the organization and the customer. 11. Review and demonstrate appropriate interviewing techniques. 12. Review the informational materials and resources needed to be successful in an interview. 13. Update sample follow-up letters. 14. Review and demonstrate appropriate follow-up procedures. 	<p>Career Planning and Management: 3.1, 3.2, 3.3, 3.4 Responsibility and Flexibility: 7.4, 7.7 Ethics and Legal Responsibilities: 8.4 Leadership and Teamwork: 9.4 Demonstration and Application: 11.1, 11.5</p> <p>CTE Pathway: C1.2, C1.8, C1.9</p>
<p>G. ENTREPRENEURIAL SKILLS</p> <p>Understand, apply, and evaluate the processes involved in becoming an entrepreneur in the HVAC field.</p>	<ol style="list-style-type: none"> 1. Define entrepreneurship. 2. Identify the necessary characteristics of successful entrepreneurs. 3. Describe the contributions of entrepreneurs to the HVAC field. 4. Explain the purpose and components of a business plan. 5. Examine personal goals prior to starting a business. 6. Evaluate sources of monetary investment in a business opportunity. 7. Describe various licensing requirements in the HVAC field. 8. Develop a scenario depicting the student as the HVAC business owner. 9. Differentiate between LEED business practices and standard business practices. 	<p>Career Ready Practice: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.3, Career Planning and Management: 3.2, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9 Technology: 4.1, 4.2, 4.3, 4.4, 4.5 Problem Solving and Critical Thinking: 5.4</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(5 hours)		<p>Health and Safety: 6.2, 6.3, 6.5, 6.6, 6.7, 6.9</p> <p>Responsibility and Flexibility: 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8</p> <p>Ethics and Legal Responsibilities: 8.1, 8.2, 8.3, 8.4, 8.5</p> <p>Leadership and Teamwork: 9.1, 9.2, 9.3, 9.4, 9.5, 9.6</p> <p>Technical Knowledge and Skills: 10.1, 10.2, 10.3, 10.4, 10.5</p> <p>Demonstration and Application: 11.1, 11.2, 11.3, 11.4, 11.5</p> <p>CTE Pathway: C1.1, C1.2, C1.4, C1.5, C1.8</p>

SUGGESTED INSTRUCTIONAL MATERIALS and OTHER RESOURCES

TEXTS AND SUPPLEMENTAL BOOKS

Day, Antony R., R.S. Bhathal, Keith Shepherd, and Martin S. Ratcliffe. Heating Systems, Plant and Control. John Wiley & Sons, Limited, 2003.

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

Incropera, Frank P., David P. DeWitt, and Theodore L. Bergman. Introduction to Heat Transfer. John Wiley & Sons, 2006.

Kissell, Thomas. Electricity, Electronics, and Control Systems. Prentice Hall, 2007.

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.

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. 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 – Cooling Control Systems – Pass all assignments and exams on cooling control systems with a minimum score of 80% or higher.

SECTION C – Commercial Air Conditioning – Pass all assignments and exams on commercial air conditioning with a minimum score of 80% or higher.

SECTION D – Integrated Controls – Pass all assignments and exams on integrated controls with a minimum score of 80% or higher.

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

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

SECTION G – Entrepreneurial Skills – Pass all assignments and exams on entrepreneurial skills 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.
