

Course Outline

Building and Construction Trades

REVISED: August/2017

Job Title

Air Conditioning 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

79-10-50

Air Conditioning Technician (Fundamentals)

Credits: 10

Hours: 120

Course Description:

This competency-based course is designed to provide training in the commercial refrigeration and air conditioning field, including terminology, employment opportunities, shop operations, and safety. Students will also demonstrate knowledge and skill in operation, maintenance, trouble shooting, and repair of refrigeration, air conditioning, and heating equipment. 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** 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. 7-13

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	p. 15
<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>	
UNITS OF STUDY, WITH APPROXIMATE HOURS ALLOTTED FOR EACH UNIT	Cover
<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>	
EVALUATION PROCEDURES	p. 15
<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>	
REPETITION POLICY THAT PREVENTS PERPETUATION OF STUDENT ENROLLMENT	Cover
<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>	

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 Air Conditioning Technician (Fundamentals) Course

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>A. INTRODUCTION</p> <p>Recognize the scope of refrigeration and air conditioning</p> <p>(2 hours)</p>	<ol style="list-style-type: none"> 1. Describe the history of refrigeration and air conditioning. 2. Describe the job opportunities in refrigeration and air conditioning. 3. Describe the wages paid to service technicians. 4. Describe various specializations found in the refrigeration and air conditioning field. 	<p>Career Ready Practice: 1, 3</p> <p>CTE Anchor: Communications: 2.1, 2.2 Career Planning and Management: 3.5 Leadership and Teamwork: 9.4 Technical Knowledge and Skills: 10.1</p> <p>CTE Pathway: C1.1, C1.2, C1.3, C1.4, C1.5, C1.7, C1.9</p>
<p>B. ORIENTATION AND SAFETY</p> <p>Recognize safety rules, procedures, and acceptable work habits.</p> <p>(3 hours)</p>	<ol style="list-style-type: none"> 1. Identify standard shop procedures. 2. Describe shop safety rules and regulations. 3. Pass the designated safety test with 100% accuracy. 4. Describe class expectations. 5. Describe class rules. 	<p>Career Ready Practice: 1, 3, 6</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.3 Health and Safety: 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.9, 6.11, 6.12</p> <p>CTE Pathway: C1.7, C1.8</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>C. BASIC ELECTRICITY</p> <p>Understand the principles of basic electricity.</p> <p>(10 hours)</p>	<ol style="list-style-type: none"> 1. Explain Ohm’s Law. 2. Calculate Ohm’s Law problems. 3. Describe series circuits. 4. Describe parallel circuits. 5. Describe series/parallel circuits. 6. Know how to use schematics. 7. Draw schematics. 8. Design schematics. 9. Describe alternating current (AC). 10. Describe direct current (DC). 11. Describe refrigeration and air conditioning applications for AC. 12. Describe refrigeration and air conditioning applications for DC. 13. Identify various power supplies. 14. Describe three-phase electrical power. 15. Analyze basic electrical problems. 16. Repair basic electrical problems. 17. Know how to read line volt unit wiring diagrams. 	<p>Career Ready Practice: 1, 3, 5, 10</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.3, 2.4 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, 6.8, 6.11, 6.12 Ethics and Legal Responsibilities: 8.1 Technical Knowledge and Skills: 10.1, 10.2</p> <p>CTE Pathway: C1.8, C7.1, C7.2, C7.3, C7.4, C7.5, C7.6, C8.1</p>
<p>D. MATTER AND HEAT</p> <p>Understand how the three states of matter affect heat.</p> <p>(15 hours)</p>	<ol style="list-style-type: none"> 1. List the three states of matter. 2. Differentiate among the three states of matter. 3. Describe molecular movement. 4. State the first law of thermodynamics. 5. Describe the first law of thermodynamics. 6. State the second law of thermodynamics. 7. Describe the second law of thermodynamics. 8. Describe temperature measurement. 9. Define British Thermal Unit (BTU). 10. List the five changes of state. 11. Describe solidification. 12. Describe liquefaction. 13. Describe vaporization. 14. Describe condensation. 15. Describe sublimation. 16. Describe how changes of state are used in the refrigeration cycle. 17. List the heat transfer methods. 18. Describe conduction. 19. Describe radiation. 20. Describe insulation. 	<p>Career Ready Practice: 1, 3, 5, 11</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.3</p> <p>CTE Pathway: C3.1, C3.2, C3.4, C3.5</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>E. METAL WORKING TECHNIQUES</p> <p>Understand how to cut, form, and join sheet metal and tubing.</p> <p>(15 hours)</p>	<ol style="list-style-type: none"> 1. Differentiate between welding, brazing, and soldering. 2. Demonstrate the ability to weld. 3. Demonstrate the ability to braze. 4. Demonstrate the ability to solder. 5. Demonstrate the ability to cut and bend tubing. 6. Demonstrate the ability to cut and form sheet metal. 	<p>Career Ready Practice: 1, 3, 7</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.3 Health and Safety: 6.1, 6.2, 6.6, 6.7, 6.8, 6.9, 6.11, 6.12 Ethics and Legal Responsibilities: 8.1, 8.2 Technical Knowledge and Skills: 10.1, 10.2</p> <p>CTE Pathway: C5.2, C5.3, C5.4, C5.5, C5.6, C5.7, C5.8, C5.9</p>
<p>F. PRINCIPLES OF AIR FLOW</p> <p>Understand the principles of air flow as they relate to temperature control.</p> <p>(10 hours)</p>	<ol style="list-style-type: none"> 1. Describe various ways of making air flow. 2. Describe natural convection. 3. Describe forced convection. 4. Draw a typical room air flow system, showing discharge, return, and air flow patterns. 5. Define resistance pressures. 6. Describe various air flow measuring instruments. 7. Know how to use air friction charts. 8. Describe the effects that various types and sizes of ducts have on air flow. 9. Describe noise considerations in choosing ducting. 10. Describe various types of fans. 11. Know how to choose the proper size and style fan for various conditions. 12. Calculate the motor size required to change a system from one volume to another. 13. Describe various air distribution problems such as balancing, volume, and noise. 	<p>Career Ready Practice: 1, 3, 5, 10</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.3 Technology: 4.1 Problem Solving and Critical thinking: 5.1, 5.2, 5.3, 5.4 Ethics and Legal Responsibilities: 8.2 Technical Knowledge and Skills: 10.1, 10.2</p> <p>CTE Pathway: C1.5, C1.6, C1.8, C11.4, C11.5</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>G. ELECTRIC MOTOR SELECTION</p> <p>Understand the various types of motors used in refrigeration and air conditioning.</p> <p>(10 hours)</p>	<ol style="list-style-type: none"> 1. Describe single-phase motors. 2. Differentiate among split-phase, capacitor-start, permanent-split, capacitor, capacitor-start-capacitor-run, and shaded-pole motors. 3. Describe three-phase motors. 4. Describe efficiency versus cost in choosing electric motors. 5. List various motor controls and accessories. 6. Describe various motor control problems and their solutions. 7. Describe various methods of improving motor efficiency. 	<p>Career Ready Practice: 1, 3, 5</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.4, Problem Solving and Critical Thinking: 5.1, 5.4 Technical Knowledge and Skills: 10.1</p> <p>CTE Pathway: C7.2, C7.4, C8.7, C8.8</p>
<p>H. TROUBLESHOOTING AND MAINTENANCE</p> <p>Demonstrate troubleshooting and maintenance techniques.</p> <p>(15 hours)</p>	<ol style="list-style-type: none"> 1. List at least three principles of maintenance. 2. Identify principles of troubleshooting. 3. Demonstrate logical thought. 4. List at least three ways of correcting existing problems in an electric heating system. 5. List at least three ways of correcting existing problems in a gas appliance. 6. Describe various ways of preventing the reoccurrence of a problem. 7. Demonstrate the ability to perform a normal maintenance check on a gas furnace. 8. Demonstrate the ability to maintain electronic air cleaners. 9. Demonstrate the ability to maintain electric furnaces. 10. Demonstrate the ability to maintain various types of cooling systems. 11. Design a properly sized disposable filter. 	<p>Career Ready Practice: 1, 3, 4, 5, 10, 11</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.3, 2.4 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4 Health and Safety: 6.1, 6.4, 6.6, 6.8, 6.12 Ethics and Legal Responsibilities: 8.1, 8.3 Technical Knowledge and Skills: 10.1, 10.2</p> <p>CTE Pathway: C6.10, C7.6, C8.1, C10.4, C10.7</p>
<p>I. COOLING CONTROL SYSTEMS</p> <p>Demonstrate troubleshooting and maintenance techniques.</p>	<ol style="list-style-type: none"> 1. List various types of cooling control systems. 2. Describe electronic cooling control systems. 3. Describe pneumatic cooling control circuits. 4. Describe multi-zone cooling control circuits. 	<p>Career Ready Practice: 1, 3, 4</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(10 hours)	<ol style="list-style-type: none"> 5. Draw a multi-zone electrical control system schematic diagram. 6. Differentiate among the various cooling control systems. 	<p>CTE Anchor: Communications: 2.1, 2.2, 2.3, 2.4 Technical Knowledge and Skills: 10.1</p> <p>CTE Pathway: C8.1, C8.2, C8.3, C9.1</p>
<p>J. ELECTRIC COOLING PROBLEMS</p> <p>Understand how to troubleshoot and repair various electrical cooling problems.</p> <p>(15 hours)</p>	<ol style="list-style-type: none"> 1. Demonstrate the ability to check out a compressor electrically. 2. Demonstrate the ability to test refrigerant temperature pressure. 3. Know how to perform a refrigerant-system change-out. 4. Describe equipment-system interface. 5. Demonstrate the ability to perform a dehydration and evaluation of a system 	<p>Career Ready Practice: 1, 3, 5</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.3 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4 Health and Safety: 6.1, 6.3, 6.4, 6.5, 6.6, 6.8, 6.9, 6.11, 6.12 Ethics and Legal Responsibilities: 8.1 Technical Knowledge and Skills: 10.1, 10.2</p> <p>CTE Pathway: C4.3, C4.4, C4.8, C4.9, C6.6, C6.7, C6.9, C6.10, C7.6, C8.1</p>
<p>K. HEAT PUMPS</p> <p>Understand the operation of heat pump system.</p>	<ol style="list-style-type: none"> 1. Describe the operation of heat pumps. 2. Compare heat pump systems with other temperature control systems. 3. Describe the thermal efficiency of a heat pump. 4. Describe component isolation in heat pumps. 5. Describe the auxiliary heat in heat pumps. 6. Demonstrate the ability to diagnose and solve problems in heat pumps. 	<p>Career Ready Practice: 1, 3, 4, 5, 10</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.3</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>M. EMPLOYABILITY SKILLS</p> <p>Understand job seeking procedures and their importance in the trade.</p> <p>(2 hours)</p>	<ol style="list-style-type: none"> 1. Describe important factors of an employee's responsibilities. 2. Describe important factors in seeking and obtaining employment. 3. Fill out employment applications. 4. Describe employment requirements. 5. Describe how to apply skills learned in this course when seeking employment. 6. Describe the importance of punctuality on the job. 7. Identify potential employers. 	<p>Career Ready Practice: 1, 2, 3, 7</p> <p>CTE Anchor: Communications: 2.1, 2.3, 2.4, 2.5 Career Planning and Management: 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9 Leadership and Teamwork: 9.4, 9.6 Demonstration and Application: 11.1, 11.2, 11.3, 11.5</p> <p>CTE Pathway: C1.1</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. Visual aids
- D. Projects
- E. Individualized instruction

EVALUATION

SECTION A – Introduction – Pass all assignments and exams on introduction with a minimum score of 80% or higher.

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

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

SECTION D – Matter and Heat – Pass all assignments and exams on basic matter and heat with a minimum score of 80% or higher.

SECTION E –Metal Working Techniques – Pass all assignments and exams on metal working techniques with a minimum score of 80% or higher.

SECTION F – Principles of Air Flow – Pass all assignments and exams on principles of air flow with a minimum score of 80% or higher.

SECTION G – Electric Motor Selection – Pass all assignments and exams on electric motor selection with a minimum score of 80% or higher.

SECTION H – Troubleshooting and Maintenance – Pass all assignments and exams on troubleshooting and maintenance with a minimum score of 80% or higher.

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

SECTION J – Electrical Cooling Problems – Pass all assignments and exams on electrical cooling problems with a minimum score of 80% or higher.

SECTION K – Heat Pumps – Pass all assignments and exams on heat pumps with a minimum score of 80% or higher.

SECTION L – Customer Relations – Pass all assignments and exams on customer relations with a minimum score of 80% or higher.

SECTION M – Employability Skills – Pass all assignments and exams on employability 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.
