

# Course Outline

**Transportation**

**REVISED: August/2017**

**Job Title**

Auto Technician

**Career Pathway:**

Systems Diagnostics and Service

**Industry Sector:**

Transportation

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

49-3023.02

**CBEDS Title:**

Advanced Automotive

**CBEDS No.:**

5669

**79-90-75**

## **Auto Tech: Heating and Air Conditioning**

**Credits:** 15

**Hours:** 180

**Course Description:**

This competency-based course is one in a sequence of courses designed to meet the Automotive Service Excellence (ASE) Program Certification Standards set by the National Automotive Technicians Education Foundation (NATEF). It provides students with technical instruction and practical experience in an automobile area incorporating sustainable and green vehicle technologies. Instruction includes classroom and workplace policies and procedures in accordance with federal, state, and local safety and environmental regulations. It covers the proper use, maintenance, and storage of auto repair tools and equipment as well as the effective use of service manuals and computer-based information systems. Emphasis is placed on the techniques in the following areas of heating and air conditioning diagnosis and repair: A/C system, refrigeration system, heating, ventilation, and engine cooling systems, operating system and related controls, and refrigerant recovery, recycling and handling. It also teaches trade mathematics, resource management, and 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:**

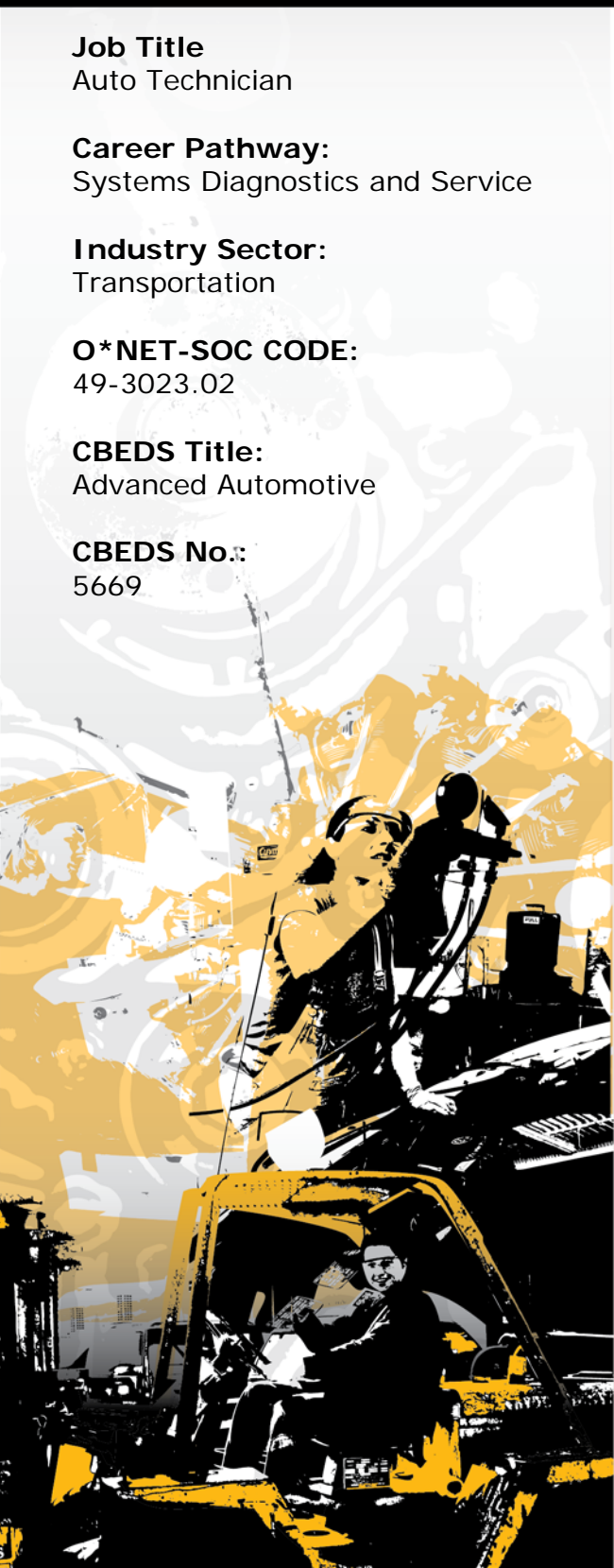
Enrollment requires successful completion of the Auto Tech: Engine Repair (79-90-73) course.

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

Meets NATEF standards and identifies priority tasks in heating and air conditioning. Check the NATEF Manual for explanation of priority 1, 2, or 3 tasks.

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

Division of Adult and Career Education  
Instructional and Counseling Services Unit  
Adult Curriculum Office  
www.wearedace.org



## **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. 7-15

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**

## ***Transportation 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 Transportation academic alignment matrix for identification of standards.

### **2.0 Communications**

Acquire and accurately use Transportation 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 Transportation 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 Transportation 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 Transportation 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 Transportation 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 Transportation 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 Transportation anchor standards, pathway standards, and performance indicators in classroom, laboratory, and workplace settings, and through the SkillsUSA career technical student organization.

## ***Transportation Pathway Standards***

### **C. Systems Diagnostics and Service Pathway**

The Systems Diagnostics and Service pathway prepares students for postsecondary education and employment in the transportation industry, which includes but is not limited to motor vehicles, rail systems, marine applications, and small-engine and specialty equipment.

Sample occupations associated with this pathway:

- ◆ Service Technician/Maintenance Worker/Shop Foreman
- ◆ Technical Writer
- ◆ Dispatcher
- ◆ Engineer
- ◆ Investigator/Inspector

- C1.0 Demonstrate the practice of personal and occupational safety and protecting the environment by using materials and processes in accordance with manufacturer and industry standards.
- C2.0 Practice the safe and appropriate use of tools, equipment, and work processes.
- C3.0 Use scientific principles in relation to chemical, mechanical, and physical functions for various engine and vehicle systems.
- C4.0 Perform and document maintenance procedures in accordance with the recommendations of the manufacturer.
- C5.0 Apply and understand appropriate business practices.
- C6.0 Demonstrate the application, operation, maintenance, and diagnosis of engines, including but not limited to two- and four-stroke and supporting subsystems.
- C7.0 Demonstrate the function, principles, and operation of electrical and electronic systems using manufacturer and industry standards.
- C8.0 Demonstrate the function and principles of automotive drivetrain, steering and suspension, brake, and tire and wheel components and systems in accordance with national industry standards.

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

**COMPETENCY-BASED COMPONENTS**  
**for the Auto Tech: Heating and Air Conditioning Course**

| COMPETENCY AREAS AND STATEMENTS  | MINIMAL COMPETENCIES  | STANDARDS  |
|--|---|--|
| <p>A. ORIENTATION AND SAFETY</p> <p>Understand, apply, and evaluate classroom and workplace policies and procedures used in accordance with federal, state, and local safety and environmental regulations.</p> <p>(8 hours)</p> | <ol style="list-style-type: none"> <li>1. Describe the scope and purpose of the course.</li> <li>2. Describe classroom policies and procedures.</li> <li>3. Identify classroom and workplace first aid and emergency procedures.</li> <li>4. Describe the different occupations in the Transportation Industry Sector which have an impact on the role of the auto technician.</li> <li>5. Describe the California Occupational Safety and Health Administration (Cal/OSHA) workplace requirements for auto technicians.</li> <li>6. Explain the impact of Environmental Protection Agency (EPA) legislation on Transportation Industry Sector practices in protecting and preserving the environment.</li> <li>7. Explain the impact of California Air Resources Board (ARB) legislation on Transportation Industry Sector practices in protecting and preserving the environment.</li> <li>8. State the Bureau of Automotive Repair (BAR) standards for safety and environmental protection.</li> <li>9. Describe and demonstrate the use of the Material Safety Data Sheet (MSDS) as it applies to the automotive industry.</li> <li>10. Identify the safety items required by federal, state, and local regulations.</li> <li>11. Describe the role of the National Automotive Technicians Education Foundation (NATEF) in auto technician training.</li> <li>12. Describe and demonstrate the NATEF standards regarding proper use of protective clothing and gloves in an auto shop.</li> <li>13. Describe and demonstrate the NATEF standards regarding proper use of protective respiratory gear in an auto shop.</li> <li>14. Describe and demonstrate the NATEF standards regarding proper use of protective eye gear in an auto shop.</li> <li>15. Describe and demonstrate the NATEF standards regarding proper ventilation in an auto shop.</li> <li>16. Describe and demonstrate NATEF standards regarding proper handling, storage, and disposal of chemicals and materials used in an auto shop.</li> <li>17. Pass the safety exam with 100% accuracy.</li> </ol> | <p><b>Career Ready Practice:</b><br/>1, 3, 6, 8, 12</p> <p><b>CTE Anchor:</b><br/>Communications:<br/>2.1, 2.2, 2.3, 2.4<br/>Career Planning and Management:<br/>3.2, 3.3, 3.4, 3.5, 3.6, 3.9<br/>Technology:<br/>4.1<br/>Health and Safety:<br/>6.1, 6.2, 6.3, 6.4, 6.5, 6.6<br/>Ethics and Legal Responsibilities:<br/>8.2<br/>Leadership and Teamwork:<br/>9.4<br/>Technical Knowledge and Skills:<br/>10.1, 10.2</p> <p><b>CTE Pathway:</b><br/>C1.1, C1.2, C1.3, C1.4, C1.5</p> |

| COMPETENCY AREAS AND STATEMENTS  | MINIMAL COMPETENCIES  | STANDARDS  |
|--|---|--|
| <p>B. RESOURCE MANAGEMENT</p> <p>Understand, apply, and evaluate the resource management principles and techniques in the auto repair and maintenance business.</p> <p>(2 hours)</p> | <ol style="list-style-type: none"> <li>1. Define the following:               <ol style="list-style-type: none"> <li>a. resources</li> <li>b. management</li> <li>c. sustainability</li> </ol> </li> <li>2. Describe the management of the following resources in the auto repair and maintenance business:               <ol style="list-style-type: none"> <li>a. time</li> <li>b. materials</li> <li>c. personnel</li> </ol> </li> <li>3. List specific examples of effective management of the following in the auto repair and maintenance business:               <ol style="list-style-type: none"> <li>a. time</li> <li>b. materials</li> <li>c. personnel</li> </ol> </li> <li>4. Describe the benefits of effective resource management in the auto repair and maintenance business:               <ol style="list-style-type: none"> <li>a. profitability</li> <li>b. sustainability</li> <li>c. company growth</li> </ol> </li> <li>5. Describe the economic benefits and liabilities of managing resources in an environmentally responsible way.</li> </ol> | <p><b>Career Ready Practice:</b><br/>1, 3, 6, 8, 9, 12</p> <p><b>CTE Anchor:</b><br/>           Communications:<br/>2.1, 2.2, 2.3, 2.4<br/>           Career Planning and Management:<br/>3.1, 3.2<br/>           Technology:<br/>4.1, 4.2<br/>           Problem Solving and Critical Thinking:<br/>5.1, 5.3<br/>           Responsibility and Flexibility:<br/>7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7<br/>           Ethics and Legal Responsibilities:<br/>8.1, 8.3, 8.4, 8.5<br/>           Leadership and Teamwork:<br/>9.1, 9.2, 9.3<br/>           Technical Knowledge and Skills:<br/>10.1, 10.2<br/>           Demonstration and Application:<br/>11.2</p> <p><b>CTE Pathway:</b><br/>C2.6, C5.2, C5.3, C5.4, C5.5</p> |
| <p>C. TRADE MATHEMATICS</p> <p>Understand, apply, and evaluate the mathematical requirements used in auto repair and maintenance.</p>  | <ol style="list-style-type: none"> <li>1. Identify the practical applications of math in auto repair and maintenance.</li> <li>2. Describe and demonstrate problem-solving techniques involving whole number problems, using addition, subtraction, multiplication, and division.</li> <li>3. Describe and demonstrate problem-solving techniques involving various fraction problems, using arithmetic operations (addition, subtraction, multiplication, and division).</li> </ol>  | <p><b>Career Ready Practice:</b><br/>1</p> <p><b>CTE Anchor:</b><br/>           Communications:<br/>2.1, 2.2, 2.3, 2.4</p>   |



| COMPETENCY AREAS AND STATEMENTS | MINIMAL COMPETENCIES  | STANDARDS  |
|---------------------------------|---|--|
| (10 hour)                       | <ol style="list-style-type: none"> <li>4. Describe and demonstrate problem-solving techniques involving various decimal problems, using arithmetic operations.</li> <li>5. Describe and demonstrate techniques for changing fractions to decimals.</li> <li>6. Describe and demonstrate techniques for changing decimals to fractions.</li> <li>7. Describe the English system of measuring length.</li> <li>8. Describe the English system of measuring weight.</li> <li>9. Describe the English system of measuring volume or capacity.</li> <li>10. Describe the relationships between various English system linear units of measurement, such as inches, feet, yards, and miles.</li> <li>11. Describe the relationships between various English system units of volume or capacity, such as cups, pints, quarts, and gallons.</li> <li>12. Describe and demonstrate problem-solving techniques for various English system measuring problems, using arithmetic operations.</li> <li>13. Describe and demonstrate measuring techniques of various objects by using the English system measuring tools common to the trade.</li> <li>14. Describe the metric system of measuring length.</li> <li>15. Describe the metric system of measuring weight.</li> <li>16. Describe the metric system of measuring volume or capacity.</li> <li>17. Describe the relationships between various metric system linear units of measurement, such as millimeters, centimeters, and meters.</li> <li>18. Describe the relationships between various metric system units of weight such as milligrams, grams, and kilograms.</li> <li>19. Describe and demonstrate problem-solving techniques for various metric system measuring problems involving addition, subtraction, multiplication, and division.</li> <li>20. Describe and demonstrate measuring techniques of objects using metric system measuring tools common to the trade.</li> <li>21. Describe and demonstrate problem-solving techniques for geometric problems that apply to auto repair and maintenance.</li> <li>22. Describe and demonstrate problem-solving techniques for algebraic problems that apply to auto repair and maintenance.</li> <li>23. Describe and demonstrate problem-solving techniques using percentages.</li> <li>24. Describe and demonstrate techniques for reading and interpreting graphs.</li> <li>25. Describe and demonstrate techniques for using a calculator.</li> </ol> | <p>Problem Solving and Critical Thinking:<br/>5.1, 5.4</p> <p>Technical Knowledge and Skills:<br/>10.1</p> <p><b>CTE Pathway:</b><br/>C2.4, C2.7</p> |

| COMPETENCY AREAS AND STATEMENTS  | MINIMAL COMPETENCIES  | STANDARDS  |
|--|---|--|
| <p>D. TOOLS AND EQUIPMENT</p> <p>Understand, apply, and evaluate the policies and procedures for using drive train tools and equipment in accordance with federal, state, and local safety and environment regulations.</p> <p>(10 hours)</p>            | <ol style="list-style-type: none"> <li>1. Identify and demonstrate the proper use, maintenance, and storage techniques for the general shop hand tools.</li> <li>2. Identify and demonstrate the proper use, maintenance, and storage techniques for the general shop equipment.</li> <li>3. Identify and demonstrate the proper use, maintenance, and storage techniques for the following specialty tools and equipment for heating and air conditioning:               <ol style="list-style-type: none"> <li>a. A/C compressor clutch service tools</li> <li>b. A/C service port Adapter set</li> <li>c. dye Injector</li> <li>d. hygrometer</li> <li>e. leak detector (SAE Standard)</li> <li>f. manifold gauge set or equivalent (HFC-134a)</li> <li>g. refrigerant charging station (HFC-134a) or equivalent</li> <li>h. refrigerant identification equipment</li> <li>i. refrigerant recovery/recycling machine (HFC-134a)</li> <li>j. thermometer</li> </ol> </li> </ol> | <p><b>Career Ready Practice:</b><br/>1, 12</p> <p><b>CTE Anchor:</b><br/>Communications: 2.1, 2.2, 2.3,<br/>Health and Safety: 6.3, 6.6<br/>Ethics and Legal Responsibilities: 8.5<br/>Technical Knowledge and Skills: 10.1, 10.2</p> <p><b>CTE Pathway:</b><br/>C1.2, C1.3, C1.4, C2.1, C2.2, C2.3</p>                              |
| <p>E. SERVICE MANUALS AND COMPUTER-BASED INFORMATION SYSTEMS</p> <p>Understand, apply, and evaluate the contents of service manuals and computer-based information systems as important sources of reference to an auto technician.</p> <p>(2 hours)</p> | <ol style="list-style-type: none"> <li>1. Identify the different types of service manuals.</li> <li>2. Describe the different types of information that can be found in service manuals such as specifications, troubleshooting charts, and repair information.</li> <li>3. Describe and demonstrate the use of service manuals.</li> <li>4. Describe and demonstrate the use of CD-ROM (compact disc) and web-based search engines in finding automotive technical information.</li> <li>5. Describe the advantages of using CD-ROM and web-based search engines over service manuals in finding automotive technical information.</li> </ol>  | <p><b>Career Ready Practice:</b><br/>1, 3, 4</p> <p><b>CTE Anchor:</b><br/>Communications: 2.1, 2.2, 2.3, 2.4,<br/>Technology: 4.1, 4.2, 4.3,<br/>Problem Solving and Critical Thinking: 5.4<br/>Ethics and Legal Responsibilities: 8.5<br/>Technical Knowledge and Skills: 10.1</p> <p><b>CTE Pathway:</b><br/>C2.6, C4.1, C4.3</p> |

| COMPETENCY AREAS AND STATEMENTS   | MINIMAL COMPETENCIES  | STANDARDS  |
|---|---|--|
| <p>F. A/C SYSTEM DIAGNOSIS AND REPAIR</p> <p>Understand, apply, and evaluate the diagnostic and repair techniques for the A/C system according to the manufacturer's specifications.</p> <p>(30 hours)</p>              | <ol style="list-style-type: none"> <li>1. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction. P-1</li> <li>2. Identify and interpret heating and air conditioning concern; determine necessary action. P-1</li> <li>3. Research applicable vehicle and service information, such as heating and air conditioning system operation, vehicle service history, service precautions, and technical service bulletins. P-1</li> <li>4. Locate and interpret vehicle and major component identification numbers. P-1</li> <li>5. Performance test A/C system; identify A/C system malfunctions. P-1</li> <li>6. Identify abnormal operating noises in the A/C system; determine necessary action. P-2</li> <li>7. Identify refrigerant type; select and connect proper gauge set; record temperature and pressure readings. P-1</li> <li>8. Leak test A/C system; determine necessary action. P-1</li> <li>9. Inspect the condition of refrigerant oil removed from the system; determine necessary action. P-2</li> <li>10. Determine recommended oil and oil capacity for system application. P-1</li> <li>11. Using scan tool, observe and record related HVAC data and trouble codes. P1</li> </ol> | <p><b>Career Ready Practice:</b><br/>1, 2, 3, 4, 11, 12</p> <p><b>CTE Anchor:</b><br/>Communications:<br/>2.1, 2.2, 2.3, 2.4<br/>Technology:<br/>4.1<br/>Problem Solving and Critical Thinking:<br/>5.1, 5.3, 5.4<br/>Health and Safety:<br/>6.1, 6.6<br/>Responsibility and Flexibility:<br/>7.7<br/>Technical Knowledge and Skills:<br/>10.1</p> <p><b>CTE Pathway:</b><br/>C1.1, C1.2, C1.3, C1.4, C2.2, C2.3, C2.6, C4.1, C4.3, C4.4, C5.5, C7.5</p> |
| <p>G. REFRIGERATION SYSTEM DIAGNOSIS AND REPAIR</p> <p>Understand, apply, and evaluate the diagnostic and repair techniques for the refrigeration system components according to the manufacturer's specifications.</p> | <ol style="list-style-type: none"> <li>1. Diagnose A/C system conditions that cause the protection devices (pressure, thermal, and PCM) to interrupt system operation; determine necessary action. P-2</li> <li>2. Inspect and replace A/C compressor drive belts, pulleys, and tensioners; determine necessary action. P-1</li> <li>3. Inspect, test, and/or replace A/C compressor clutch components and/or assembly; check compressor clutch air gaps and adjust as needed. P-2</li> <li>4. Remove, inspect, and reinstall A/C compressor and mountings; determine required oil quantity. P-1</li> <li>5. Identify hybrid vehicle A/C system electrical circuits, service and safety precautions. P-3</li> <li>6. Determine the need for an additional A/C system filter; perform necessary action. P-3</li> <li>7. Remove and inspect A/C system mufflers, hoses, lines, fittings, O-rings, seals, and service valves; perform necessary action. P-2</li> </ol>   | <p><b>Career Ready Practice:</b><br/>1, 3, 5, 12</p> <p><b>CTE Anchor:</b><br/>Communications:<br/>2.1, 2.2, 2.3<br/>Health and Safety:<br/>6.1, 6.3, 6.4, 6.6<br/>Responsibility and Flexibility:<br/>7.4, 7.7<br/>Technical Knowledge and Skills:<br/>10.1</p>   |

| COMPETENCY AREAS AND STATEMENTS  | MINIMAL COMPETENCIES  | STANDARDS  |
|--|---|--|
| (30 hours)   | <ol style="list-style-type: none"> <li>8. Inspect A/C condenser for airflow restrictions; perform necessary action. P-1</li> <li>9. Remove, inspect, and reinstall receiver/drier or accumulator/drier; determine required oil quantity. P-1</li> <li>10. Remove, inspect, and install expansion valve or orifice (expansion) tube. P-1</li> <li>11. Inspect evaporator housing water drain; perform necessary action. P-2</li> <li>12. Remove, inspect, and reinstall evaporator; determine required oil quantity. P-3</li> <li>13. Remove, inspect, and reinstall condenser; determine required oil quantity. P-3</li> </ol>  | <p><b>CTE Pathway:</b><br/>C1.2, C1.3, C1.4, C2.2, C2.3, C3.5, C4.1, C4.3, C7.5</p>  |
| <p>H. HEATING, VENTILATION, AND ENGINE COOLING SYSTEMS DIAGNOSIS AND REPAIR</p> <p>Understand, apply, and evaluate the diagnostic and repair techniques for the heating, ventilation, and engine cooling systems according to the manufacturer's specifications.</p> <p>(30 hours)</p> | <ol style="list-style-type: none"> <li>1. Diagnose temperature control problems in the heater/ventilation system; determine necessary action. P-2</li> <li>2. Perform cooling system pressure tests; check coolant condition, inspect and test radiator, cap (pressure/vacuum), coolant recovery tank, and hoses; perform necessary action. P-1</li> <li>3. Inspect engine cooling and heater system hoses and belts; perform necessary action. P-1</li> <li>4. Inspect, test, and replace thermostat and gasket/seal. P-1</li> <li>5. Determine coolant condition and coolant type for vehicle application; drain and recover coolant. P-1</li> <li>6. Flush system; refill system with recommended coolant; bleed system. P-2</li> <li>7. Inspect and test cooling fan, fan clutch, fan shroud, and air dams; perform necessary action. P-1</li> <li>8. Inspect and test electric cooling fan, fan control system and circuits; determine necessary action. P-1</li> <li>9. Inspect and test heater control valve(s); perform necessary action. P-2</li> <li>10. Remove, inspect, and reinstall heater core. P-3</li> </ol> | <p><b>Career Ready Practice:</b><br/>1, 3, 5, 10</p> <p><b>CTE Anchor:</b><br/>Communications: 2.1, 2.2, 2.3<br/>Health and Safety: 6.1, 6.3, 6.4, 6.6<br/>Responsibility and Flexibility: 7.4, 7.7<br/>Technical Knowledge and Skills: 10.1</p> <p><b>CTE Pathway:</b><br/>C1.2, C1.3, C1.4, C2.2, C2.3, C4.3, C6.2</p> |
| <p>I. OPERATING SYSTEMS AND RELATED CONTROLS DIAGNOSIS AND REPAIR</p> <p>Understand and evaluate the diagnostic and repair techniques for the operating systems and related controls according to the manufacturer's specifications.</p>   | <ol style="list-style-type: none"> <li>1. Diagnose malfunctions in the electrical controls of heating, ventilation, and A/C (HVAC) systems; determine necessary action. P-2</li> <li>2. Inspect and test A/C-heater blower, motors, resistors, switches, relays, wiring, and protection devices; perform necessary action. P-1</li> <li>3. Test and diagnose A/C compressor clutch control systems; determine necessary action. P-1</li> <li>4. Diagnose malfunctions in the vacuum, mechanical, and electrical components and controls of the heating, ventilation, and A/C (HVAC) system; determine necessary action. P-2</li> <li>5. Inspect and test A/C-heater control panel assembly; determine necessary action. P-3</li> </ol>  | <p><b>Career Ready Practice:</b><br/>1, 3, 4, 5</p> <p><b>CTE Anchor:</b><br/>Communications: 2.1, 2.2, 2.3<br/>Technology: 4.1<br/>Problem Solving and Critical Thinking: 5.3, 5.4</p>  |

| COMPETENCY AREAS AND STATEMENTS   | MINIMAL COMPETENCIES   | STANDARDS  |
|---|--|--|
| (30 hours)  | <ol style="list-style-type: none"> <li>6. Inspect and test A/C-heater control cables, motors, and linkages; perform necessary action. P-3</li> <li>7. Inspect A/C-heater ducts, doors, hoses, cabin filters and outlets; perform necessary action. P-2</li> <li>8. Identify the source of A/C system odors. P-2</li> <li>9. Check operation of automatic or semi-automatic heating, ventilation, and air-conditioning (HVAC) control systems; determine necessary action. P-2</li> </ol> | <p>Health and Safety:<br/>6.6</p> <p>Technical Knowledge and Skills:<br/>10.1</p> <p><b>CTE Pathway:</b><br/>C1.3, C1.4, C2.1, C2.3, C3.2, C3.3, C3.5, C4.3, C6.2, C7.1, C7.5, C7.7</p>  |
| <p>J. REFRIGERANT RECOVERY, RECYCLING, AND HANDLING</p> <p>Understand, apply, and evaluate the recovery, recycling, and handling techniques for the refrigerant according to the manufacturer's specifications.</p> <p>(15 hours)</p> | <ol style="list-style-type: none"> <li>1. Perform correct use and maintenance of refrigerant handling equipment according to equipment manufacturer's standards. P-1</li> <li>2. Identify and recover A/C system refrigerant. P-1</li> <li>3. Recycle, label, and store refrigerant. P-1</li> <li>4. Evacuate and charge A/C system; add refrigerant oil as required. P-1</li> </ol>   | <p><b>Career Ready Practice:</b><br/>1, 2, 3, 5, 8, 12</p> <p><b>CTE Anchor:</b><br/>Communications:<br/>2.1, 2.2, 2.3, 2.4<br/>Technology:<br/>4.1<br/>Problem Solving and Critical Thinking:<br/>5.1, 5.4<br/>Health and Safety:<br/>6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7<br/>Responsibility and Flexibility:<br/>7.5, 7.7<br/>Ethics and Legal Responsibilities:<br/>8.1, 8.2<br/>Technical Knowledge and Skills:<br/>10.1, 10.2</p> <p><b>CTE Pathway:</b><br/>C1.1, C1.2, C1.3, C1.4, C2.2, C2.3, C2.6, C3.2, C4.2, C4.3, C5.2, C5.4, C6.2, C7.5</p> |

| COMPETENCY AREAS AND STATEMENTS   | MINIMAL COMPETENCIES  | STANDARDS   |
|---|---|---|
| <p>K. EMPLOYABILITY SKILLS</p> <p>Understand, apply, and evaluate the employability skills required in auto repair and maintenance.</p> <p>(10 hours)</p>             | <ol style="list-style-type: none"> <li>1. Describe employer requirements for the following:               <ol 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. responsibility</li> <li>g. timeliness</li> <li>h. communication skills</li> </ol> </li> <li>2. Identify potential employers through traditional and internet sources.</li> <li>3. Design sample résumés.</li> <li>4. Describe the importance of filling out a job application legibly, with accurate and complete information.</li> <li>5. Complete sample job application forms correctly.</li> <li>6. Describe the importance of enthusiasm on a job.</li> <li>7. Describe the importance of appropriate appearance on a job.</li> <li>8. Describe the importance of the continuous upgrading of job skills.</li> <li>9. Describe customer service as a method of building permanent relationships between the organization and the customer.</li> </ol> | <p><b>Career Ready Practice:</b><br/>1, 2, 3, 7, 8</p> <p><b>CTE Anchor:</b><br/>Communications:<br/>2.1, 2.2, 2.3, 2.4<br/>Career Planning and Management:<br/>3.1, 3.2, 3.3, 3.4, 3.5, 3.8, 3.9<br/>Technology:<br/>4.1<br/>Responsibility and Flexibility:<br/>7.2, 7.3, 7.4, 7.5, 7.6, 7.7<br/>Ethics and Legal Responsibilities:<br/>8.3, 8.4, 8.5<br/>Leadership and Teamwork:<br/>9.1, 9.2, 9.3<br/>Technical Knowledge and Skills:<br/>10.1, 10.2<br/>Demonstration and Application:<br/>11.1, 11.2, 11.5</p> <p><b>CTE Pathway:</b><br/>C1.3, C4.1, C5.2, C5.4, C5.5, C5.6</p> |
| <p>L. ENTREPRENEURIAL SKILLS</p> <p>Understand, apply, and evaluate the process involved in becoming an entrepreneur in the auto repair and maintenance industry.</p> | <ol style="list-style-type: none"> <li>1. Define entrepreneurship.</li> <li>2. Identify the necessary characteristics of successful entrepreneurs.</li> <li>3. Describe the contributions of entrepreneurs to the auto repair and maintenance industry.</li> <li>4. Explain the purpose and components of a business plan.</li> <li>5. Examine personal goals prior to starting a business.</li> <li>6. Evaluate sources of monetary investment in a business opportunity.</li> <li>7. Describe various licensing requirements in the auto repair and maintenance business.</li> <li>8. Develop a scenario depicting the student as the repair and maintenance business owner.</li> </ol>   | <p><b>Career Ready Practice:</b><br/>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12</p> <p><b>CTE Anchor:</b><br/>Communications:<br/>2.1, 2.2, 2.3, 2.4, 2.5<br/>Career Planning and Management:<br/>3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7</p>  |

| COMPETENCY AREAS AND STATEMENTS | MINIMAL COMPETENCIES   | STANDARDS   |
|---------------------------------|--|---|
| (3 hours)                       | 9. Differentiate between sustainable and green business practices and standard business practices. | <p>Technology:<br/>4.1, 4.2</p> <p>Responsibility and Flexibility:<br/>7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8</p> <p>Ethics and Legal Responsibilities:<br/>8.1, 8.2, 8.3, 8.4, 8.5</p> <p>Leadership and Teamwork:<br/>9.1, 9.2, 9.3, 9.6</p> <p>Technical Knowledge and Skills:<br/>10.1, 10.2, 10.3, 10.4</p> <p>Demonstration and Application:<br/>11.1, 11.2, 11.3, 11.4, 11.5</p> <p><b>CTE Pathway:</b><br/>C1.1, C1.3, C4.1, C4.2, C5.2, C5.4, C5.5, C5.6</p> |

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

### **TEXTS AND SUPPLEMENTAL BOOKS**

Birch, Thomas. Automotive Heating and Air Conditioning, with CD, (4<sup>th</sup> Edition.) Prentice Hall, 2005.

Duffy, James E. Modern Automotive Technology, 7<sup>th</sup> Edition. Goodheart-Willcox Publishing, 2009

Johanson, Chris. Auto Heating & Air Conditioning. Goodheart-Willcox Co., 2003.

Schnubel, Mark and Jack Erjavec. Classroom Manual for Automotive Heating and Air Conditioning. Addison-Wesley, 2005.

Schnubel, Mark. Today's Technician: Automotive Heating & Air Conditioning, ASE Class Manual & Shop Manual, 3<sup>rd</sup> Edition. Delmar Publishers©, 2003.

### **RESOURCES**

Employer Advisory Board members

Foundation Standards

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

Automotive Retailing Today (ART) 8400 Westpark Dr., MS 2, McLean, VA 22102. Phone: (703) 556-8578.

Automotive Youth Educational Systems (AYES) 50 W. Big Beaver, Suite 145, Troy, MI 48084. Phone: (248) 526-1750. Fax: (248) 526-1751.

National Automobile Dealers Association (NADA) Public Relations Dept., 8400 Westpark Dr., McLean, VA 22102-3591. Phone: (703) 821-7000.

National Automotive Technicians Education Foundation (NATEF) 101 Blue Seal Dr. SE, Suite 101, Leesburg, VA 20175. Phone: (703) 669-6650. Fax: (703) 669-6125.

[www.natef.org](http://www.natef.org)

[http://www.ed-foundation.org/html\\_pages/products\\_programs\\_services/natef\\_tools/non-structural\\_analysis/non-structural\\_analysis.shtml](http://www.ed-foundation.org/html_pages/products_programs_services/natef_tools/non-structural_analysis/non-structural_analysis.shtml)

National Institute for Automotive Service Excellence (ASE) 101 Blue Seal Dr. SE, Suite 101, Leesburg, VA 20175. Phone: (703) 669-6600.

SkillsUSA P.O. Box 3000, Leesburg, VA 20177-0300. Phone: (703) 777-8810. Fax: (703) 777-8999.

[www.skillsusa.org](http://www.skillsusa.org)

[www.fueleconomy.gov](http://www.fueleconomy.gov)

### **COMPETENCY CHECKLIST**



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

### **METHODS AND PROCEDURES**

- A. Lecture and discussion
- B. Multimedia presentations
- C. Visual aids
- D. Projects
- E. Individualized instruction

### **EVALUATION**

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

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

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

SECTION D – Tools and Equipment – Pass all assignments and exams on tools and equipment with a minimum score of 80% or higher.

SECTION E – Service Manuals and Computer-Based Information Systems – Pass all assignments and exams on service manuals and computer-based information systems with a minimum score of 80% or higher.

SECTION F – A/C System Diagnosis and Repair – Pass all assignments and exams on a/c system diagnosis and repair with a minimum score of 80% or higher.

SECTION G – Refrigeration System Components Diagnosis and Repair – Pass all assignments and exams on refrigeration system components diagnosis and repair with a minimum score of 80% or higher.

SECTION H – Heating, Ventilation, and Engine Cooling Systems Diagnosis and Repair – Pass all assignments and exams on heating, ventilation, and engine cooling systems diagnosis and repair with a minimum score of 80% or higher.

SECTION I – Operating Systems and Related Controls Diagnosis and Repair – Pass all assignments and exams on operating systems and related controls diagnosis and repair with a minimum score of 80% or higher.

SECTION J – Refrigerant Recovery, Recycling, and Handling – Pass all assignments and exams on refrigerant recovery, recycling, and handling with a minimum score of 80% or higher.

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

SECTION L – Entrepreneurial Skills – Pass all assignments and exams on entrepreneurial skills with a minimum score of 80% or higher.

**NATEF TASK PRIORITY ITEM TOTALS (by area)**

I. Engine Repair

P-1 = 26 95% = 25 tasks  
P-2 = 22 80% = 18 tasks  
P-3 = 9 50% = 5 tasks

II. Automatic Transmission and Transaxle

P-1 = 21 95% = 20 tasks  
P-2 = 17 80% = 14 tasks  
P-3 = 4 50% = 2 tasks

III. Manual Drive Train and Axles

P-1 = 24 95% = 23 tasks  
P-2 = 24 80% = 19 tasks  
P-3 = 17 50% = 9 tasks

IV. Suspension and Steering

P-1 = 25 95% = 24 tasks  
P-2 = 25 80% = 20 tasks  
P-3 = 11 50% = 6 tasks

V. Brakes

P-1 = 39 95% = 37 tasks  
P-2 = 10 80% = 8 tasks  
P-3 = 11 50% = 6 tasks

VI. Electrical/Electronic Systems

P-1 = 39 95% = 37 tasks  
P-2 = 13 80% = 10 tasks  
P-3 = 10 50% = 5 tasks

VII. Heating and Air Conditioning

P-1 = 26 95% = 25 tasks  
P-2 = 14 80% = 11 tasks  
P-3 = 7 50% = 4 tasks

VIII. Engine Performance

P-1 = 39 95% = 37 tasks  
P-2 = 12 80% = 10 tasks  
P-3 = 7 50% = 4 tasks

## DEFINITIONS OF TECHNICAL TERMS

ADJUST - to bring components to specified operational settings.

ALIGN - to restore the proper position of components.

ANALYZE - to assess the condition of a component or system.

ASSEMBLE (REASSEMBLE) - to fit together the components of a device or system.

BALANCE - to establish correct linear, rotational or weight relationship.

BLEED - to remove air from a closed system.

CAN – Controller Area Network. CAN is a network protocol (SAE J2284/ISO 15765-4) used to interconnect a network of electronic control modules

CHARGE - to bring to a specified state, e.g., battery or air conditioning system.

CHECK - to verify condition by performing an operational or comparative examination.

CLEAN - to rid component of foreign matter for the purpose of reconditioning, repairing, measuring or reassembling.

DEGLAZE – to remove a smooth glossy surface.

DETERMINE - to establish the procedure to be used to perform the necessary repair.

DETERMINE NECESSARY ACTION – indicates that the diagnostic routine(s) is the primary emphasis of a task. The student is required to perform the diagnostic steps and communicate the diagnostic outcomes and corrective actions required addressing the concern or problem. The training program determines the communication method (worksheet, test, verbal communication, or other means deemed appropriate) and whether the corrective procedures for these tasks are actually performed.

DIAGNOSE - to identify the cause of a problem.

DISASSEMBLE - to separate a component's parts as a preparation for cleaning, inspection or service.

DISCHARGE - to empty a storage device or system.

EVACUATE - to remove air, fluid or vapor from a closed system by use of a vacuum pump.

FLUSH - to internally clean a component or system.

HIGH VOLTAGE – voltages of 50 volts and higher.

HONE - to restore or resize a bore by using rotating cutting stones.

JUMP START - to use an auxiliary power supply to assist a battery to crank an engine.

LOCATE – to determine or establish a specific spot or area.

MEASURE - to determine existing dimensions/values for comparison to specifications.

NETWORK - a system of interconnected electrical modules or devices.

ON-BOARD DIAGNOSTICS (OBD) - diagnostic protocol which monitors computer inputs and outputs for failures.

PARASITIC DRAW - electrical loads which are still present when the ignition circuit is OFF.

PERFORM - to accomplish a procedure in accordance with established methods and standards.

PERFORM NECESSARY ACTION – indicates that the student is to perform the diagnostic routine(s) and perform the corrective action item. Where various scenarios (conditions or situations) are presented in a single task, at least one of the scenarios must be accomplished.

PURGE - to remove air or fluid from a closed system.

REMOVE - to disconnect and separate a component from a system.

REPAIR - to restore a malfunctioning component or system to operating condition.

REPLACE - to exchange a component; to reinstall a component.

RESURFACE – to restore correct finish.

SERVICE - to perform a procedure as specified in the owner's or service manual.

TEST - to verify condition through the use of meters, gauges or instruments.

TORQUE - to tighten a fastener to specified degree or tightness (in a given order or pattern if multiple fasteners are involved on a single component).

VERIFY - to confirm that a problem exists after hearing the customer's concern; or, to confirm the effectiveness of a repair.

VOLTAGE DROP - a reduction in voltage (electrical pressure) caused by the resistance in a component or circuit.

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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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