

# **COURSE OUTLINE**

**DIVISION:** Workforce Development (WFD)

COURSE: ATO 2250: Heating & Air Conditioning

Effective Date: Summer 2026

Submitted Date: Apr-25

Credit Hours: 3

IAI Number (if applicable): N/A

Complete all that apply or mark "None" where appropriate: Prerequisite(s): None.

Enrollment by assessment or other measure?  $\Box$  Yes  $\Box$  No

If yes, please describe:

Corequisite(s): None

Pre- or Corequisite(s): None

Consent of Instructor:  $\Box$  Yes  $\boxtimes$  No

Delivery Method:	⊠Lecture	2 Contact Hours (1 contact = 1 credit hour)
	□Seminar	0 Contact Hours (1 contact = 1 credit hour)
	⊠Lab	2 Contact Hours (2-3 contact = 1 credit hour)
	□Clinical	0 Contact Hours (3 contact = 1 credit hour)
	□Practicum	0 Contact Hours (5 contact = 1 credit hour)
	□Internship	0 Contact Hours (5 contact = 1 credit hour)

Offered: □**Fall** □**Spring** ⊠**Summer** 

#### CATALOG DESCRIPTION:

This course covers the theory, construction, operation and servicing of the air conditioning, heating and cooling systems found on the automobile. Emphasis will be placed on testing, troubleshooting and servicing of the air conditioning system using appropriate manuals, tools, equipment and safety practices. The recovery and recycling of refrigerant, laws governing R-134a and R-1234yf, and technician refrigerant certification will also be covered. A special emphasis will be placed on the safety and procedures needed when working on Hybrid and Electric vehicle air conditioning systems. IAI Number (if applicable): N/A

SP25 Outline Template

#### ACCREDITATION STATEMENTS AND COURSE NOTES:

The Automotive Technology program at Illinois Valley Community College is a ASE Education Foundation Master Certified Automotive Technology Program. The program goes through an on-site evaluation every five years and the ASE Education Foundation tasks that are taught in this course are also updated every five years to align with any changes made by the ASE Education Foundation national automotive advisory council.

#### COURSE TOPICS AND CONTENT REQUIREMENTS:

- I. Cooling System
  - A. Basic Theory
    - 1. Purpose of System
      - a. Operating temperature (too cool)
      - b. Operating temperature (too hot)
    - 2. Coolant
      - a. 50-50 mix (Ethylene glycol and water)
      - b. Maintenance
      - c. Additives
    - 3. Component parts
      - a. Radiator
        - 1) Construction
        - 2) Purpose
        - 3) Downflow
        - 4) Crossflow
        - 5) Transmission cooler
        - 6) Service (flushing)
      - b. Water pump
        - 1) Construction
        - 2) New and rebuild
        - 3) Replacement
        - 4) Drive belts
      - c. Water jackets
        - 1) Design
        - 2) Air cooled
      - d. Pressure caps
        - 1) Purpose
        - 2) Testing
        - 3) Coolant recovery

- e. Hoses
  - 1) Inspection
  - 2) Replacement
- f. Thermostat
  - 1) Purpose
  - 2) Types
  - 3) Testing
- g. Fans
  - 1) Thermostatic
  - 2) Fluid
  - 3) Variable pitch
  - 4) Shrouds
  - 5) Electrical
- II. Heating System
  - A. Basic Theory
    - 1. Heater Core
      - a. Construction
      - b. Location
      - c. Service
      - d. Air flow circuits
    - 2. Vacuum Controls
      - a. Temperature doors
      - b. Switches
      - c. Diagrams
      - d. Heater control valve
    - 3. Electrical circuits
      - a. Blower motors
      - b. Cable controls (temperature)
      - c. Auto temperature control
    - 4. Thermostats
      - a. Operation
      - b. Three types
      - c. Replacement
- III. The A/C System
  - A. Basic Theory
    - 1. Atmospheric Pressure
    - 2. Vacuum
    - 3. Heat
      - a. Transfer
      - b. Pressure-temperature relationship

SP25 Outline Template

- c. BTU
- d. Latent-heat
- 4. Humidity
- 5. Refrigerant
  - a. R-12
  - b. HFC-134a
  - c. R-1234yf
  - d. EPA Approved Blend refrigerants
  - e. Montreal protocol
  - f. CO2 as a Refrigerant
  - g. Ozone layer
  - h. Ozone depletion
- B. Component Parts
  - 1. Compressor
    - a. Purpose
    - b. Types
      - 1) Piston
      - 2) Rotary Vane
      - 3) Scroll
      - 4) Variable displacement
    - c. Service (seals, bearings and clutches)
    - d. Replacement
    - e. Controls
      - 1) Ambient temperature switch
      - 2) Pressure cycling switch
      - 3) Thermostatic cycling switch/Evaporator Temperature Sensor
      - 4) Low pressure cut-off switch/Low side pressure transducer
      - 5) High pressure cut-off switch/High side pressure transducer
      - 6) ECM/PCM/HVAC control modules
  - 2. Evaporator
    - a. Purpose and construction
    - b. Types
    - c. Replacement
  - 3. Controls
    - a. Expansion valve
    - b. Orifice Tube
    - c. Variable Orifice Tube

- d. Replacement
- 4. Condenser
  - a. Purpose
  - b. Construction
  - c. Receiver drier
  - d. Replacement
- 5. Servicing the system
  - a. Safety precautions
  - b. Use of gauge set
  - c. Use of recovery/recycling/recharging machine
  - d. Proper recovery of refrigerant
  - e. Evacuation
  - f. Charging
  - g. Leak testing
  - h. Performance testing
    - 1) Diagnosis
    - 2) Repair
- 6. Common malfunctions and diagnosis
  - a. Low Refrigerant Level
  - b. System overcharged
  - c. Air in system
  - d. Moisture in system (freezing up)
  - e. Condenser blockage
  - f. Faulty compressor
  - g. Expansion valve stuck
    - 1) Open
    - 2) Closed
  - h. Internal restrictions in the system
  - i. Defective cycling switch
  - j. Clogged receiver drier
- C. EPA Section 609 Certification
  - 1. Clean Air Act, Section 609
  - 2. Society of Engineering Standards
    - a. J1989
    - b. J1990
    - c. J1991
  - 3. Refrigerant Recovery and Recycling Certification exam
- D. Hybrid and Electric Vehicle Air Conditioning Systems
  - 1. PTC coolant heater and heater core
  - 2. PTC Heater air heater

- 3. Heat Pump System with inside condenser
- 4. Sources of heat energy, heat energy paths
- 5. 1234YF refrigerant, non-conductive refrigerant POE oil
- 6. Special procedures for recovering refrigerant and equipment flushing
- 7. Service intervals for both refrigerant and desiccant bags
- 8. Proper evacuation procedures to remove all moisture
- 9. Understanding that Removal/Recovery/Recycling equipment used on hybrid/electric vehicles cannot be used on non-hybrid/electric vehicles.
- 10. High Voltage thermal system heating and cooling loops
- 11. HV battery thermal management system service

#### **INSTRUCTIONAL METHODS:**

- Lecture
- Demonstrations
- Videos
- PowerPoint Presentations

#### EVALUATION OF STUDENT ACHIEVEMENT

- Complete Lab Objectives (ASE Educational Foundation Tasks)
- Satisfactory Performance on written Exams
- Safety Practices
- Work Habits
- Attendance
- Attitude
- Class Participation

#### INSTRUCTIONAL MATERIALS: Textbooks

• Electude Online software

#### Resources

- Pro-Demand Information System
- All Data Pro Information System

#### LEARNING OUTCOMES AND GOALS: Institutional Learning Outcomes

- $\boxtimes$  1) Communication to communicate effectively.
- ⊠2) Inquiry to apply critical, logical, creative, aesthetic, or quantitative analytical reasoning to formulate a judgement or conclusion.

- □ 3) Social Consciousness to understand what it means to be a socially conscious person, locally and globally.
- $\boxtimes$  4) Responsibility to recognize how personal choices affect self and society.

# **Course Outcomes and Competencies**

#### ASE Education Foundation 2024 Tasks completed in this course.

<u>Note</u>: The numbering of these tasks correlates with the ASE 2024 Master Automobile Service Technology task list.

#### VII. HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) A. General

- 1. Research vehicle service information, including refrigerant/oil/fluid type, vehicle service history, service precautions, technical service bulletins, and recalls including vehicles equipped with advanced driver assistance systems (ADAS).
- 2. Identify heating, ventilation, and air conditioning (HVAC) components and configurations.
- 3. Retrieve and record DTCs, OBD monitor status, and freeze frame data; clear codes and data when directed.
- 4. Perform A/C system performance test; interpret results; determine needed action.
- 5. Identify abnormal operating noises in the A/C system; determine needed action.
- 6. Leak test A/C system; determine needed action.
- 7. Verify and interpret heating and air conditioning problems; determine needed action.
- 8. Place a vehicle in service mode as needed before servicing and diagnosing the HVAC System.
- 9. Identify refrigerant type; test for sealant; select and connect proper gauge set/test equipment; record temperature and pressure readings.
- 9. Inspect condition/quantity of refrigerant oil removed from A/C system; determine needed action.
- 10. Determine recommended oil and oil capacity for system application and component(s) replacement.

#### VII. HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) B. Refrigeration System Components

- 1. Inspect, remove, and/or replace A/C compressor drive belts, pulleys, tensioners; determine needed action.
- 2. Inspect for proper A/C condenser airflow; determine needed action.

- 3. Inspect evaporator housing condensation drain; determine needed action.
- 4. Inspect, test, and/or service A/C compressor clutch components and/or assembly; determine needed action.
- 5. Remove, inspect, reinstall, and/or replace A/C compressor and mountings; determine recommended oil type and quantity.
- 6. Remove and inspect A/C system mufflers, hoses, lines, fittings, O-rings, seals, and service valves; determine needed action.
- 7. Remove, inspect, and replace receiver/drier or accumulator/drier; determine recommended oil type and quantity.
- 8. Remove, inspect, and install expansion valve or orifice (expansion) tube.
- 9. Diagnose A/C system conditions that cause the protection devices (pressure, thermal, and/or control module) to interrupt system operation; determine needed action.
- 10. Determine procedure to remove and reinstall evaporator; determine required oil type and quantity.
- 11. Remove, inspect, reinstall, and/or replace condenser; determine required oil type and quantity

# VII. HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) C. Heating, Ventilation, and Engine Cooling Systems

- 1. Inspect engine cooling and heater systems hoses and pipes; determine needed action.
- 2. Inspect and test heater control valve(s); determine needed action
- 3. Diagnose temperature control problems in the HVAC system related to the engine cooling system, including electric heating; determine needed action.
- 4. Determine procedure to remove, inspect, reinstall, and/or replace heater core; properly refill system

# VII. HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) D. Operating Systems and Related Controls

- 1. Inspect HVAC system ducts, doors, hoses, cabin filters, and outlets; determine needed action.
- 2. Identify the source of HVAC system odors.
- 3. Inspect and test HVAC system blower motors, resistors, switches, relays, wiring, and protection devices; determine needed action.
- 4. Diagnose A/C compressor control systems; determine needed action.
- 5. Diagnose malfunctions in the vacuum, mechanical, and/or electrical components and controls of the HVAC system; determine needed action.
- 6. Inspect, test, remove and/or replace HVAC system control panel; determine needed action.

7. Check operation of automatic HVAC control systems; determine needed action.

#### VII. HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) E. Refrigerant Recovery, Recycling, and Handling

- 1. Demonstrate awareness of the need to recover, recycle, and handle refrigerants using proper equipment and procedures
- 2. Use and maintain refrigerant handling equipment according to equipment manufacturer's standards.
- 3. Identify A/C system refrigerant; test for sealants; recover, evacuate, and charge A/C system; add refrigerant oil as required.
- 4. Recycle, label, and store refrigerant.

# VI. Electrical/Electronic Systems

# G. xEV Systems

- 1. Locate procedures to safely de-energize/disable and energize/enable high-voltage systems.
- 2. Identify potential safety and material handling concerns associated with high-voltage battery/energy storage systems.
- 3. Demonstrate knowledge of special multimeters, insulated tools, and other test equipment required for use in high-voltage circuits.
- 4. Demonstrate knowledge of personal protective equipment (PPE) required for use while servicing high-voltage circuits.
- 5. Demonstrate knowledge of the use of a live-dead-live/zero potential test to verify isolation of the high-voltage battery/energy storage system.
- 6. Demonstrate knowledge of the testing and verification of ground circuit isolation between vehicle chassis ground and the high-voltage circuits and components.
- 7. Demonstrate knowledge of safe handling procedures associated with high-voltage A/C compressors and wiring.
- 8. Demonstrate knowledge of high-voltage thermal management systems.

#### FOUNDATIONAL TASKS - 2024

# Shop and Personal Safety

- 1. Identify general shop safety rules and procedures.
- 2. Utilize safe procedures for handling of tools and equipment.
- 3. Identify and use proper placement of floor jacks and jack stands.
- 4. Identify and use proper procedures for safe lift operation, ensuring the configuration and weight rating of the lift is appropriate for the vehicle being lifted, including xEV's.
- 5. Utilize proper ventilation procedures for working within the lab/shop area.
- 6. Identify marked safety areas.
- 7. Identify the location and the types of fire extinguishers and other fire safety equipment; demonstrate knowledge of the procedures for using fire extinguishers and other fire safety equipment.
- 8. Identify the location and use of eye wash stations.
- 9. Identify the location of the posted evacuation routes.
- 10. Comply with the required use of safety glasses, ear protection, gloves, and shoes during lab/shop activities.
- 11. Identify and wear appropriate clothing for lab/shop activities.
- 12. Secure hair and jewelry for lab/shop activities.
- 13. Identify vehicle systems which pose a safety hazard during service such as: supplemental restraint systems (SRS), electronic brake control systems, stop/start systems, and remote start systems.
- 14. Identify vehicle systems which pose a safety hazard during service due to high voltage such as: hybrid/electric drivetrain, lighting systems, ignition systems, A/C systems, injection systems, etc.
- 15. Locate and demonstrate knowledge of safety data sheets (SDS).
- 16. Demonstrate knowledge of personal protective equipment (PPE) required for use in high voltage/electric vehicle circuits.

# Tools and Equipment

- 1. Identify tools and their usage in automotive applications.
- 2. Identify standard and metric designation.
- 3. Demonstrate safe handling and use of appropriate tools.
- 4. Demonstrate proper cleaning, storage, and maintenance of tools and equipment.

# Preparing for Vehicle Service

- 1. Identify information needed and the service requested on a repair order.
- 2. Identify purpose and demonstrate proper use of vehicle protection such as: fender covers, mats, seat, and steering wheel covers.

- 3. Perform a vehicle walk-around inspection; identify and document existing vehicle conditions such as body damage, paint damage, windshield damage.
- 4. Perform a vehicle multi-point inspection and complete a vehicle inspection report.
- 5. Demonstrate use of the three C's (concern, cause, and correction).
- 6. Create a plan of action for each specific service or diagnostic situation including placing the vehicle in service mode as required.
- 7. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.

# Preparing Vehicle for Customer

1. Ensure vehicle is prepared to return to customer per school/company policy (floor mats, steering wheel cover, etc.).

# xEV Vehicle Safety

- 1. Demonstrate knowledge of hazards related to high voltage systems/electric vehicles including electrocution, fire, explosion, arc flash, gases and fumes, hazardous chemicals, and EMF, and how to properly respond to emergency situations.
- 2. Demonstrate knowledge of high voltage system and component coloring, warning labels, lights, signage and lock-out/tag-out procedures.
- 3. Demonstrate ability to identify which components and circuits contain high voltage.
- 4. Demonstrate knowledge of steps needed to assess possible hazards prior to servicing a high voltage/electric vehicle, including awareness of automatic systems that may operate while the key switch/ignition is off.
- 5. Understand limitations on which systems, components, and circuits of a high voltage/electric vehicle a technician is capable of safely servicing based on their level of training and qualifications.
- 6. Demonstrate knowledge of high voltage/electric vehicle intake process, inspection, handling, and in-process monitoring for all vehicles including damaged/compromised vehicles.

#### **Personal Standards**

- 1. Reports to work daily on time; able to take directions and motivated to accomplish the task at hand.
- 2. Dresses appropriately and uses language and manners suitable for the workplace.
- 3. Maintains personal hygiene appropriate for the workplace.

- 4. Meets and maintains employment eligibility criteria, such as drug/alcoholfree status, clean driving record, etc.
- 5. Demonstrates honesty, integrity, and reliability.

# Work Habits / Ethic

- 1. Complies with workplace policies/laws.
- 2. Contributes to the success of the team, assists others and requests help when needed.
- 3. Works well with all customers and coworkers.
- 4. Negotiates solutions to interpersonal and workplace conflicts.
- 5. Contributes ideas and initiative.
- 6. Follows directions.
- 7. Communicates effectively, both in writing and verbally, with customers and coworkers.
- 8. Reads and interprets workplace documents; writes clearly and concisely.
- 9. Analyzes and resolves problems that arise in completing assigned tasks.
- 10. Organizes and implements a productive plan of work.
- 11. Uses scientific, technical, engineering and mathematics (STEM) principles and reasoning to accomplish assigned tasks.
- 12. Identifies and addresses the needs of all customers, providing helpful, courteous, and knowledgeable service and advice as needed.
- 13. Respectful of tools and property used in school and workplace environment.
- 14. Contributes to an inclusive environment where every coworker and customer feels welcomed, heard, and valued.