This is an introductory course that covers theory, knowledge, and skills necessary to understand automotive Heating, Ventilation, and Air Conditioning (HVAC) systems. Instruction is given and lab experience provided which will enable students to successfully perform diagnostics and repair on both manual and automatic HVAC systems. EPA-accepted techniques for recovering and recycling R134 and R12 refrigerants will also be covered. Coursework is based on the Automotive Service Excellence (ASE) Tasks and Standards intended to prepare students for the ASE A-7 Heating and Air Conditioning certification examination.
1. Demonstrate an ability to self-assess progress and development in a specific area and to further design and pursue a course of action based on the self-assessment.

2. Demonstrate mastery of diagnostic tools and equipment used for automotive repair.

3. Evaluate system pressures and discriminate between mechanical and/or electrical faults.

4. Analyze and diagnose automotive engines and related components for correct system operation.

COURSE OBJECTIVES:
1. Pass the SP-2 Mechanical Safety and Mechanical Pollution Prevention Test.
2. Retrieve and interpret service and repair information.
3. Analyze and interpret wiring diagrams, schematics, and electrical power flow on HVAC system circuits.
4. Perform related electrical measurements and compare against factory specifications.
5. Perform systematic analysis on HVAC systems using industry-accepted testing procedures, and diagnostic tools and equipment such as ‘smoke’ machines, Air Conditioning (A/C) system recycling and recovery machines, test lights, logic probes, digital volt ohm meters (DVOM’s), and scan tools.
6. Apply industry-accepted processes and principles for circuit analysis and repairs.
7. Apply learned safety concepts when servicing HEV’s, identifying the location of high voltage service disconnect switches.

COURSE CONTENT:

LECTURE CONTENT:

A. Safety
   1. Basic auto technology shop safety instruction and demonstrations
   2. SP-2 Mechanical Safety and Mechanical Pollution Prevention tests

B. HVAC basic theory and concepts
   1. Measuring heat
   2. Human comfort level parameters and related topics

C. Heat transfer theory
   1. Heat movement
      a. Conduction, convection
      b. Radiant heat movement
   2. ‘States of matter’ as applied to HVAC systems
      a. Molecules
      b. Solid, liquid and gas
   3. States of heat
      a. Latent and sensible heat
      b. Boiling points (BP)
      c. Saturated vapor and pressure-temperature relationship
   4. Air pressure
      a. Vacuum and pressure concepts
      b. Gauge and absolute pressure
   5. System internal fluids
      a. Refrigerants: R-12, R-22, R-134a, and Blends
      b. Compressor lubrication oils: PAG, ESTER, SUVA
      c. Dyes for tracing system leaks

D. Refrigerants and the environment
   1. Ozone layer, O3
   2. Legislation.
   3. Recovery and recycling
4. Refrigerants
   a. Ozone depletion potential
   b. Tank color identification codes
   c. Hazards

E. Principles of heat vs. cooling
   1. Theory of heat transfer
   2. Heat and cooling load factors
   3. Compression and expansion: Effects on heat and cooling

F. Air conditioning components
   1. Compressor
   2. Condenser
   3. Evaporator, expansion devices
   4. Receiver - drier and accumulator
   5. Muffler and filters
   6. Lines and hoses
   7. System switches
   8. Rear A/C units
   9. Aftermarket units

G. Heating systems
   1. System components and operation
   2. Dual/Rear heating systems
   3. After-market systems

H. System air management and ducting
   1. Main and remote controls
   2. Plastic/composite cases and ducts
   3. Automatic Temperature Control (ATC)
   4. Rear Window defroster

I. HVAC system inspection and trouble diagnosis
   1. Initial (first) checks
      a. A/C ‘in-cabin’ performance test using thermometer
      b. Visual inspection, under hood, in vehicle
      c. ‘Touch-test’ of Air Conditioner (AC) lines and hoses
      d. Infrared thermometer usage
   2. A/C system pressure checks
      a. Gauge sets and fittings
      b. Gauge hookups: Low vs. high side connections
      c. Verifying charge levels
      d. Thermal Expansion Valve (TXV) tests
   3. Refrigerant leak tests
      a. Checking for refrigerant ‘witness marks’
      b. Use of dyes to trace refrigerant leaks
   4. Vacuum leak-down test

K. Heating and air management system inspection and diagnosis
   1. Heater problems and solutions
   2. Blend door operation and checks
   3. Mode and fresh air door operation and checks

L. HVAC system electrical/electronic controls, theory, inspection, and diagnosis
   1. Basic electrical theory and concepts
   2. System electronic controls
   3. HVAC system circuits
   4. Measuring electrical values, test devices
5. Circuit issues: shorts, opens, grounds
6. Circuit repairs
7. Electronic self-diagnosis

M. A/C refrigerant maintenance and service operations
   1. Safety
   2. Identifying refrigerant type, recovery, and recycling
   3. System evacuating and flushing
   4. Inline filter: Purpose and installation
   5. System evacuation process
   6. System recharging
   7. Labeling and storing A/C refrigerant
   8. Retrofitting: R-12 to 134a

N. A/C system parts and components: Diagnostics and repairs
   1. Compressor
   2. Hoses and fittings
   3. Components Remove & Replace (R & R)

O. Vehicle cooling system
   1. Engine and radiator heat transfer concepts and theory
   2. Parts and component, operation
   3. Coolant types
   4. Block heaters
   5. Use of infrared thermometer to check system temperatures

P. Cooling system service maintenance, inspection, and diagnostics
   1. Maintenance operations
   2. System inspection
   3. Trouble diagnosis
   4. Service and repair
   5. System flush and fill

Q. Practice sample (A-6) ASE Heating and Air Conditioning Certification Test

LABORATORY CONTENT:

Heating and Air Conditioning

For every task in Heating and Air Conditioning, the following safety requirement must be strictly enforced: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

A. A/C system diagnosis and repair
   1. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction
   2. Identify and interpret heating and air conditioning concern; determine necessary action
   3. Research applicable vehicle and service information, such as heating and air conditioning system operation, vehicle service history, service precautions, and technical service bulletins
   4. Locate and interpret vehicle and major component identification numbers
   5. Performance test A/C system; identify A/C system malfunctions
   6. Identify abnormal operating noises in the A/C system; determine necessary action
   7. Identify refrigerant type; select and connect proper gauge set; record temperature and pressure readings
   8. Leak test A/C system; determine necessary action
9. Inspect the condition of refrigerant oil removed from the system; determine necessary action
10. Determine recommended oil and oil capacity for system application
11. Using scan tool, observe and record related HVAC data and trouble codes

B. Refrigeration system component diagnosis and repair

1. Diagnose A/C system conditions that cause the protection devices (pressure, thermal, and PCM) to interrupt system operation; determine necessary action
2. Inspect and replace A/C compressor drive belts, pulleys, and tensioners; determine necessary action
3. Inspect, test, and/or replace A/C compressor clutch components and/or assembly; check compressor clutch air gap and adjust as needed
4. Remove, inspect, and reinstall A/C compressor and mountings; determine required oil quantity
5. Identify hybrid vehicle A/C system electrical circuits, service and safety precautions
6. Determine the need for an additional A/C system filter; perform necessary action
7. Remove and inspect A/C system mufflers, hoses, lines, fittings, O-rings, seals, and service valves; perform necessary action
8. Inspect A/C condenser for airflow restrictions; perform necessary action
9. Remove, inspect, and reinstall receiver/drier or accumulator/drier; determine required oil quantity
10. Remove, inspect, and install expansion valve or orifice (expansion) tube
11. Inspect evaporator housing water drain; perform necessary action
12. Remove, inspect, and reinstall evaporator; determine required oil quantity
13. Remove, inspect, and reinstall condenser; determine required oil quantity

C. Heating, ventilation, and engine cooling systems diagnosis and repair

1. Diagnose temperature control problems in the heater/ventilation system; determine necessary action
2. Perform cooling system pressure tests; check coolant condition, inspect and test radiator, cap (pressure/vacuum), coolant recovery tank, and hoses; perform necessary action
3. Inspect engine cooling and heater system hoses and belts; perform necessary action
4. Inspect, test, and replace thermostat and gasket/seal
5. Determine coolant condition and coolant type for vehicle application; drain and recover coolant
6. Flush system; refill system with recommended coolant; bleed system
7. Inspect and test cooling fan, fan clutch, fan shroud, and air dams; perform necessary action
8. Inspect and test electric cooling fan, fan control system and circuits; determine necessary action
9. Inspect and test heater control valve(s); perform necessary action
10. Remove, inspect, and reinstall heater core

D. Operating systems and related controls diagnosis and repair

1. Diagnose malfunctions in the electrical controls of heating, ventilation, and A/C (HVAC) systems; determine necessary action
2. Inspect and test A/C-heater blower, motors, resistors, switches, relays, wiring, and protection devices; perform necessary action
3. Test and diagnose A/C compressor clutch control systems; determine necessary action
4. Diagnose malfunctions in the vacuum, mechanical, and electrical components and controls of the heating, ventilation, and A/C (HVAC) system; determine necessary action
5. Inspect and test A/C-heater control panel assembly; determine necessary action
6. Inspect and test A/C-heater control cables, motors, and linkages; perform necessary action
7. Inspect A/C-heater ducts, doors, hoses, cabin filters and outlets; perform necessary action
8. Identify the source of A/C system odors
9. Check operation of automatic or semi-automatic heating, ventilation, and air-conditioning (HVAC) control systems; determine necessary action

E. Refrigerant recovery, recycling, and handling
   1. Perform correct use and maintenance of refrigerant handling equipment according to equipment manufacturer’s standards
   2. Identify and recover A/C system refrigerant
   3. Recycle, label, and store refrigerant
   4. Evacuate and charge A/C system; add refrigerant oil as required

METHODS OF INSTRUCTION:
   A. Lecture:
   B. Lab:
   C. Independent Study:

INSTRUCTIONAL TECHNIQUES:

COURSE ASSIGNMENTS:
   Reading Assignments
      Textbook
      Websites: Web-based assignments: Autoshop101.com, CTEonline.com, other topic specific websites as needed

Out-of-class Assignments

   Writing Assignments
   1. Create vehicle repair orders, perform math exercises for flat rate labor, parts and materials totals.
   2. Demonstrate an understanding of HVAC operation by performing math equations to figure values for HVAC performance, system charge values, compressor oil content, and related electrical values.
   3. Use info and concepts learned in class to successfully pass a practicum exam or written test or assignment.
   4. Use service and repair information to compare factory specs with actual readings and measurements.

METHODS OF STUDENT EVALUATION:
Midterm Exam
Final Exam
Written Assignments
Objective Examinations
Report
Projects (ind/group)
Problem Solving Exercises
Oral Presentations
Skills Demonstration
**Demonstration of Critical Thinking:**

1. Demonstrate the ability to analyze and troubleshoot HVAC electrical circuits and restore them to proper service.
2. Analyze, confirm, and diagnose HVAC system faults based on symptoms indicated on repair orders.
3. Relate diagnostic test results directly to circuit or component failures based on gauge pressure or electrical meter readings.
4. Analyze wiring diagrams to determine integrity of circuits which support HVAC systems.

**Required Writing, Problem Solving, Skills Demonstration:**

1. Create vehicle repair orders, perform math exercises for flat rate labor, parts and materials totals.
2. Demonstrate an understanding of HVAC operation by performing math equations to figure values for HVAC performance, system charge values, compressor oil content, and related electrical values.
3. Use info and concepts learned in class to successfully pass a practicum exam or written test or assignment.
4. Use service and repair information to compare factory specs with actual readings and measurements.

**TEXTS, READINGS, AND RESOURCES:**

**TextBooks:**


**Other:**

1. GWC Auto Tech work shirt
2. Basic hand tool set
3. Refrigerant R134 as needed

**LIBRARY:**

Adequate library resources include:

**Comments:**

**Attachments:**

[Attached Files]