COURSE OUTLINE

Course Number	Course Title	Credits
AUT 212	Automotive Air Conditioning	3

Hours: lecture/Lab/Other	Co- or Pre-requisite	Implementation
2 2	AUT 110 and AUT 111	Spring 2019

Catalog description (2018-2019 Catalog):
This course focuses on automotive air conditioning and heating systems in past and present automobile designs. Topics range from fundamental of refrigeration to electronic automatic temperature control (EATC) system operation. Proper diagnosis and repair of systems and components will be emphasized. Federal and State environmental policies will be discussed in detail as to their impact and implementation during system services.

Is course New, Revised, or Modified? Revised

Required texts/other materials: Halderman, James D, Automotive Heating and Air Conditioning, (current edition), Pearson Education, 2018

Revision date:
January 2019

Course coordinator: Jason Evans, ext. 3776, evansj@mccc.edu

Information resources: DealerConnect web-site, Learning Center Training Reference Books, Subaru of America resources, Service Manuals, On-line and CD Disc Self-study Courses and the AllData Online Service Information Database.

Other learning resources: ASE Study Guides, Automotive Related Articles Obtained From Magazines and Journals

Course Competencies/Goals:

The student will be able to:

- demonstrate his/her ability to perform automotive service and repair following protocol that promotes personal safety and the safety of others working in the repair facility or auto shop.

- explain the use of basic hand tools and be able to use basic hand tools to perform service and repair of automotive systems. This includes fastener thread repair.

- explain the fundamental theories of operation of automobile climate control systems, both heating and cooling.

- analyze automotive climate control systems an accomplish the following:
  - Use diagnostic scan tools to verify proper operation of system components and identify components that are not operating within normal parameters.
  - Utilize printed and electronic service information to obtain guidance before beginning the diagnosis and/or repair of automobile systems.
  - Communicate with automotive repair professionals in a manner that follows standards of the automotive repair industry.

Course-specific General Education Knowledge Goals and Core Skills.

General Education Knowledge Goals

Goal 1. Communication. Students will communicate effectively in both speech and writing.
Goal 2. Mathematics. Students will use appropriate mathematical and statistical concepts and operations to interpret data and to solve problems.
Goal 3. Science. Students will use the scientific method of inquiry, through the acquisition of scientific knowledge.
Goal 4. Technology. Students will use computer systems or other appropriate forms of technology to achieve educational and personal goals.
Goal 5. History. Students will understand historical events and movements in World, Western, non-Western or American societies and assess their subsequent significance.
Goal 6. Diversity. Students will understand the importance of a global perspective and culturally diverse peoples.
Goal 7. Ethical Reasoning and Action. Students will understand ethical issues and situations.

MCCC Core Skills

Goal A. Written and Oral Communication in English. Students will communicate effectively in speech and writing, and demonstrate proficiency in reading.
Goal B. Critical Thinking and Problem-solving. Students will use critical thinking and problem solving skills in analyzing information.
Goal C. Ethical Decision-Making. Students will recognize, analyze and assess ethical issues and situations.
Goal D. Information Literacy. Students will recognize when information is needed and have the knowledge and skills to locate, evaluate, and effectively use information for college level work.
Goal E. Computer Literacy. Students will use computers to access, analyze or present information, solve problems, and communicate with others.
Goal F. Collaboration and Cooperation. Students will develop the interpersonal skills required for effective performance in group situations.
Goal G. Intra-Cultural and Inter-Cultural Responsibility. Students will demonstrate an awareness of the responsibilities of intelligent citizenship in a diverse and pluralistic society, and will demonstrate cultural, global, and environmental awareness.

Units of study in detail.

Unit I: FUNDAMENTALS OF REFRIGERATION

Learning Objectives

The student will be able to…

- recognize potential hazard associated with the use and handling of automotive refrigerants.
- demonstrate professionalism by understanding the legal requirement to be licensed in refrigerant handling prior to performing air conditioning repairs for his / her employer.
- demonstrate his / her knowledge of heat transfer principles, when presented with a relevant exam question.

A. FUNDAMENTALS OF THE REFRIGERATION PROCESS
    a. Evaporation Removes Heat
    b. Relative Humidity
        i. The Psychrometer
            1. Amount of Moisture in the Air

B. BEAHAVIOR AND MEASUREMENT OF HEAT
    a. Conduction
        i. Heat transfer from a solid object to another solid object
            1. Example: Transfer of Heat From Your Hand to An Ice Cube
    b. Convection
        i. Heat transfer through the surrounding air
            1. Example: Convection Oven
    c. Radiation
        i. Heat Transferred Through Heat Rays
            1. Example: Sunlight
    d. Removal of Heat
        i. Refrigerant R-12 and R-134a
        ii. Heat Transfer Through Matter Change of State
            1. Vapor to Liquid
            2. Liquid to Vapor
        iii. Heat
            1. “Sensible” Heat
    e. Pressure / Temperature Relationship
        i. Change of State
        ii. Boiling Point
            1. Pressure – Vacuum

Unit II R-12 AND R-134a REFRIGERENT

Learning Objectives

The student will be able to…

- demonstrate their ability to adhere to safety procedures while using or working with automotive refrigerants.
- explain the differences in application for the use of both R-12 and R-134a refrigerants.
- analyze most automotive air conditioning systems to determine what type of refrigerant is used in the system.
- explain the process of refrigerant leak detection to customers and others with a technical knowledge of refrigerant applications.
- explain how the liquid and vapor forms of refrigerant work in conjunction to remove excess heat from cabin air.
- provide examples of what might cause an automotive air conditioning system to fail or create a customer concern.

A. Refrigerant R-12
    a. Liquid vs. Vapor
    b. Safety in Handling and Leak Detection
    c. Operation of the Air Conditioning System
        i. Components
            1. Evaporator
            2. Cycling Switches
            3. Restriction
                a. Expansion Tube (Fixed Orifice Tube)
                b. Expansion Valve (Chrysler – "H" Valve)
            4. Filter / Dryer
            5. Condenser
            6. Refrigerant Lines / Tubes
            7. Compressor
            8. Service Valves / Fittings
            9. Flow of Refrigerant
            10. Removal of Heat From Passenger Compartment
B. Refrigerant R-134a
    a. Liquid vs. Vapor
    b. Safety in Handling and Leak Detection
    c. Operation of the Air Conditioning System
        i. Components
            1. Evaporator
            2. Cycling Switches
            3. Restriction
                a. Expansion Tube (Fixed Orifice Tube)
                b. Expansion Valve (Chrysler – "H" Valve)
            4. Filter / Accumulator
            5. Condenser
            6. Refrigerant Lines / Tubes
            7. Compressor
            8. Service Valves / Fittings
            9. Flow of Refrigerant
            10. Removal of Heat From Passenger Compartment

Unit III AIR CONDITIONING SYSTEM COMPONENTS AND OPERATION

Learning Objectives

The student will be able to…

- explain the purpose and function of each component constructing and automotive air condition system.
- describe special equipment that might be required during the service of an air conditioning system and its components.
- successfully and safely recover, evacuate, and recharge an automotive air conditioning system using a modern refrigerant recovery / recycling machine.
- explain the refrigerant flow in an automotive air conditioning system.

A. EVAPORATOR / HEATER ASSEMBLY
    a. Function and Location
    b. Air Outlet Assemblies
    c. Air Distribution Ducts
    d. Mode-Door Activation Methods
B. CYCLING CLUTCH AND "H" VALVE ASSEMBLIES

a. Function and Location
b. Low-Pressure Cut-Out Switch
c. A/C Pressure Transducer

C. FILTER / DRYER
a. Function and Location
b. High Pressure Relief Valve
c. Sight Glass

D. CONDENSOR
a. Function
b. Construction
c. Cooling Fan(s)
i. Engine Driven
ii. Electric

E. COMPRESSOR
a. Function
b. Types
c. Compressor Clutch

F. REFRIGERANT LINES AND SERVICE VALVES / FITTINGS
a. Function and Location
b. R-12 vs. R-134a
c. R-12 to R-134a Conversion

Unit IV HEADING SYSTEMS

Learning Objectives

The student will be able to…

- describe the operations of an automotive heating system.
- explain antifreeze requirement needed to provide ample protection of metal components.
- demonstrate his / her ability to explain the function and operation of automotive heating system components.

A. HEATING SYSTEM COMPONTS
a. Antifreeze
b. Hoses / Pipes
c. Coolant Pump
d. Thermostat
e. Heater Core
f. HVAC Box Assembly
g. Blower Motor
h. Heater Ducts
i. Mode Control Head
i. Mechanical
ii. Electronic / Automatic
j. Actuators
i. Mechanical
ii. Electrical

B. COMPONENTS
a. Antifreeze
i. Propylene Glycol
ii. Ethylene Glycol
iii. 50 / 50 Dilution Mixture
iv. Corrosion Prevention
v. Boiling Point / Freezing Point

C. HOSES / PIPES
    a. Coolant Transfer
    b. Rubber / Metal / Plastic
D. COOLANT PUMP
    a. Coolant Circulation
    b. Engine Driven
E. THERMOSTAT
    a. Regulates Coolant Flow
    b. Maintains Optimal Engine Temperature
F. HEATER CORE
    a. Design / construction / placement
    b. Heat Exchanger
G. HVAC BOX ASSEMBLY
    a. Direction of Air Flow
H. BLOWER MOTOR
    a. Flow of Heated or Cooled Air into The Passenger Compartment
I. HEATER DUCTS
    a. Flow of Treated Air into Passenger Compartment
J. MODE CONTROL HEAD
    a. Operator Interface With HVAC System
K. OPERATION OF HEATER SYSTEM
    a. Function / Operation
L. REAR HEATING SYSTEMS
    a. Stand-Alone System
    b. Integrated System

Unit V HEATER DIAGNOSIS AND SERVICE

Learning Objectives

The student will be able to…

- analyze a heating system malfunction to determine the cause of the malfunction.
- demonstrate his/her knowledge of air distribution in all HVAC modes.
- provide understandable explanation of system operation to customers with limited or no technical background.

A. MALFUNCTION CONDITIONS AND POSSIBLE CAUSES
    a. Insufficient or No Heated Air Discharge
        i. Obstruction in Coolant Flow
            1. Pinched / Collapsed / Plugged Heater Hose
            2. Improper Hose Routing
            3. Water Flow Control Valve Malfunction
            4. Plugged Heater Core
        ii. Heater System Mechanical Malfunction
            1. Obstructed Air Intake Vent
            2. Obstructed Air Distribution Duck
            3. Blend Air Door Malfunction
            4. Mode Door Malfunction
        iii. Inoperative Temperature Adjustment
            1. Blend Air Door / HVAC Box Malfunction
            2. Door Mode Control Malfunction
            3. Insufficient Engine Coolant Temperature
        iv. Customer Expectations
    b. Blower Motor Malfunctions / Inoperative
        i. Open Fuse
        ii. Open Circuitry

iii. Faulty Blower Motor Control Switch / Control Head
iv. Faulty Blower Motor Assembly
v. Faulty Blower Motor Resistor

c. Blower Motor Vibration / Noise
i. Vibration
1. Blower Motor Mounting Loose
2. Blower Motor Fan Wheel Loose on Motor Shaft
3. Fan Wheel Broken
4. Faulty Blower Motor
ii. Noise
1. Foreign Material Around Fan Wheel
2. Fan Wheel Contacting Housing
3. Faulty Blower Motor

B. COMPONENT SERVICE
a. Actuator Cables
b. Circuit Repair
c. Actuator Motor
d. Blower Motor
e. Heater Core
f. HVAC Box
g. Cabin Air Filter

Unit VI AIR CONDITIONING DIAGNOSIS

Learning Objectives

The student will be able to…

- demonstrate his/her ability to pinpoint the cause of an air conditioning malfunction.
- locate appropriate diagnostic information regarding air conditioning service and diagnosis.
- explain the function of each air conditioning component and elaborate on what might cause the component to malfunction.

A. CONDITIONS
a. Insufficient A/C Cooling
b. Loss of Refrigerant
c. No Blower Motor Operation
d. Abnormal Noise During A/C Operation
e. Cannot Adjust A/C Mode Doors
f. Compressor Clutch Will Not Engage / Disengage

B. OPERATIONAL CHECKS
a. Check Accessory Belt Tension
b. Check For Proper Compressor Clutch Engagement
c. Check For Proper Cooling Fan Operation
d. Check Refrigerant Charge Level
e. Check For Proper Blower Motor Operation
f. Check For Adequate Air Discharge From Cabin Vents
g. Check For Refrigerant Contamination
i. Check Sight Glass
1. Clear
2. Bubbles
3. Discolored
h. Check Common Leak Points
i. Check Temperature of
i. Suction Line
1. Cool
ii. Liquid Line

1. Warm or Hot

C. A/C BLOWER MOTOR AND CPNTOL SYSTE, - ELECTRICAL
D. COMPRESSOR AND CLUTCH
E. VACUUM SUPPLYS
    a. Off
    b. Max A/C
    c. Normal A/c
    d. Vent
    e. Floor
    f. Defroster
    g. Bi-level
F. COMPRESSER LUBRICATION LEVEL
    a. Qualities of Refrigerant Oils
        i. PAG
        ii. Mineral
        iii. Ester
G. TESTING
    a. A/C Tests
        i. Vacuum Tests
        ii. Refrigerant Leak Test
        iii. Service Gauge Test
        iv. Performance Test
    b. Vacuum Tests
        i. Vacuum Supply to HVAC Box Actuators (If Equipped)
    c. Manifold Gauge Set Installation
        i. Schrader Valve
        ii. Gauge Reading Interpretation
    d. Refrigerant Leak Test
        i. Visual Inspection
        ii. Electronic Leak Detection
            1. Halogen Leak Detection
            2. Black Light With Tracer Dye
            3. Cautions For Other Testing
                a. Do Not Use Torch Tester
                    i. Poisonous Gases Released
            4. Leak Types
                a. Low Charge
                b. No Charge
                    i. Leak Repair
H. PERFORMANCE TESTING
    a. Settings to Max A/C
    b. Windows Up
    c. Temperature Gauge in Center Discharge Vent
    d. Engine Speed At 1,500 RPM's
    e. Fan Placed in Front of the Radiator / Condenser

Unit VII **AIR CONDITIONING SYSTEM SERVICE AND COMPRESSOR SERVICE**

Learning Objectives

The student will be able to…

- safely remove refrigerant from an automotive air conditioning system in compliance with EPA regulations.
- follow all printed or electronic service procedures when servicing systems related to the sir

conditioning system.
- analyze an air conditioning system to determine refrigerant type to prevent damage to costly air conditioning service equipment.
- properly remove and install an air conditioning compressor clutch and field coil.

A. SERVICE PROCEDURES
    a. Discharging the System
        i. Recycling and Recovery Procedures
    b. Evacuating the System
    c. Recharging the System
        i. With Recovery / Recycling Machine
        ii. Without Recovery / Recycling Machine
        iii. With Manifold Gauge Set and Service Hose / Valve
        iv. R-12 / R-134a Refrigerant
        v. Adding Oil
        vi. Adding Dye
    d. Component Checks and replacement
        i. Low Pressure Cut-Out Switch
        ii. High Pressure Cut-Out Switch
        iii. Expansion Tube
        iv. Expansion Valve
        v. Resealing the System
            1. Replacement of “O” Rings and Seals
        vi. Evaporator Temperature Sensor
        vii. Refrigerant Lines / Hoses
        viii. Compressor
        ix. Condenser
B. COMPRESSOR SERVICE
    a. A/C Clutch
        i. Car Voltage and Current Draw
        ii. Clutch Removal and Inspection
            1. Special Tools
            2. Inspection
                a. Cracks
                b. Scoring
                c. Burning
        iii. Clutch Installation
            1. Special Tools
            2. Checking Air Gap
        iv. Compressor Replacement
            1. Measuring Oil Level in Old Compressor
            2. Adding Oil to New Compressor
C. EVAPORATOR SERVICE
    a. Leak Detection
    b. Replacement
        i. Removal in Engine Compartment
        ii. Removal in Cabin
            1. Dashboard Removal and Installation

Unit VIII ELECTRONIC AUTOMATIC TEMPERATURE CONTROL (EATC)

Learning Objectives

The student will be able to…

- explain the inputs and outputs of an EATC module that allows automatic temperature control of the cabin.
- describe potential methods for activating EATC self-diagnostics, using the control head.
- successfully diagnose a customer concern related to EATC operation.
- utilize electronic scan tool information to aide him / her in the diagnostic process.

A. OPERATION
   a. Controlled By Computer Module
   b. Adjustment Made Frequently By Computer Module
   c. Blower Relay During Cold Operation
      i. Delay Time Varies With Temperature
      ii. Defroster Can Operate Immediately
   d. Display
      i. Soft-Touch, Precision-Feel Buttons
      ii. Digital Display
      iii. International Standard Organization (ISO) Symbols
      iv. Optional Display of External Temperature

B. COMPONENTS: LOCATION AND FUNCTION
   a. Control Module – Control Head
   b. Ambient Air Temperature Sensor
   c. Sun-Load Sensor
   d. Power / Vacuum Module Assembly
   e. Other Sensors = Part of Standard A/C System

C. DIAGNOSTICS
   a. Visual Inspection
      i. Drive Belt Tension and Condition
      ii. Vacuum Lines
         1. Routing and Connections
      iii. Electrical
         1. Routing and Connections
      iv. A/C Clutch Operation
      v. Refrigerant Level Check
      vi. Switching of Air Flow in Reaction to Mode Selection
      vii. Control Head Illumination
      viii. Blower Speed Test (All Speeds)
      ix. Blending of Air Temperature
         1. Hot to Cold
         2. Cold to Hot
   b. Self Diagnostic Mode
      i. Mode Activation
   c. Diagnostics With Scan Tool
      i. Connections
      ii. Testing of Actuators
      iii. Obtaining DTC's

D. REFRIGERANT DIAGNOSIS
   a. See Refrigerant for Standard A/C System

E. VACUUM COMPONENTS
   a. Vacuum Diagrams
   b. System Components and Operation
   c. Mode Diagrams

i. Off Mode
ii. Panel Mode
iii. Bi-Level Mode
iv. Floor Mode
v. Defrost Mode
vi. Recirculation Mode
    1. On
    2. Off

Unit VIII COURSE REVIEW/FINAL EXAM

A. FUNDAMENTALS OF REFRIGERATION
B. R-12 AND R-134a REFRIGERENT
C. AIR CONDITIONING SYSTEM COMPONENTS AND OPERATION
D. HEATING SYSTEMS
E. HEATER DIAGNOSIS AND SERVICE
F. AIR CONDITIONING DIAGNOSIS
G. AIR CONDITIONING SYSTEM SERVICE AND COMPRESSOR SERVICE
H. ELECTRONIC AUTOMATIC TEMPERATURE CONTROL (EATC)

Evaluation of student learning:

A. Lab Work 50%
B. Test/Quizzes/Homework Assignments/Final Exam 50%

Academic Integrity Statement:

Mercer County Community College is committed to Academic Integrity-- the honest, fair and continuing pursuit of knowledge, free from fraud or deception. This implies that students are expected to be responsible for their own work, and that faculty and academic support services staff members will take reasonable precautions to prevent the opportunity for academic dishonesty.

Reasonable Accommodations for Students with Documented Disabilities

Mercer County Community College is committed to ensuring the full participation of all students in all activities, programs and services. If you have a documented differing ability or think that you may have a differing ability that is protected under the ADA and Section 504 of the Rehabilitation Act, please contact Arlene Stinson in LB 216 stinsona@mccc.edu for information regarding support services. If you do not have a documented differing ability, remember that other resources are available to all students on campus including academic support through our Academic Learning Center located in LB 214.