COURSE OUTLINE

Course Number: AUT 211  
Course Title: Automotive Emissions and Driveability Diagnosis  
Credits: 3

Hours: lecture/Lab/Other 2     2

Co- or Pre-requisite: AUT 110, AUT 111, and AUT 112

Implementation: sem/year  
Spring 2019

Catalog description (2001-2019 Catalog): Examines the relationship of automotive emissions with engine driveability concerns. Utilizing information presented in AUT 111 and AUT 112, proper diagnosis of driveability concerns and recommended repair procedures are explored to achieve the best performance and reduced emissions. Emission control devices are examined with an emphasis on operation and emission standards.

Is course New, Revised, or Modified? Revised


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 knowledge of principles, terminology, theories of operation, and service procedures associated with current electronic engine control systems.
• analyze the symptoms of drivability concerns and choose the most logical approach to correcting the concern.
• determine, through the use of printed or electronic service information, the root cause of customer driveability or emissions compliance concerns.
• identify likely causes of tailpipe emissions outputs that register over the cut-point during emissions testing.
• explain the function and purpose of emissions components on past and present vehicle platforms.
• compare OBDI and OBDII engine control systems by describing the implementation of each and what differentiates one from the other.

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.

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.

Unit I REVIEW OF ELECTRONIC FUEL INJECTION SYSTEMS

Learning Objectives

The student will be able to...

• identify components constructing electronic fuel injection systems.
• understand why certain electronic fuel injection components in one system design are superior to their counterpart components found in other electronic fuel injection system designs.
• explain how concerns of various systems can be interpreted as an engine performance concern

A. INTRODUCTION
   a. Computers and Engine Controls
   b. Fuel Delivery Calculations
i. Open Loop
ii. Closed Loop

c. SUBSYSTEMS
a. Fuel Delivery System
   i. Fuel Rail Pressure Sensor
   ii. Camshaft, Crankshaft Position Sensor (CMP, CKP)
   iii. Manifold Absolute Pressure Sensor (MAP)
   iv. Mass Air Flow (MAF)
   v. Vehicle Speed Sensor (VSS)
   vi. Throttle Position Sensor (TPS)
   vii. Engine Coolant Temperature (ECT)
   viii. Cylinder Head Temperature (CHT)
   ix. Intake Air Temperature (IAT)
   x. Oxygen Sensor (O₂ Sensor)
   xi. Engine Load (Calculated)
   xii. Electronic Engine Control Hardware and Software
b. Ignition System
   i. See Fuel Delivery Components
c. Starting System
   i. Starter Relay
   ii. Ignition Switch
   iii. Starter Motor
   iv. Battery
d. Charging System
   i. Battery
   ii. Accessory Drive System
   iii. Alternator/Generator
   iv. Charging Regulator
   v. PCM / ECM
e. Electronic Engine Controls
   i. Uses sensor inputs from engine, transmission, charging, starting, climate control, emission control, and other systems to calculate optimum vehicle performance requirements.
   ii. Provides an electronic diagnostic link for use with many electronically controlled systems.
f. Emissions Control System
   i. Electronic Engine Controls
   ii. Catalytic Converters
   iii. AIR Injection
   iv. Positive Crankcase Ventilation (PCV)
   v. Exhaust Gas Recirculation (EGR)
   vi. Evaporative Emissions Control (EVAP)
g. Air Intake System
   i. Intake Manifold
   ii. Throttle Body
   iii. MAF / MAP
   iv. TPS
   v. Idle Air Control Motor
   vi. Air Filter
Unit II  FUEL AND INTERNAL COMBUSTION

Learning Objectives

The student will be able to...

• explain fundamental differences between gasoline and diesel engines.
• recognize common performance symptoms caused by poor fuel quality or contamination.
• explain the importance of certain fuel additives.
• describe the function of a properly operating fuel injection system.

A. FUNDAMENTALS OF FUEL

a. Gasoline
   i. Octane Rating
   ii. Water Content
   iii. Quality

b. Diesel
   i. Heat Value
   ii. Ignition Quality / Cetane Number
   iii. Viscosity
   iv. Sulfur Content
   v. Water and Sediment Content
   vi. Carbon Residue
   vii. Flash Point
   viii. Corrosion Inhibitors
   ix. Ash Formation
   x. Distillation / Volatility

c. Biodiesel
   i. Quality
   ii. Production of
   iii. Advantages
   iv. Disadvantages

d. Fuel Additives
   i. Cetane Improvers
   ii. Octane
   iii. Detergents
   iv. Oxidation and Corrosion Inhibitors
   v. Lubricity Improvers
   vi. Microbiocide Additives

e. Fuel Blends
   i. Winter Blend Fuel
      1. Potential engine performance problems
   ii. Summer Blend Fuel

B. INTERNAL COMBUSTION

a. Gasoline Engine Combustion Process
   i. Air / Fuel
   ii. Compression
   iii. Spark

b. Diesel Engine Combustion Process
   i. Air / Fuel
   ii. Compression
   iii. Heat / Compression = Ignition
      1. Poor Combustion Indicators
         a. Black Smoke
b. White Smoke
c. Blue Smoke
c. Diesel Fuel System Components
   i. Fuel Transfer Pump
   ii. High Pressure Fuel Pump
   iii. Fuel Filter(s)
   iv. Fuel / Water Separator
   v. Fuel Tank
   vi. Fuel Injectors
   vii. Fuel Heater
   viii. Turbocharger(s)
   ix. Glow Plugs
   x. Block Heater
   xi. Injection Pump / Distributor (where applicable)
d. Diesel Driveability Diagnosis

Unit III ALTERNATIVE FUELS

Learning Objectives
The student will be able to...
• explain the purpose of the investigation into alternative fuels technology.
• demonstrate his / her ability to compare and contrast different alternative fuel sources.
• identify possible long-term effects of different alternative fuel sources.
• understand the severity of the United States’ dependence on foreign oil sources.

A. INTRODUCTION TO FLEX FUEL VEHICLES
   a. Government Regulations
      i. The Clean Air Act
   b. Applications

B. METHANOL (M85) FUELED VEHICLES
   a. Methanol Characteristics
      i. Low Energy Content
      ii. Poor Fuel Economy
      iii. Poor Cold Engine Starting Performance
      iv. Corrosive to Metal, Sealants, and Resins
      v. Burns Colorless
   b. Components
      i. Stainless Steel Fuel Rail
      ii. Stainless Steel Fuel injectors
      iii. PCV System
      iv. Specially Formulated Synthetic Engine Oil
      v. Alterations to Internal Engine Design
      vi. Plastic Fuel Tanks
      vii. Fuel Sending Unit
      viii. Methanol Concentration Sensor
      ix. M85 Fuel
      x. EVAP System
   c. Methanol Safety Precautions
      i. Skin Contact
      ii. Inhalation
      iii. Protective Clothing
      iv. Ingestion
   d. System Operation
i. Sequential-Fire Fuel Injection
ii. Driveability Diagnosis
C. ETHANOL (E85) FUELED VEHICLES
a. Ethanol Characteristics
b. Ethanol Safety Precautions
c. System Operation
   i. Components
   ii. Similarities to M85 Systems
   iii. Drivability Diagnosis
D. COMPRESSED NATURAL GAS (CNG) VEHICLE
a. CNG and the Environment
   i. Emissions Output
b. CNG Safety Precautions
   i. Storage
      1. Under Extreme Pressure
c. CNG Fuel Safety
   i. Components
   ii. Theory of Operation
   iii. Inputs / Outputs of the PCM
   iv. Internal Engine Components
d. CNG Service Procedures
   i. Purging the Fuel System
   ii. Vehicle Diagnostics
E. HYBRID / ELECTRIC VEHICLES
a. Hybrid
   i. Gasoline Engine
   ii. Large Electric Motor
   iii. High Voltage System
   iv. Cooling System for High Voltage System
   v. Large Capacity High Voltage Battery
   vi. Standard 12 Volt Battery
   vii. High Voltage Control Module
   viii. Regenerative Braking System (where equipped)
b. Advantages / Disadvantages
c. Service Procedures / Precautions
d. Special Service Technician Training

Unit IV  AUTOMOTIVE EXHAUST EMISSIONS

Learning Objectives
The student will be able to...
• explain the harmful effects of greenhouse gasses on vegetation and air quality.
• identify potential hazards associated with carbon monoxide emissions.
• demonstrate his/her knowledge of the relationship between engine temperature and emissions.
• explain the differences between hydrocarbons, carbon monoxide, and oxides of nitrogen.

A. FUEL ADDITIVES AND TAILPIPE EMISSIONS
   a. Light-End Fuels
   b. Methyl Tertiary-Butyl Ether (MBTE), Alcohol, Methanol, Ethanol
   c. Leaded vs. Unleaded Fuels
B. VEHICLE EMISSION CATEGORIES
   a. Crankcase
   b. Exhaust
c. Evaporative

C. VEHICLE EMISSIONS
   a. Hydrocarbons (NC)
   b. Carbon Monoxide (CO)
   c. Oxides of Nitrogen (NOx)

D. GENERATION OF VEHICLE EMISSIONS
   a. Ideal Air / Fuel Ratio and Complete Combustion
      i. Stoichiometric Ratio
   b. Cold Engine Operation
   c. Idling
   d. Acceleration
   e. Deceleration
   f. Emissions Control Device Malfunction
   g. Raw Fuel Leak

E. EXHAUST EMISSIONS CONTROL
   a. Control the Air / Fuel Mixture
   b. Control the Combustion Process
   c. Eliminate Harmful Combustion Byproducts After Combustion

**Unit V**  EMISSIONS REGULATION AND ENGINE DESIGN

*Learning Objectives*
*The student will be able to…*
- explain how engine designers comply with emissions regulations.
- identify how changes in engine design can affect tailpipe emissions levels.
- demonstrate his/her knowledge in combustion chamber design and purposes for each design.

A. INTRODUCTION
   a. Atomization and Vaporization

B. INTAKE MANIFOLD
   a. Purpose
   b. Design

C. VALVE OVERLAP
   a. Camshaft Profile
   b. Dilution of Intake Charge with Exhaust Gases

D. VALVE DESIGN
   a. Port Design
   b. Valve Position
   c. Valve Size

E. COMBUSTION CHAMBER DESIGN
   a. L – Head Design
   b. Hemispherical Design (I – Head)
   c. Wedge Design
   d. Spark Plug Placement
   e. Volume
   f. Quench Area
Learning Objectives
The student will be able to...
• explain the reasons for using auxiliary emissions control systems.
• analyze an emission control system and determine if the system is performing as designed.
• identify vehicle performance concerns related to emissions control system malfunctions.
• explain how each emissions control system reduces or eliminated emissions output.

A. COMPONENTS, OPERATION, AND FUNCTION
   a. Heated Air Inlet
   b. Air Injection (Secondary Air)
   c. Thermal Vacuum Valve (TVV)
   d. Air Aspiration System
   e. Exhaust Gas Recirculation
   f. Catalytic Converter
   g. Crankcase Emissions Control (PCV)
   h. Evaporative Emissions Control (EVAP)

B. HEATED AIR INLET
   a. Effects on Performance
   b. Testing

C. AIR INJECTION (SECONDARY AIR)
   a. Purpose and Operation
   b. Air Pump
   c. Air Switch / Relief Valve / Check Valve
   d. Diagnosis and Service
   e. Pulse Air Injection
      i. Reed / Check Valve
      ii. Diagnosis and Testing / Service

D. THERMAL VACUUM VALVE (TVV)
   a. Operation
   b. Service and Testing

E. EXHAUST GAS RECIRCULATION (EGR)
   a. Purpose and Operation
   b. EGR Valve
      i. Vacuum Operated
      ii. Digital
   c. EGR Solenoid
   d. Vacuum Sources
   e. Gas Recirculation Process
   f. Valve Diagnosis / Service
   g. Relate Driveability Concerns

F. CATALYTIC CONVERTER
   a. Catalyst
   b. Types
      i. Oxidizing
      ii. Reducing
      iii. Two-Way
      iv. Three-Way
   c. Heat Shield
   d. Converter Operation
   e. Safety Precautions
      i. Overheating
Learning Objectives

The student will be able to...

• demonstrate his/her ability to successfully operate a 5-gas exhaust analyzer.
• describe current Federal and State emissions regulation cut-points.
• identify exhaust gas emissions that are over regulation standards.
• hypothesize possible malfunction that might be causing emissions readings that are over regulation limits.

A. FOUR-GAS ANALYZER
   a. Hydrocarbons (HC)
   b. Carbon Monoxide (CO)
   c. Oxygen (O_2)
   d. Carbon Dioxide (CO_2)

B. FIVE-GAS ANALYZER
   a. Hydrocarbons (HC)
   b. Carbon Monoxide (CO)
   c. Oxygen (O_2)
   d. Carbon Dioxide (CO_2)
   e. Oxides of Nitrogen (NO_x)

C. PREPARING THE ANALYZER AND TEST VEHICLE
   a. Vehicle
i. Normal Operating Temperature

b. Analyzer
   i. Calibration
   ii. Electrical and Test Connections

D. TEST RESULTS
   a. Interpreting the Results – Possible Causes
      i. High HC
      ii. High CO
      iii. High CO₂
      iv. High O₂
      v. High NOₓ
   b. Vehicle Repairs and Adjustments
   c. Other Tests With the Analyzer
      i. Combustion Leak Test
      ii. Exhaust Fume Test
      iii. Air and Vacuum Leak Test
      iv. PCV System Test
      v. EVAP Test
      vi. Gas Cap Pressure Test

E. EMISSIONS OUTPUT REGULATIONS
   a. Federal
   b. State

Unit VIII  ENHANCED INSPECTION AND MAINTIANCE PROCEDURES

Learning Objectives
The student will be able to...
• explain the difference between standard and enhanced vehicle emission testing.
• identify advantages and disadvantages of enhances emissions inspections.
• explain why enhanced testing is becoming more common in the United States.

A. PURPOSE / NEEDS
   a. Pros vs. Cons
   b. Overview of I/M Test Failure Repair

B. TYPES OF TESTS
   a. I/M 5015
   b. I/M 2525
   c. I/M 240

C. EMISSIONS DIAGNOSTICS
   a. Gas Analysis
   b. Non-Pollutant Gas Analysis
      i. Carbon Dioxide (CO₂)
      ii. Oxygen (O₂)
   c. HC / CO Diagnostics
   d. NOₓ Emissions Diagnostics

D. EVAPORATIVE EMISSIONS SYSTEM DIAGNOSTICS
   a. Purge Diagnostics
      i. Carbureted
      ii. Electronic Fuel Injection
   b. System Pressure Test

E. DIAGNOSTICS / FUNCTION CHECKS
   a. Secondary Air Injection System
   b. PCV System Test
c. Exhaust System Test (Tests For Restrictions)
d. EGR System Test
e. O₂ Function Test
F. USING AN EMISSIONS TESTING DYNAMOMETER
  a. Securing the Vehicle
  b. Operating the Dynamometer
  c. Performing the Test
d. Interpreting the Test Results

Unit IX PROCEDURES IN IDENTIFYING CAUSES OF DRIVEABILITY CONCERN

Learning Objectives
The student will be able to...
• explain how to approach a customer’s driveability concern using the 6-step troubleshooting method.
• describe methods that are effective in duplicating intermittent or hard to verify performance concerns.
• analyze test data to determine proper or faulty operation of components before component replacement.
• distinguish between normal operation and actually system malfunctions.
• verify a repair that he / she have made to a customer’s vehicle.

A. DRIVEABILITY TEST PROCEDURES
  a. A Total System Approach of Diagnosis
     i. 6 – Step Troubleshooting Procedure
  b. Distinguishing Between Transmission and Engine Performance Concerns
  c. Duplicating the Customer’s Concern
     i. Replicating Conditions
B. COMMON DRIVEABILITY CATEGORIES
  a. Engine No Start
     i. Visual Inspection
     ii. System Checks
  b. Cold Engine Performance Concerns
     i. Visual Inspection
     ii. System Checks
        1. Testing Under Cold-Engine Conditions
  c. Warm Engine Performance Concerns
     i. Visual Inspection
     ii. System Checks
        1. Testing Under Warm-Engine Conditions
C. SERVICE PUBLICATIONS
  a. Printed
     i. DTC Diagnostics
     ii. No DTC Diagnostics
        1. Comprehensive Check of Many systems
  b. Electronic
     i. DTC Diagnostics
     ii. No DTC Diagnostics
        1. Comprehensive Check of Many systems
D. DIAGNOSING CARBURATED SYSTEMS
  a. With Oxygen Feedback
  b. Without Oxygen Feedback
  c. Adjustment Procedures
i. Ignition Timing  
ii. Curb Idle RPM  
iii. Fast Idle RPM  
iv. Solenoid Idle Stop RPM  
v. Propane Enrichment  

1. Dangers  
2. Purpose

E. DIAGNOSING ELECTRONIC FUEL INJECTION SYSTEMS  
   a. Verification of Concern  
   b. Visual Inspection  
   c. Scan Tool Connections  
   d. Accessing DTC’s  
      i. Freeze Frame Data  
      ii. Mode-6 Data  
   e. Data Recorders  
   f. Monitoring PCM Inputs and Outputs  
   g. No DTC Diagnostics  
      i. Comprehensive Systems Checks

Unit X  
COURSE REVIEW/FINAL EXAM  
A. REVIEW OF ELECTRONIC FUEL INJECTION SYSTEMS  
B. FUEL AND INTERNAL COMBUSTION  
C. ALTERNATIVE FUELS  
D. AUTOMOTIVE EXHAUST EMISSIONS  
E. EMISSIONS REGULATION AND ENGINE DESIGN  
F. EMISSIONS CONTROL SYSTEMS  
G. USING THE EXHAUST GAS ANALYZER / EMISSIONS DIAGNOSIS  
H. ENHANCED INSPECTION AND MAINTIANCE PROCEDURES  
I. PROCEDURES IN IDENTIFYING CAUSES OF DRIVEABILITY CONCERN

Evaluation of student learning:  
A. Lab Work  
   40%  
B. Test/Quizzes/Homework Assignments/Final Exam  
   60%
**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.