

Mercer County Community College

Division of Business and Technology

AUT 211

Automotive Emissions and Driveability Diagnosis

COURSE DESCRIPTION:

Automotive emission reduction and its relationship to engine driveability problems. Driveability situations will be discussed with possible solutions, utilizing information presented in AUT 111 and AUT 112. Emphasis will be placed on proper diagnosis of driveability problems and recommended repair procedures.

Text (s): **Reference Division Booklist**

Prerequisites: **AUT111, AUT112**

Corequisites: **None**

Credits: **3** Lecture Hours: **2** Studio/Lab Hours: **2**

Food and drink are strictly prohibited in classrooms as per health and safety laws. Students are not permitted to bring in any chemicals or cleaning fluids without the appropriate MSD sheets.

Course Coordinator: **Fred C. Bassini**

Latest Review: Summer 2003

GENERAL LEARNING OBJECTIVES

1. To acquaint the student/apprentice with the types of emission devices used on today's automobile and their relationship with engine driveability problems.
2. To provide the student/apprentice with the intermediate level skills of driveability diagnosis using the technical service manuals and his/her knowledge of the fuel and ignition systems.

TOPIC SUMMARY

- I. Review of Electronic Fuel Injection Principles**
 - A. System Components and Operation
 - B. On-Board Diagnostics (OBD)
- II. Diesel Fuel System**
 - A. Introduction
 - B. Fuel Fundamentals
 - C. Diesel Combustion Process
 - D. Fuel System Operation
- III. Alternative Fuel Systems**
 - A. Methanol (M85) fuel
 - B. Ethanol (E85) fuel
 - C. Compressed Natural Gas (CNG)
- IV. Introduction to Automotive Exhaust Emissions**
- V. Engine Designs and Emissions**
- VI. Emission Control Systems**
- VII. Using the Exhaust Emissions Analyzer for Diagnosis**
 - A. Four-Gas Theory
 - B. State/Federal Requirements
- VIII. Enhanced Inspection/Maintenance Procedures**
 - A. Purpose/Need
 - B. Types of Tests
 - C. Emissions Diagnostics
 - D. Evaporative Systems Diagnostics
 - E. Diagnostics/Function Checks
 - F. Using the Emission Testing Dynamometer
- IX. Identifying Driveability Problems and Procedures**
 - A. Driveability Test Procedures
 - B. Using the Driveability Test Procedure Books
 - C. Mopar Diagnostic System II (MDSII) and (DRBIII)
 - D. Diagnosing Fuel Injection (EFI) Systems
 - E. Data Recording

X. Course Review/Final Exam

I. REVIEW OF ELECTRONIC FUEL INJECTION

Performance Tasks

A. System Components and Operation

1. Introduction
 - a. Speed Density System
 - b. Computers and Engine Controls
 - c. PCM Operating Modes
2. Subsystems
 - a. Fuel Delivery System
 - b. Ignition System
 - c. Engine Start Requirements
 - d. Emission System
 - e. Oxygen Feedback System
 - f. Charging System
3. Sensors (Monitored Parameters)
 - a. MAP: Manifold Absolute Pressure
 - b. TPS: Throttle Position
 - c. Coolant Temperature (ECT)
 - d. Intake Air Temperature (IAT)
 - e. Throttle Body Temperature
 - f. Battery Temperature
 - g. Vehicle Speed (Distance)
 - h. Battery Voltage
 - I. O₂: Oxygen
4. Idle Speed control (IAC) Motor
5. Relays and Solenoids
 - a. Automatic Shutdown Relay (ASD)
 - b. Fuel Pump Relay
 - c. A/C Clutch Relay
 - d. Purge Solenoid
 - e. EGR Solenoid
 - f. Torque Converter Clutch (TCC) Solenoid
 - g. Radiator Fan Relay
 - h. Injector(s)
6. Alternator Field Control (Charging System Output)
7. Switches
 - a. Brake
 - b. A/C
 - c. Park/Neutral
 - d. Electronic Speed Control
 - e. Vehicle Speed
 - f. Overdrive "Off"

LAB ACTIVITY: C-1: Sensor Input Measurement

II. DIESEL FUEL SYSTEM

Performance Tasks

- A. Introduction to Diesel
- B. Fuel Fundamentals
 - 1. Fuel Characteristics
 - a. Heat Value
 - b. Ignition Quality/Cetane Number
 - c. Viscosity
 - d. Sulfur Content
 - e. Water and Sediment Content
 - f. Carbon Residue
 - g. Flash Point
 - h. Corrosion
 - i. Ash Forming
 - j. Distillation/Volatility
 - 2. Fuel Additives
 - a. Cetane Improvers
 - b. Detergent Additives
 - c. Oxidation and Corrosion Inhibitors
 - d. Lubricity Improvers
 - e. Microbial Contamination of Fuel
 - f. Microbiocide Additives
 - g. Fuel Testing
 - 3. Winter Fuel Problems
 - a. Cloud Point and Pour Point
 - b. Engine Idling
- C. Diesel Combustion Process
 - 1. Diesel Fuel Injectors
 - 2. Black Smoke
 - 3. White Smoke
 - 4. Blue Smoke
- D. Fuel System Operation
 - 1. Components
 - a. Fuel Transfer Pump
 - b. Fuel/Water Drain Valve
 - c. Water-In-Fuel Sensor
 - d. Fuel Tank and Fuel Tank Module
 - e. Fuel/Water Separation Filter
 - f. Injectors
 - g. Fuel Drain Manifold
 - h. Low Pressure Supply Lines

D. Fuel System Operation (cont'd)

Performance Objectives

1. Components
 - i. High Pressure Fuel Lines
 - j. In-Line Injection Pump, Model #P7100
 - k. Throttle Position Sensor (TPS)
 - l. Fuel Heater
 - m. Turbocharger
 - n. Intake Air Heater Grid
2. Component Operation and Diagnosis
 - a. Injection Pump Timing
 - b. Injector Service
 - c. Fuel/Water Separator Replacement
 - d. Turbocharger Diagnosis Basics
3. Driveability Diagnosis

LAB ACTIVITY: C-2: Diesel Fuel System Service

III. ALTERNATIVE FUEL SYSTEMS

Performance Tasks

- A. Introduction to Flex Fuel Vehicles
 1. Government Regulations
 - a. Clean Air Act
 2. Applications
- B. Methanol (M85) Fueled Vehicles
 1. Methanol Characteristics
 - a. Low Energy Content
 - b. Poor Fuel Economy
 - c. Cold Start Difficulties
 - d. Corrosion of Metal, Sealants and Resins
 - e. Burns Colorless
 2. Components
 - a. Stainless Steel Fuel Rail
 - b. Stainless Injectors
 - c. PCV System
 - d. Specially Formulated Synthetic Oil
 - e. Internal Engine Changes
 - f. Plastic Fuel Tank
 - g. Fuel Sending Unit
 - h. Methanol Concentration Sensor
 - i. M85 Fuel
 - j. EVAP System

III. ALTERNATIVE FUEL SYSTEMS (cont'd)

Performance Tasks

3. Methanol Safety Precautions
 - a. Skin Contact
 - b. Breathing
 - c. Proper Clothing
 - d. Ingestion
 4. System Operation
 - a. Sequential Fire Fuel Injection
 - b. Driveability Diagnosis
- C. Ethanol (E85) Fueled Vehicles
1. Ethanol Characteristics
 2. Ethanol Safety Precautions
 3. System Operation
 - a. Components
 - b. Similarities to M85 System
 - c. Driveability Diagnosis
- D. Compressed Natural Gas (CNG) Vehicles
1. CNG and the Environment
 - a. Emission Output
 2. CNG Safety Precautions
 - a. Stored Under Extreme Pressure
 3. CNG Fuel Safety
 - a. Components
 - b. Theory of Operation
 - c. Inputs/Outputs of the PCM
 - d. Internal Engine Components
 4. CNG Service Procedures
 - a. Purging the Fuel System
 - b. Vehicle Diagnostics

IV. INTRODUCTION TO AUTOMOTIVE EXHAUST EMISSIONS

Performance Tasks

- A. Fuel Additives
 - 1. Light-End Fuels
 - 2. MBTE, Alcohol, Methanol

- B. Vehicle Emissions Categories
 - 1. Crankcase
 - 2. Evaporative
 - 3. Exhaust

- C. Vehicle Emissions
 - 1. Hydrocarbons (HC)
 - 2. Carbon Monoxide (CO)
 - 3. Oxides of Nitrogen (NO_x)

- D. Causes of Vehicles Emissions
 - 1. Ideal Air/Fuel Ratio/Complete Combustion
 - 2. Cold Engine Operation
 - 3. Idling
 - 4. Acceleration
 - 5. Deceleration

- E. Exhaust Emission Control
 - 1. Control the Air/Fuel Ratio
 - 2. Control the Combustion Process
 - 3. Eliminate Harmful Emission By-Products
After Combustion

V. ENGINE DESIGNS AND EMISSIONS

Performance Tasks

- A. Introduction
 - 1. Atomization and Vaporization

- B. Intake Manifold
 - 1. Purpose
 - 2. Design

- C. Valve Overlap
 - 1. Camshaft Profile
 - 2. Exhaust Gas/Intake Charge Dilution

- D. Valve Design
 - 1. Port Design
 - 2. Valve Position
 - 3. Valve Size

- E. Combustion Chamber Design
 - 1. "HEM I" Head Type
 - 2. "WEDGE" Type
 - 3. Volume
 - 4. Quench Area

VI. EMISSION CONTROL SYSTEMS

Performance Tasks

- A. Components, Operation and Function
 - 1. Heated Air Inlet/Early Fuel Evaporation (EFE)
 - 2. Air Injection (Secondary Air)
 - 3. Thermal Vacuum Valve (TVV)
 - 4. Air Aspiration System
 - 5. Exhaust Gas Re-circulation
 - 6. Catalytic Converter
 - 7. Crankcase Emission Control (PCV)
 - 8. Evaporative Emission Control (EVAP)

- B. Heated Air Inlet/Early Fuel Evaporation (EFE)
 - 1. Effect on Performance EP56, EP57, EP58
 - 2. Testing

- C. Air Injection (Secondary Air)
 - 1. Purpose and Operation EP52, EP53, EP54
 - 2. Air Pump
 - 3. Air Switch/Relief Valve/Check Valve
 - 4. Diagnosis and Service

- D. Thermal Vacuum Valve (TVV)
 - 1. Operation
 - 2. Service and Testing

- E. Exhaust Gas Re-circulation
 - 1. Purpose and Operation
 - 2. EGR Valve
 - 3. EGR Solenoid
 - 4. Vacuum Sources
 - 5. Re-circulation
 - 6. Valve Service/Diagnosis
 - 7. Related Driveability Problems EP49

- F. Catalytic Converter
 - 1. Catalyst
 - 2. Oxidizing vs. Reducing
 - 3. Heat Shields
 - 4. Converter Operation
 - 5. Cautions
 - a. Overheating
 - b. Fire
 - 6. Lead Fouling
 - 7. Diagnosis of Operation
 - 8. Driveability Problems EP52, EP55

VI. EMISSION CONTROL SYSTEMS (cont'd)

Performance Tasks

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|------|-------------------------------------|-------|
| G. | Crankcase Emission Control (PCV) | EP 42 |
| | 1. Configuration | |
| | 2. PCV Valve | |
| | 3. System Operation | |
| | 4. Relationship to Performance | |
| | 5. Inspection and Text Procedures | EP43 |
| | | |
| H. | Evaporative Emission Control (EVAP) | |
| | 1. Function/Operation | |
| | 2. Thermal Expansion | |
| | 3. Filler Cap | |
| | 4. Rollover/Vapor Separator Valve | |
| | 5. Check Valve | |
| | 6. Charcoal Canister (EVAP) | |
| | 7. Purging/Solenoid | |
| | 8. Bowl Vent Valve | |
| | 9. Crankcase Vent Filter | |
| | 10. System Diagnosis | |

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| LAB ACTIVITY: | C-4: Emission Control Component Diagnosis | EP49, EP50, EP51 EP59, EP60, EP61 |
|----------------------|----------------------------------------------|--------------------------------------|

VII. USING THE EXHAUST EMISSIONS ANALYZER FOR DIAGNOSIS

Performance Tasks

- A. Five-Gas Theory
 - 1. Hydrocarbon (HC)
 - 2. Carbon Monoxide (CO)
 - 3. Oxygen (O₂)
 - 4. Carbon Dioxide (CO₂)
 - 5. Oxides of Nitrogen (NO_x)

- B. Setting up the Exhaust Emissions Analyzer EP10
 - 1. Machine Calibrations and Connections
 - 2. Interpreting the Readings - Possible Causes
 - a. High HC
 - b. High CO
 - c. High O₂
 - d. High CO₂
 - e. High NO_x
 - 3. Performing Engine Adjustments and Repairs
 - 4. Other Tests Performed with Analyzer
 - a. Combustion Leak Test
 - b. Exhaust Fume Test
 - c. Air and Vacuum Leak Tests
 - d. PCV System Test

- C. Emission Output Requirements
 - 1. Federal
 - 2. State

VIII. ENHANCED INSPECTION/MAINTENANCE PROCEDURES

Performance Tasks

- A. Purpose/Need
 - 1. Pros/Cons
 - 2. Overview of Strategy to Repair I/M Failures

- B. Types of Tests
 - 1. I/M 5015
 - 2. I/M 2525
 - 3. I/M 240

- C. Emissions Diagnostics
 - 1. Gas Analysis
 - 2. Non-Pollutant Exhaust Gases
 - a. Carbon Dioxide (CO₂)
 - b. Oxygen (O₂)
 - 3. HC/CO Emissions Diagnostics
 - 4. NO_x Emissions Diagnostics

- D. Evaporative System Diagnostics
 - 1. Purge Diagnostics
 - a. Carbureted
 - b. Early E.F.I.
 - c. Late E.F.I.
 - 2. Evaporative System Pressure Test

- E. Diagnostics/Function Checks
 - 1. Secondary Air Systems
 - 2. PCV Valve Functional Check
 - 3. Exhaust Restriction Test
 - 4. EGR System
 - 5. O₂ Sensor Function
 - 6. Coolant Controlled Vacuum Control Valves

VIII. ENHANCED INSPECTION/MAINTENANCE PROCEDURES (cont²)

Performance Tasks

F. Using the Emissions Testing Dynamometer

1. Securing the Vehicle
2. Operating the Dynamometer
3. Performing the Test
 - a. I/M 50/15
 - b. I/M 25/25
 - c. I/M 240
4. Interpreting the Readings

LAB ACTIVITY: C-5: Using the Emissions Testing
Dynamometer

IX. IDENTIFYING DRIVEABILITY PROBLEMS AND PROCEDURES

Performance Tasks

- A. Driveability Test Procedures EP01
1. A Total System Approach of Diagnosis
 2. Inter-Relationship Testing of Engine Control Systems
 3. Checking for the Driveability Problem Under the Same Circumstances the Owner Experienced It
- B. Driveability Categories
1. Engine Will Not Start
 - a. Visual Inspection
 - b. No Start
 2. Cold Driveability Problem
 - a. Visual Inspection
 - b. Driveability Test-Cold
 3. Warm Driveability Problem
 - a. Visual Inspection
 - b. Driveability Test-Warm
- C. Using the Driveability Test Procedure Books
1. No Start Tests
 2. Driveability Tests
- D. Mopar Diagnostic System II (MDSII)
1. MDSII Components and Operation
 2. Diagnostic Readout Box (DRB) III

IX. IDENTIFYING DRIVEABILITY PROBLEMS AND PROCEDURES (cont'd)

| | <u>Performance Tasks</u> |
|------------------------------------------------------|---------------------------------|
| E. Diagnosing Carbureted Systems | EP29 |
| 1. With Oxygen Feedback | |
| a. No Start Tests | |
| b. Driveability Tests | |
| 2. Adjustment Procedures | EP44 |
| a. Ignition Timing | |
| b. Carb Idle RPM | EP48 |
| c. Fast Idle RPM | |
| d. Solenoid Idle Stop (SIS) RPM | EP46 |
| e. Propane Enrichment | |
| 3. Computer Application and Specifications | |
| 4. Sample Driveability Problems | |
| F. Diagnosing Fuel Injection (EFI) Systems | EP30 |
| 1. No Start Diagnosis | |
| 2. Diagnosis with Diagnostic Trouble Codes (DTC) | |
| 3. "No Fault" Driveability | |
| 4. EFI Data Recording | |
| a. Recording with the Co-Pilot | |
| b. Recording with the DRBIII | |
| c. Interpreting Data Recordings | |
| d. Interpreting Operating Conditions | |
| LAB ACTIVITIES: C-5 Performing Data Recording | |
| C-6A, and 6B Diagnosing Driveability Problems | EP11, EP12, EP19, EP20 |

X. COURSE REVIEW/FINAL EXAM

- A. Review of Electronic Fuel Injection
- B. Diesel Fuel Systems
- C. Alternative Fuel Vehicles
- D. Automotive Exhaust Emissions
- E. Engine Designs and Emissions
- F. Emission Control Systems
- G. Using the Exhaust Emissions Analyzer and Diagnosis
- H. Enhanced Inspection/Maintenance Procedures
- I. Identifying Driveability Problems and Procedures
 - 1. Carbureted
 - 2. Fuel Injection
- J. Final Exam

LAB REQUIREMENTS

- 1. Sensor Input Measurement
- 2. Diesel Fuel System Service
- 3. Emission Control Components Diagnosis
- 4. Diagnosis with the Emission Testing Dynamometer
- 5. Creating a Data Recording
- 6. Diagnosing Driveability Problems

Evaluation:

- 50% Direct Evaluation of Shop Work
- 40% Four quizzes, midterm and final exams
- 10% Class participation