



# **ILLINOIS VALLEY COMMUNITY COLLEGE**

## **COURSE OUTLINE**

**DIVISION: Workforce Development**

**COURSE: ATO 2220 - Fuel Systems and Emission Controls**

Date: Fall 2016

Credit Hours: 4.5

Prerequisite(s): ATO 1220, ATO1250, or consent of the instructor

Delivery Method:

<input checked="" type="checkbox"/> Lecture	2 Contact Hours (1 contact = 1 credit hour)
<input type="checkbox"/> Seminar	0 Contact Hours (1 contact = 1 credit hour)
<input checked="" type="checkbox"/> Lab	5 Contact Hours (2-3 contact = 1 credit hour)
<input type="checkbox"/> Clinical	0 Contact Hours (3 contact = 1 credit hour)
<input type="checkbox"/> Online	
<input type="checkbox"/> Blended	

Offered:  Fall    Spring    Summer

IAI Equivalent –**Only for Transfer Courses**-go to <http://www.itransfer.org>:

### **CATALOG DESCRIPTION:**

The theory, service, diagnosis of gasoline fuel systems (fuel injection and direct fuel injection) will be the main emphasis of this class. Other areas studied will be computer controls, sensors, forced induction intake systems and exhaust systems. The following emission control systems will be covered: positive crankcase ventilation, exhaust gas recirculation, air management, catalytic converters and evaporative control systems.

## GENERAL EDUCATION GOALS ADDRESSED

*[See last page for Course Competency/Assessment Methods Matrix.]*

### Upon completion of the course, the student will be able:

*[Choose up to three goals that will be formally assessed in this course.]*

- To apply analytical and problem solving skills to personal, social and professional issues and situations.
- To communicate successfully, both orally and in writing, to a variety of audiences.
- To construct a critical awareness of and appreciate diversity.
- To understand and use technology effectively and to understand its impact on the individual and society.
- To work and study effectively both individually and in collaboration with others.
- To understand what it means to act ethically and responsibly as an individual in one's career and as a member of society.
- To develop and maintain a healthy lifestyle physically, mentally, and spiritually.
- To appreciate the ongoing values of learning, self-improvement, and career planning.

### EXPECTED LEARNING OUTCOMES AND RELATED COMPETENCIES:

*[Outcomes related to course specific goals. See last page for more information.]*

### Upon completion of the course, the student will be able to:

#### VIII. ENGINE PERFORMANCE (NATEF Tasks)

##### A. General: Engine Diagnosis

1. Identify and interpret engine performance concerns; determine necessary action.
2. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins.
3. Diagnose abnormal engine noises or vibration concerns; determine necessary action.
4. Diagnose the cause of excessive oil consumption, coolant consumption, unusual exhaust color, odor, and sound; determine necessary action.
5. Perform engine absolute (vacuum/boost) manifold pressure tests; determine necessary action.
6. Perform cylinder power balance test; determine necessary action.
7. Perform cylinder cranking and running compression tests; determine necessary action.
8. Diagnose engine mechanical, electrical, electronic, fuel, and ignition concerns; determine necessary action.
9. Verify engine operating temperature; determine necessary action.

##### B. Computerized Controls Diagnosis and Repair

1. Retrieve and record diagnostic trouble codes, OBD monitor status, and freeze frame data; clear codes when applicable.
2. Access and use service information to perform step-by-step (troubleshooting) diagnosis.
3. Perform active tests of actuators using a scan tool; determine necessary action.
4. Describe the importance of running all OBDII monitors for repair verification.

5. Diagnose the causes of emissions or driveability concerns with stored or active diagnostic trouble codes; obtain, graph, and interpret scan tool data.
6. Diagnose emissions or driveability concerns without stored diagnostic trouble codes; determine necessary action.
7. Inspect and test computerized engine control system sensors, powertrain/engine control module (PCM/ECM), actuators, and circuits using a graphing multimeter (GMM)/digital storage oscilloscope (DSO); perform necessary action.
8. Diagnose driveability and emissions problems resulting from malfunctions of interrelated systems (cruise control, security alarms, suspension controls, traction controls, A/C, automatic transmissions, non-OEM installed accessories, or similar systems); determine necessary action.

### **C. Fuel, Air Induction, and Exhaust Systems Diagnosis and Repair**

1. Diagnose (troubleshoot) hot or cold no-starting, hard starting, poor driveability, incorrect idle speed, poor idle, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, dieseling, and emissions problems; determine necessary action.
2. Check fuel for contaminants; determine necessary action.
3. Inspect and test fuel pumps and pump control systems for pressure, regulation, and volume; perform necessary action.
4. Replace fuel filter(s).
5. Inspect, service, or replace air filters, filter housings, and intake duct work.
6. Inspect throttle body, air induction system, intake manifold and gaskets for vacuum leaks and/or unmetered air.
7. Inspect and test fuel injectors.
8. Verify idle control operation.
9. Inspect integrity of the exhaust manifold, exhaust pipes, muffler(s), catalytic converter(s), resonator(s), tail pipe(s), and heat shields; perform necessary action.
10. Inspect condition of exhaust system hangers, brackets, clamps, and heat shields; repair or replace as needed.
11. Perform exhaust system back-pressure test; determine necessary action.
12. Check and refill diesel exhaust fluid (DEF).
13. Test the operation of turbocharger/supercharger systems; determine necessary action.

### **D. Emissions Control Systems Diagnosis and Repair**

1. Diagnose oil leaks, emissions, and driveability concerns caused by the positive crankcase ventilation (PCV) system; determine necessary action.
2. Inspect, test, and service positive crankcase ventilation (PCV) filter/breather cap, valve, tubes, orifices, and hoses; perform necessary action.
3. Diagnose emissions and driveability concerns caused by the exhaust gas recirculation (EGR) system; determine necessary action.
4. Diagnose emissions and driveability concerns caused by the secondary air injection and catalytic converter systems; determine necessary action.
5. Diagnose emissions and driveability concerns caused by the evaporative emissions control system; determine necessary action.
6. Inspect and test electrical/electronic sensors, controls, and wiring of exhaust gas recirculation (EGR) systems; perform necessary action.

7. Inspect, test, service, and replace components of the EGR system including tubing, exhaust passages, vacuum/pressure controls, filters, and hoses; perform necessary action.
8. Inspect and test electrical/electronically-operated components and circuits of air injection systems; perform necessary action.
9. Inspect and test catalytic converter efficiency.
10. Inspect and test components and hoses of the evaporative emissions control system; perform necessary action.
11. Interpret diagnostic trouble codes (DTCs) and scan tool data related to the emissions control systems; determine necessary action.

## **REQUIRED SUPPLEMENTAL TASKS**

### **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.
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. Demonstrate awareness of the safety aspects of high voltage circuits (such as high intensity discharge (HID) lamps, ignition systems, injection systems, etc.).
14. Locate and demonstrate knowledge of material safety data sheets (MSDS).

### **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 Vehicle for Service**

1. Identify information needed and the service requested on a repair order.
2. Identify purpose and demonstrate proper use of fender covers, mats.
3. Demonstrate use of the three C's (concern, cause, and correction).
4. Review vehicle service history.
5. 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.).

**Note: NATEF Tasks are completed by students either individually or with a partner.**

**COURSE TOPICS AND CONTENT REQUIREMENTS:**

- I. Engine Operating Principles
  - A. Atmospheric Pressure
  - B. Air Pump
  - C. Vacuum
  - D. Pressure Differential
  - E. Four Stroke Cycle
  - F. Engine Displacement
    - 1. Compression Ratio
    - 2. Bottom Dead Center
    - 3. Top Dead Center
- II. Air – Fuel Requirement
  - A. Volumetric Efficiency
  - B. Air – Fuel Ratio
    - 1. Stoichiometric
    - 2. Power vs. Economy
  - C. Gasoline
    - 1. Hydrocarbon
    - 2. Chemical impurities
    - 3. Octane Rating
    - 4. Atomization
    - 5. Vaporization
    - 6. Reid Vapor Pressure (RVP)
    - 7. Oxygenated Fuels
- III. Fuel Pumps and Filters
  - A. Mechanical Pumps
  - B. Electric Pumps
  - C. Fuel Filters
  - D. Pump Operation
  - E. Testing
    - 1. Pressure
    - 2. Volume
    - 3. Flow
    - 4. Current draw
    - 5. Pump Speed
    - 6. Dead Head Pressure
- IV. Intake and Exhaust Manifolds
  - A. Manifold Principles
  - B. Manifold Types
  - C. Exhaust Manifolds
  - D. Testing
    - 1. Leaks
    - 2. Back Pressure
    - 3. Restriction

- V. Electronic Fuel Injection
    - A. Injection Fuel Injection
    - B. Types
      - 1. Port Fuel Injection
        - a. Injector types
        - b. Synchronized mode
        - c. Non-synchronized mode
        - d. Gang fired
        - e. Sequential
        - f. Testing
        - g. Cleaning
        - h. Service
      - 2. Gasoline Direct Injection
        - a. Components
        - b. Safety (High Pressure System)
        - c. Classifications
          - 1. Wide vs. Narrow injector spacing
          - 2. Creating a Stratified Charge
          - 3. Charge Motion
          - 4. Injector Location
          - 5. Injector Types
          - 6. Fuel Distribution
          - 7. Injection Timing
          - 8. Air/Fuel Ratio
        - d. Testing
        - e. Service
    - C. Powertrain Control Module
    - D. Input Sensors
    - E. Theory of Operation
    - F. Service
    - G. Diagnosis
- VI. Superchargers and Turbochargers
  - A. Supercharging
  - B. Turbochargers
    - 1. Controls
    - 2. Service
    - 3. Types
    - 4. Overhaul
- VII. Emission Control Systems
  - A. Air Pollutants
    - 1. Combustion
    - 2. Clean Air Act
    - 3. Government Standards
    - 4. Emission Testing
  - B. Thermostatic Air Cleaners
    - 1. Fresh Air Intakes
    - 2. Air Filter Elements
    - 3. Testing and Servicing

- C. Positive Crankcase Ventilation
  - 1. Draft tube
  - 2. PCV Systems
  - 3. Testing and Servicing
- D. Air Injection
  - 1. Air Pumps
  - 2. Pulse Air Injection
  - 3. Diverter Valves
  - 4. Switching Valves
  - 5. Testing and Servicing
- E. Exhaust Gas Recirculation
  - 1. Nox Formation
  - 2. System Components
  - 3. Operating Principles
  - 4. Testing and Servicing
- F. Catalytic Converters
  - 1. Converting Operation
  - 2. Converter Types
  - 3. By-pass Systems
  - 4. Precautions
  - 5. Testing and Servicing
  - 6. EPA Regulations
- G. Evaporative Controls
  - 1. Charcoal canisters
  - 2. System Operation
  - 3. Non-Enhanced Systems
  - 4. Enhanced Systems
  - 5. Testing and Servicing

**INSTRUCTIONAL METHODS:**

Lecture  
Demonstrations  
Videos  
Practical Operations  
Power Point Presentations  
Class discussion  
Handout material  
Quizzes and tests

**INSTRUCTIONAL MATERIALS:**

Argo "On-line" software  
Power Point Presentations  
Videos

**STUDENT REQUIREMENTS AND METHODS OF EVALUATION:**

Complete all lab objectives (NATEF Tasks)  
Satisfactory performance on written exams  
Attitude  
Attendance  
Work Habits  
Safety Practices  
Class participation

**OTHER REFERENCES**

1. "Pro-Demand" On-Line Information System – Mitchell (Both shops)
2. "All Data" On-Line Information System (Both Shops)



# Course Competency/Assessment Methods Matrix

(Dept/# Course Name)	Assessment Options																																				
For each competency/outcome place an "X" below the method of assessment to be used.	Assessment of Student Learning	Article Review	Case Studies	Group Projects	Lab Work	Oral Presentations	Pre-Post Tests	Quizzes	Written Exams	Artifact Self Reflection of Growth	Capstone Projects	Comprehensive Written Exit Exam	Course Embedded Questions	Multi-Media Projects	Observation	Writing Samples	Portfolio Evaluation	Real World Projects	Reflective Journals	Applied Application (skills) Test	Oral Exit Interviews	Accreditation Reviews/Reports	Advisory Council Feedback	Employer Surveys	Graduate Surveys	Internship/Practicum /Site Supervisor Evaluation	Licensing Exam	In Class Feedback	Simulation	Interview	Written Report	Assignment					
	Direct/ Indirect	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	I	I	I	I	D	D											
Assessment Measures – Are direct or indirect as indicated. List competencies/outcomes below.																																					
8.A.1. Identify and interpret engine performance concerns; determine necessary action.				X										X																							
8.A.2. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins.					X										X																						
8.A.3. Diagnose abnormal engine noises or vibration concerns; determine necessary action.						X																															
8.A.4. Diagnose the cause of excessive oil consumption, coolant consumption, unusual exhaust color, odor, and sound; determine necessary action.					X																																













