



# ILLINOIS VALLEY COMMUNITY COLLEGE

## COURSE OUTLINE

**DIVISION: Workforce Development**

**COURSE: ATO 1210 Basic Gas Engines**

Date: Spring 2022

Credit Hours: 5

*Complete all that apply or mark "None" where appropriate:*

Prerequisite(s): None

Enrollment by assessment or other measure?  Yes  No

If yes, please describe:

Corequisite(s): None

Pre- or Corequisite(s): None

Consent of Instructor:  Yes  No

Delivery Method:  **Lecture**                      **2 Contact Hours** (1 contact = 1 credit hour)  
 **Seminar**                              **0 Contact Hours** (1 contact = 1 credit hour)  
 **Lab**                                        **6 Contact Hours** (2-3 contact = 1 credit hour)  
 **Clinical**                                **0 Contact Hours** (3 contact = 1 credit hour)  
 **Online**  
 **Blended**  
 **Virtual Class Meeting (VCM)**

Offered:  **Fall**     **Spring**     **Summer**

### **CATALOG DESCRIPTION and IAI NUMBER (if applicable):**

The purpose is to give the student a background in the theory, construction, design, operation and service of gasoline piston engines. Laboratory work will consist of the following requirements on a given engine: disassembly, cleaning, inspecting, measuring, recording, machining and reassembly. Students are encouraged to supply their own engine for this course.

## **ACCREDITATION STATEMENTS AND COURSE NOTES:**

The Automotive Technology program at Illinois Valley Community College is a ASE Education Foundation Master Certified Automotive Technology Program.

The program goes through an on-site evaluation every five years and the ASE Education Foundation tasks that are taught in this course are also updated every five years to align with any changes made by the ASE Education Foundation national automotive advisory council.

## **COURSE TOPICS AND CONTENT REQUIREMENTS:**

- I Basic Engine Operation
  - A. Four stroke cycle.
  - B. Construction
  - C. Major components
  - D. Work, energy, heat
  - E. Thermal efficiency
- II The Cylinder Block
  - A. Purpose of block
  - B. Stresses in block
  - C. Parts of the block
  - D. Manufacture of blocks
  - E. Block designs
  - F. Block service
    - 1. Cleaning
    - 2. Crack detection
    - 3. Cylinder measurement
    - 4. Cylinder boring, honing, deglazing
    - 5. Cylinder sleeves
    - 6. Align-boring
    - 7. Deck inspection, resurfacing
    - 8. Ridge reaming
- III The Crankshaft
  - A. Nomenclature
  - B. Function
  - C. Design and construction
  - D. Forces to be balanced
    - 1. Static
    - 2. Dynamic
  - E. Firing order
  - F. Cylinder angle
    - 1. Even
    - 2. Odd
  - G. Flywheels, vibration dampener
  - H. Crankshaft service
    - 1. Cleaning
    - 2. Grinding and polishing
    - 3. Inspection and measurement
    - 4. Balancing
    - 5. Removal and installation

- IV Engine Bearings
  - A. Bearing Function
    - 1. Support
    - 2. Reduction of friction
  - B. Bearing characteristics
    - 1. Fatigue strength
    - 2. Conformability
    - 3. Embedability
    - 4. Surface action
    - 5. Resist corrosion
    - 6. Temperature strength
    - 7. Thermal conductivity
  - C. Bearing materials
  - D. Bearing designs
    - 1. Full circle
    - 2. Split
    - 3. Spread
    - 4. Crush
    - 5. Locating devices
  - E. Oil clearance
    - 1. Plastigage
    - 2. Rule of thumb
  - F. Bearing replacement
- V Engine Lubricating Systems
  - A. Purpose and theory
  - B. Properties of oil
  - C. Oil ratings
  - D. Oil pumps
  - E. Oil filtering systems
  - F. Service and diagnosis
- VI Pistons and Connecting Rods
  - A. Nomenclature
  - B. Characteristics of piston
    - 1. Heat resistance
    - 2. Strength
    - 3. Weight
    - 4. Tightness
  - C. Types of Pistons
    - 1. Cast
    - 2. Forged
    - 3. Hypereutectic
  - D. Thrust faces
  - E. Piston markings
  - F. Piston design
    - 1. Cam grinding
    - 2. Piston head
    - 3. Shirt types
    - 4. Expansion control
    - 5. Surface finish

- G. Piston rings
  - 1. Design and function
  - 2. Ring materials
    - a. Cast iron
    - b. Chrome
    - c. Moly
    - d. Steel
    - e. Oil control
  - 3. Choosing rings
- H. Piston pins
  - 1. Methods of attachment
  - 2. Methods of lubricating
- I. Connecting rods
  - 1. Design function
  - 2. Types of rods
  - 3. Rod manufacture
  - 4. Lubrication of walls
- J. Piston-connecting rod services
  - 1. Ring groove cleaning – measuring
  - 2. Knurling of pistons
  - 3. Rod reconditioning – measuring
  - 4. Piston inspection – measuring
  - 5. Piston installation
  - 6. Rings – remove – replace
  - 7. Balancing of assembly
  - 8. Pin fitting
  - 9. Piston to wall clearance
  - 10. Piston cleaning
- VII The Cylinder Heads
  - A. Construction
    - 1. Cast iron
    - 2. Aluminum
    - 3. Machine operations
  - B. Design
    - 1. Method of cooling
      - a. Liquid
      - b. Air
    - 2. Combustion chamber
      - a. Wedge
      - b. Hemispheric
      - c. Semi-hemi
      - d. Stratified charge
    - 3. Valve operating mechanism
      - a. L-head
      - b. F-head
      - c. I-head
      - d. Overhead cam
      - e. Dual overhead cam
    - 4. Valve ports

- a. Seamed
    - b. Cross-flow
    - c. Pre-combustion chamber
  - C. Service
    - 1. Measure valve stem & guide clearance
    - 2. Knurl valve guides
    - 3. Measure cylinder head warpage
    - 4. Grind valves & seats
    - 5. Measure spring tension
    - 6. Measure spring installed height
    - 7. Cylinder head assembly
    - 8. Cylinder head installation
    - 9. Torque cylinder head
- VIII Valves and Valve Trains
  - A. Poppet valve
    - 1. History (instant valve jobs)
    - 2. Head
    - 3. Stem
    - 4. Fillet
    - 5. Margin
    - 6. Face
    - 7. Retainers
  - B. Valve train design
    - 1. Breathing efficiency
      - a. Diameter of intake
      - b. Exhaust valve (85% as large)
      - c. Lift equal 25% of head diameter
    - 2. Durability
    - 3. Cost efficiency
  - C. Types of valves
    - 1. Flathead
    - 2. Tulip
    - 3. SAE valve head
  - D. Valve construction
    - 1. Steel alloy
    - 2. Stainless (austenitic)
    - 3. Bi- and tri- metal
    - 4. Aluminized
    - 5. Sodium cooled
  - E. Valve guides
    - 1. Integral
    - 2. Replaceable
    - 3. Function
    - 4. Wear patterns
    - 5. Measurements
  - F. Valve seats
    - 1. Integral
    - 2. Seat inserts
    - 3. Induction hardened

4. Valve face
5. Seat dimensions
6. Seat width
7. Interference angle
- G. Valve springs
  1. Harmonics
  2. Retainers and keepers
  3. Rotators
  4. Testing
    - a. Installed height
    - b. Tension
    - c. Shims
- H. Camshaft
  1. Duration
  2. Overlap
  3. Lift
  4. Cam contour
  5. Construction
  6. Roller cam design
- I. Valve operating mechanisms
  1. L-head
  2. I-head
  3. Rocker arm ratio
  4. Types of rockers
  5. Hydraulic lifters
  6. Lifter operation
  7. Cam to lifter contact
  8. Valve stem seals
  9. Roller lifters
  10. Valve lash adjustments
- J. Overhead camshaft
  1. SOHC
    - a. With rockers
    - b. Without rockers
  2. DOHC
- K. Cam drive systems
  1. Gear – driven
  2. Chain – driven
  3. Chain – drive (OHC engines)
  4. Cogged timing belt

### **INSTRUCTIONAL METHODS:**

1. Lecture
2. Power Point Presentations
3. Videos
4. Demonstrations
5. Hands-on experience
6. Written exams and quizzes

## **EVALUATION OF STUDENT ACHIEVEMENT:**

1. Complete all lab objectives (ASE Education Foundation Tasks required for this course)
2. Satisfactorily perform complete engine over-haul according to manufacturer's specifications and procedures
3. Pass written exams and quizzes
4. Attitude
5. Work habits
6. Attendance
7. Safety practices

## **INSTRUCTIONAL MATERIALS:**

### **Textbooks**

1. Electude Online software
2. S/P 2 – Online Safety Software

### **Resources**

1. Pro-Demand – Information System
2. All Data Pro - Information System

## **LEARNING OUTCOMES AND GOALS:**

### **Institutional Learning Outcomes**

- 1) Communication – to communicate effectively;
- 2) Inquiry – to apply critical, logical, creative, aesthetic, or quantitative analytical reasoning to formulate a judgement or conclusion;
- 3) Social Consciousness – to understand what it means to be a socially conscious person, locally and globally;
- 4) Responsibility – to recognize how personal choices affect self and society.

## **Course Outcomes and Competencies**

### **I. ENGINE REPAIR (ASE Education Foundation Tasks)**

#### **A. General**

1. Research vehicle service information such as fluid type, internal combustion engine operation, vehicle service history, service precautions, technical service bulletins, and recalls including vehicles equipped with advanced driver assistance systems (ADAS).
2. Retrieve and record DTCs, OBD monitor status, and freeze frame data; clear codes and data when directed.
3. Verify operation of the instrument panel engine warning indicators.
4. Inspect engine assembly for fuel, oil, coolant, and other leaks; determine needed action.
5. Install engine covers using gaskets, seals, and sealers as required.
6. Verify engine mechanical timing.
7. Inspect, remove, and/or replace engine mounts.
8. Identify service precautions related to service of the internal combustion engine of a hybrid electric vehicle.
9. Remove and reinstall engine on a newer vehicle equipped with OBD; reconnect all attaching components and restore the vehicle to running condition.

## **I. ENGINE REPAIR**

### **B. Cylinder Head and Valve Train**

1. Identify cylinder head and valve train components and configurations.
2. Remove cylinder head; inspect gasket condition; install cylinder head and gasket; tighten according to manufacturer's specification and procedure.
3. Clean and visually inspect a cylinder head for cracks; check gasket surface areas for warpage and surface finish; check passage condition.
4. Inspect valve actuating mechanisms for wear, bending, cracks, looseness, and blocked oil passages (orifices); determine needed action.
5. Adjust valves (mechanical or hydraulic lifters).
6. Inspect and replace camshaft and drive belt/chain; includes checking drive gear wear and backlash, end play, sprocket and chain wear, overhead cam drive sprocket(s), drive belt(s), belt tension, tensioners, camshaft reluctor ring/tone-wheel, and valve timing components; verify correct camshaft timing.
7. Inspect valve springs for squareness and free height comparison; determine needed action.
8. Replace valve stem seals on an assembled engine; inspect valve spring retainers, locks/keepers, and valve lock/keeper grooves; determine needed action.
9. Inspect valve guides for wear; check valve stem-to-guide clearance; determine needed action.
10. Inspect valves and valve seats; determine needed action.
11. Check valve spring assembled height and valve stem height; determine needed action.
12. Inspect valve lifters and hydraulic lash adjusters; determine needed action.
13. Inspect and/or measure camshaft for runout, journal wear and lobe wear.
14. Inspect camshaft bearing surface for wear, damage, out-of-round, and alignment; determine needed action.

## **I. ENGINE REPAIR**

### **C. Engine Block Assembly**

1. Identify engine block assembly components and configurations.
2. Remove, inspect, and/or replace crankshaft vibration damper (harmonic balancer).
3. Disassemble engine block; clean and prepare components for inspection and reassembly.
4. Inspect engine block for visible cracks, passage condition, core and gallery plug condition, and surface warpage; determine needed action.
5. Inspect and measure cylinder walls/sleeves for damage, wear, and ridges; determine needed action.
6. Perform deglazing and cleaning of cylinder walls.
7. Inspect and measure camshaft bearings for wear, damage, out-of-round, and alignment; determine needed action.
8. Inspect crankshaft for straightness, journal damage, keyway damage, thrust flange and sealing surface condition, and visual surface cracks; check oil passage condition; measure end play and journal wear; check crankshaft position sensor reluctor ring (where applicable); determine needed action.
9. Inspect main and connecting rod bearings for damage and wear; determine needed action.
10. Identify piston and bearing wear patterns that indicate connecting rod alignment and main bearing bore problems; determine needed action.



11. Inspect and measure piston skirts and ring lands; determine needed action.
12. Determine piston-to-bore clearance.
13. Inspect, measure, and install piston rings.
14. Inspect auxiliary shaft(s) (balance, intermediate, idler, counterbalance and/or silencer); inspect shaft(s) and support bearings for damage and wear; determine needed action; reinstall and time.
15. Assemble engine block.

## **I. ENGINE REPAIR**

### **D. Lubrication and Cooling Systems**

1. Identify lubrication and cooling system components and configurations
2. Perform engine oil and filter change; use proper fluid type per manufacturer specification; reset maintenance reminder as required.
3. Perform cooling system pressure and dye tests to identify leaks; check coolant condition and level; inspect and test radiator, pressure cap, coolant recovery tank, heater core, and galley plugs; determine needed action.
4. Identify causes of engine overheating.
5. Inspect, replace, and/or adjust drive belts, tensioners, and pulleys; check pulley and belt alignment.
6. Inspect and test coolant; drain and recover coolant; flush and/or refill cooling system; use proper fluid type per manufacturer specification; bleed air as required.
7. Inspect, remove, and replace water pump.
8. Remove, inspect, and replace thermostat and gasket/seal.
9. Remove and replace radiator.
10. Inspect and test fan(s), fan clutch (electrical or mechanical), fan shroud, and air dams; determine needed action.
11. Perform oil pressure tests; determine needed action.
12. Inspect auxiliary coolers; determine needed action.
13. Inspect, test, and/or replace oil temperature and pressure switches and sensors.
14. Inspect oil pump gears or rotors, housing, pressure relief devices, and pump drive; determine needed action.

## **VIII. ENGINE PERFORMANCE**

### **A. General**

3. Verify proper engine cooling system operation; determine needed action.
4. Verify correct camshaft timing including engines equipped with variable valve timing (VVT) systems; determine needed action.
6. Diagnose abnormal engine noises or vibration concerns; determine needed action.
7. Diagnose the cause of excessive oil consumption, coolant consumption, unusual exhaust color, odor, and sound; determine needed action.
10. Perform cylinder cranking and running compression tests; determine needed action.
11. Perform cylinder leakage test; determine needed action.

## **VII. HEATING, VENTILATION, AND AIR CONDITIONING (HVAC)**

### **C. Heating, Ventilation, and Engine Cooling Systems**

1. Inspect engine cooling and heater systems hoses and pipes; determine needed action.
2. Inspect and test heater control valve(s); determine needed action.

## **FOUNDATIONAL TASKS – 2022**

### **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. Identify vehicle systems which pose a safety hazard during service such as: supplemental restraint systems (SRS), electronic brake control systems, stop/start systems, and remote start systems.
14. Identify vehicle systems which pose a safety hazard during service due to high voltage such as: hybrid/electric drivetrain, lighting systems, ignition systems, A/C systems, injection systems, etc.
15. Locate and demonstrate knowledge of safety data sheets (SDS).

### **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.
5. Demonstrate proper use of precision measuring tools (e.g., micrometer, dial-indicator, dial-caliper).
6. Perform common fastener and thread repair, including removing broken bolts, restoring internal and external threads, and repairing internal threads with a thread insert.

### **Personal Standards**

1. Reports to work daily on time; able to take directions and motivated to accomplish the task at hand.
2. Dresses appropriately and uses language and manners suitable for the workplace.
3. Maintains personal hygiene appropriate for the workplace.
4. Meets and maintains employment eligibility criteria, such as drug/alcohol-free status, clean driving record, etc.
5. Demonstrates honesty, integrity, and reliability.

### **Work Habits / Ethic**

1. Complies with workplace policies/laws.
2. Contributes to the success of the team, assists others and requests help when needed.
3. Works well with all customers and coworkers.
4. Negotiates solutions to interpersonal and workplace conflicts.
5. Contributes ideas and initiative.
6. Follows directions.
7. Communicates effectively, both in writing and verbally, with customers and coworkers.
8. Reads and interprets workplace documents; writes clearly and concisely.
9. Analyzes and resolves problems that arise in completing assigned tasks.
10. Organizes and implements a productive plan of work.
11. Uses scientific, technical, engineering and mathematics (STEM) principles and reasoning to accomplish assigned tasks.
12. Identifies and addresses the needs of all customers, providing helpful, courteous, and knowledgeable service and advice as needed.
13. Respectful of tools and property used in school and workplace environment.
14. Contributes to an inclusive environment where every coworker and customer feels welcomed, heard, and valued.