AUME-750: AUTOMOTIVE ENGINE THEORY AND REPAIR (LOWER END)

Effective Term
Fall 2024

BOT Approval Date
01/11/2024

Discipline
AUME - Automotive/Transportation Tech
Course Number
750

Course Title
Automotive Engine Theory and Repair (Lower End)

Short Title
Engine Theory & Repair-Lower

Credit Status (CB 04)
D - Credit - Degree applicable

Units

Lecture Units
2.00

Lab Units
1.00

Total Units
3.00

Hours

Lecture Contact Hours
32-36
Out of Class Hours Lecture
64-72

Lab Contact Hours
48-54
Out of Class Hours Lab
0.00

Total Contact Hours
80 - 90

Total Out of Class Hours
64 - 72

Total Student Learning Hours
144 - 162

Is this an existing Extensive Lab?
Yes

Distance Education

No

Catalog Description

This course covers the theory of operation, diagnosis, disassembly, inspection and repair of the cylinder block portion or lower end of a modern automotive internal combustion engine, including the pistons, crankshaft and engine lubrication system.

Attach Supporting Documents

23_ General Technician Employment Concentration.pdf
ASE PROGRAM STANDARDS ENGINE REPAIR.pdf

Requisites

Recommended Preparation

Recommended Preparation (note that students can enroll in the class even if they haven't take the recommended course)
AUME-700.

Codes

TOP Code (CB 03)

0948.00* - *Automotive Technology

CIP Code

47.0604 - Automobile/Automotive Mechanics Technology/Technician.

Student Accountability Model (SAM) Priority Code (CB 09)

C - Clearly Occupational

Noncredit Category (CB 22)

Y - Credit Course

Repeatability Code

No

Grading Option

Letter grade OR P/NP

Minimum Qualifications

Minimum Qualifications	And/Or
Automotive Technology	End

CSU Area(s)

IGETC Area(s)

Learning Objectives

Learning Objectives

Learning Objective
1. Exhibit the proper use of technical manuals, web-based resources and manufacturer prescribed test and repair procedures as required by this course.
2. Prepare a work order and provide a cost estimate that conforms to State of California Bureau of Automotive Repair (BAR) standards.
3. Develop safe work habits in the shop setting that conform to industry standards that apply to the use of personal protective equipment.

4. Exhibit the ability to identify the specialized tools necessary to disassemble, inspect, diagnose and repair the components of the lower end of the engine.
5. Dissect the bottom end of an internal combustion engine.
6. Evaluate the condition of engine components by employing precision measuring and test equipment.
7. Examine the component parts of the engine lubrication system and evaluate the condition of those components.
8. Discover employment opportunities available to all, with particular emphasis on those available to women, displaced homemakers and dislocated workers.

Learning Outcome Information

Course Learning Outcomes

Learning Outcome
1. The student will demonstrate compliance with personal and environmental safety practices used in the diagnosis, repair and maintenance of automotive engines and comply with applicable local, state and federal regulations governing the storage, handling and disposal of hazardous materials.
2. The student will identify the components used on the lower end of modern automotive internal combustion engines and discuss the theory of operation for those components.
3. The student will demonstrate the ability to verify, diagnose and repair faults related to the upper end components of a modern automotive internal combustion engine.
4. Students will exhibit the ability to discuss the employment opportunities available to women, displaced homemakers and dislocated workers.

Program Learning Outcomes

Learning Outcome
Complete all NATEF (National Automotive Technician Education Foundation) task sheets.
Enter the workforce in the automotive industry.
Pass all eight areas in the ASE certification.

Institutional Learning Outcomes

Communication: The student will effectively express and exchange ideas through listening, speaking, reading, writing, visual works, and other modes of interpersonal expression.
Critical Thinking: The student will analyze problems, gather and synthesize relevant information, evaluate ideas, information, and evaluate alternative points of view to create, innovate and implement effective solutions.
Information and Technology Literacy: The student will access, interpret, evaluate, and apply relevant information sources and digital media effectively, and in an ethical and legal manner.
Scientific Awareness: The student will apply the scientific method of inquiry to assess potential solutions for real-life challenges by employing science-based knowledge and methodologies in daily life.
Social Awareness: The student will recognize and analyze the interconnectedness of global, national, and local concerns, analyzing cultural, political, social, and environmental issues from multiple perspectives and appreciate similarities and differences among cultures.
Civic
Personal
and Professional Responsibility

Content

Course Lecture Content

1. Safety and Pollution Prevention Training
    a. S/P2 Online Training
        i. Automotive Service Safety Online Module
        ii. Automotive Pollution Prevention Online Module
        iii. The Automotive Lift Institute's "Lifting It Right" Online Module
        iv. "Ethics and You in the Automotive Industry" Online Module
2. Automotive Online Database Navigation

a. Alldata Online Repair Information
   i. Repair Manual Information Availability
   ii. How to Navigate Part and Labor Expense Information
b. Mitchell Prodemand Database Navigation
   i. Repair Manual Information Availability
   ii. How to Navigate Part and Labor Expense Information

3. General Engine Repair Tasks
   a. How to Identify Necessary Vehicle Information
      i. How to Decode the Vehicle Identification Number (VIN)
      ii. How to Interpret and Decode the Vehicle Emission Control Information Label (VECI)
   b. Identification of Fluid Types
      i. Coolant Type Identification
         1. Organic Additive Technology (OAT)
         2. Hybrid-Organic Additive Technology (HOAT)
      ii. Engine Oil Types
         1. Society of Automotive Engineers (SAE) Specifications
            a. Viscosity Rating Interpretation
            b. Additive Rating Identification
         2. American Petroleum Institute (API) Specifications
            a. Identification of Oil Usage Recommendations
               i. For Gasoline Engines
               ii. For Diesel Engines
4. Internal Combustion Engine Diagnostic Techniques
   a. Electronic Diagnostic Techniques
      i. Using a Scan Tool to Perform Initial Diagnosis
         1. Diagnostic Trouble Code (DTC) Interpretive Techniques
            a. By Suffix
            b. By Number
         2. Using a Wireless Chassis Ear to Detect Unwanted Sounds
            a. Locating a Knock
            b. Vibration Analysis
         3. The Use of Thermal Imaging Technology
            a. To Detect Abnormal Cooling System Performance
            b. To Detect Abnormal Lubrication System Performance
5. Special Precautions Related to Hybrid Vehicle Powertrains
   a. Personal Protective Equipment (PPE) Requirements
      i. Class 0 (1,000 Volt) Lineman's Gloves
         1. Classification Requirements
         2. Age Requirements
      ii. How to Perform the High-Voltage Disconnect
         1. Disconnection Device Locations
         2. Live-Dead-Live Disconnect Validation Techniques
      iii. Use of the Technician Removal Tool
      iv. Other Precautions Related to High-Voltage Hazards
6. The Engine Block Assembly
   a. Precision Measurement Techniques
      i. Using the Online Micrometer Simulator
      ii. Introduction to the Micrometer
         1. Using Inside Micrometers
         2. Using Outside Micrometers
         3. How to Use the Bore Gauge
         4. How to Use Feeler Gauges
   b. The Components of the Engine Block
      i. Pistons and Connecting Rods
         1. Their Purpose and Function
         2. Piston Design
            a. Gasoline Engines
            b. Diesel Engines

ii. The Crankshaft
    1. Its Purpose
    2. Design Variations of Crankshafts
iii. Devices Used to Limit Engine Vibration
    1. Flywheels and Flexplates
    2. Harmonic Balancers
    3. Balance Shafts
iv. The Gaskets and Seals Used in the Block
    1. Oil Pan and Cover Gaskets
    2. Rear Main and Front Crankshaft Seals

7. Engine Design Classification and Configurations
   a. Design Classifications
      i. Inline Engines
      ii. V-Type Engines
      iii. Horizontally Opposed Engines
   b. Configurations
      i. Longitudinal Placement Designs
      ii. Transverse Placement Designs
8. The Engine Lubrication System
   a. Types of Oil Pumps
      i. The Gear-Type Pump Design
      ii. The Geroter Oil Pump Design
      iii. The Dry-Sump System Design
   b. Location of the Oil Pump
      i. Pumps Mounted in the Oil Sump
      ii. Pumps Mounted on the Front Timing Cover
      iii. Remote Mounting of the Dry Sump System Pump
   c. Engine Oil Filter Design
      i. Cartridge Type Filter Design
      ii. Spin-On Filter Design
      iii. Full-Flow Oil Filter Design
   d. The Importance of Oil Specifications
      i. For Proper Operation of the Engine Bearings
      ii. For Proper Operation of the Variable Valve Timing (VVT) System
   e. The Causes of Plain Bearing Failure
      i. Lack of Lubrication
      ii. Intrusion of Impurities
      iii. Cooling System Issues Related to Plain Bearing Failures
   f. Engine Oil Cooler Design and Function
      i. Location of Engine Oil Coolers
      ii. How to Determine the Design and Proper Function of the Oil Cooler
          1. By Using a Thermal Imager
          2. By Using an Infrared Pyrometer
9. Cooling System Design and Operation
   a. The Essential Components of the Cooling System
      i. The Radiator
          1. Cross-Flow Radiator Design
          2. Vertical Flow Radiator Design
      ii. The Water Pump
          1. Belt-Driven Water Pumps
          2. Electrically Operated Water Pumps
      iii. The Cooling System Thermostat
          1. Single Thermostat Designs
          2. Dual Thermostat Designs
          3. Electrically Assisted Thermostats
      iv. Pressurized Cooling Systems

1. Advantages of the Pressurized Cooling System
    a. Higher Boiling Points
        i. Effect of Pressure on the Boiling Point
        ii. Reduced Service and Refill Requirements
2. How to Inspect the Cooling System
    a. System Performance Checks
        i. Coolant Fan Operation Tests
        ii. Coolant Circulation Inspection
        iii. Cooling System Pressure Testing
    b. Types of Coolants Used
        i. For Standard Gasoline Engines
        ii. For Hybrid Powertrains

10. Exploration of Employment Opportunities Available in the Automotive Aftermarket
    a. Technician Employment
        i. Lubrication Technicians
        ii. Automotive Specialty Technicians
        iii. Job Openings Available to Technicians
        iv. Compensation Amounts and Techniques for Technicians
    b. Service Advisor Positions
        i. Requirements for Service Advisors
            1. Working Conditions for Service Advisors
                a. Hours
                b. Work Demands
            2. Compensation of Service Advisors
        ii. Service Management Positions
            1. Shop Foremen
                a. Job Requirements
                b. Working Conditions
                c. Compensation
            2. Service Management Positions
                a. Service Managers
                    i. Job Requirements
                    ii. Compensation
                    iii. Working Conditions
        iii. The Changing Face of the Automotive Aftermarket
            1. Improving Conditions for Traditionally Dispossessed Groups
                a. Gains for Women
                b. Lack of Discrimination in Hiring and Compensation
                c. Special Advantages Available for Women
                    i. To Compensate for Past Exclusion
                    ii. Advantages Produced by Characteristic
                        1. Increased Level of Trust
                        2. Increase in Female Vehicle Ownership
                        3. Increase in Female Business Ownership

Course Lab Content

1. Prepare a Work Order
    a. The Three "Cs"
        i. Verify Customer Complaint
        ii. Discover the Cause of the Complaint
        iii. Propose a Correction to Resolve the Complaint
    b. Bureau of Automotive Repair Standards
        i. Prepare an Initial Repair Estimate
            1. Gather Customer Information
            2. Gather Vehicle Information
            3. Remember the Date
            4. Getting the Customer Authorizations

ii. Prepare the Revised Estimate or Estimates
iii. Prepare the Final Invoice

2. General Engine Repair
   a. Research Vehicle Information
      i. Technical Service Bulletins
         1. General Technical Service Bulletins
         2. Recalls
      ii. Technician and Vehicle Safety Precautions
      iii. Vehicle Service History
      iv. Fluid Type Requirements
   b. Retrieve and Record Electronic Vehicle Data
      i. DTCs and OBD Monitor Status
      ii. Freeze Frame Data
      iii. Clear DTCs When Directed
   c. Basic Mechanical Checks
      i. Verify Mechanical Timing
         1. Camshaft Timing Verification (Mechanical Method)
         2. Camshaft/Crankshaft Coordination (Electronic Method)
      ii. Inspect for Leaks
         1. Engine Oil Leaks
         2. Cooling System Leaks
      iii. High-Voltage Service Precautions
         1. Remove the Service Disconnect
         2. Perform the Live-Dead-Live Verification
      iv. Verify the Operation of Gauges and Warning Indicators
         1. Check Engine Light Operation Test
         2. Oil Pressure Test Using a Pressure Gauge
         3. Cooling System Function Test
            a. Thermostat Operation Verification
            b. Coolant Fan Operation Verification
            c. Radiator Inspection
               i. Pressure Testing
               ii. Infrared Pyrometer Test
3. Engine Block Assembly Procedures
   a. Remove, Inspect and Replace Crankshaft Vibration Damper
   b. Disassemble Engine Block Components
      i. Clean and Prepare Components for Inspection and Reassembly
   c. Inspection of Components
      i. Cylinder Walls
         1. Crack Inspection
         2. Warpage Inspection
         3. Glazing Inspection
         4. Ridge Inspection
      ii. Crankshaft Inspection
         1. Straightness
         2. Journal Damage
         3. Keyway Damage
         4. Inspect for Oil Passage Condition
         5. Measure End Play and Journal Wear
      iii. Determine Piston-to-Bore Clearance
      iv. Inspect, Measure, and Install Piston Rings
      v. Identify Piston and Bearing Wear Patterns
      vi. Inspect and Measure Piston Skirts and Ring Lands
   d. Reassemble the Engine Block Assembly
      i. Install the Crankshaft
         1. Check Bearing Clearance with Plastigage
         2. Measure Crankshaft End Play

ii. Install the Pistons
1. Use a Piston Ring Compressor
2. Measure Deck-Height Clearances

4. Inspect and Service the Cooling System
   a. Identify Causes of Engine Overheating
      i. Identify Leaks
         1. Perform Cooling System Pressure and Dye Tests
         2. Check Coolant Condition and Level
         3. Inspect and Test Radiator and Pressure Cap
         4. Remove, Inspect, and Replace Thermostat and Gasket or Seal
         5. Inspect and Test Fan(s) and Fan Clutches
         6. Inspect Fan Shroud and Air Dams
5. Inspect and Service the Lubrication System
   a. Perform Engine Oil and Filter Change
      i. Use Proper Fluid Type Per Manufacturer Specification
      ii. Reset Maintenance Reminder
   b. Inspect Auxiliary Coolers
   c. Inspect, Test, and/or Replace Oil Temperature and Pressure Switches and Sensors
   d. Inspect Oil Pump Gears or Rotors
6. Investigate Employment Opportunities for Engine Repair Technicians
   a. Job Shadowing
   b. Interview a Professional Technician
   c. Research Employment Data
      i. Number of Jobs Available
      ii. Compensation
      iii. Benefits
      iv. Opportunities Available for Women, Displaced Homemakers and Dislocated Workers.

Methods of Instruction

Method

Lab Activities

Integration

Students will be required to perform lab assignments related to the disassembly, inspection and repair of the cylinder block assembly and lubrication system of an automotive internal combustion engine. The inspection will focus upon the conformity of the component to the manufacturer's specifications for that component.

Method

Lecture

Integration

Lectures will be presented by the instructor to introduce the students to the component parts of the cylinder block portion or lower end of a modern automotive internal combustion engine and their theory of operation. For this course, lectures will focus on the component parts and theory of operation of the cylinder block, crankshaft, pistons and lubrication system of the modern automotive internal combustion engine. Students will be prompted to ask questions or make comments about the lecture material during the class period.

Method

Reading

Integration

Readings will be assigned from the required textbook(s). Students will be required to complete the quiz questions from the end of the assigned chapters in order to assess their understanding of the materials presented.

Method

Role Playing/Simulation

Integration

Students will be required to perform the diagnostic and repair tasks related to the proper operation of the cylinder block portion and lubrication system of an internal combustion engine. These tasks will be performed under the observation of the instructor. Student performance will be coached in order to assure conformity to the commonly accepted standards of the automotive repair industry.

Method

Directed Study

Integration

Students will be directed to research sources that examine the many job opportunities open to special populations in general, and women, displaced homemakers and dislocated workers in particular.

Methods of Evaluation

Method

Class Participation

Integration

Students will be required to discuss various engine testing and diagnostic strategies and compare and contrast different industry standard reconditioning practices related to the lower end of the modern internal combustion engine. Students will be evaluated on their ability to select the best possible practices to be used for the diagnosis and repair of different engine lower end designs.

Method

Class Performance

Integration

The instructor will evaluate the student's ability to perform the work required to complete the task sheets consistent with the standards of the ASE Education Foundation (ASEEF) which are relevant to the diagnosis and repair of the lower end and lubrication system of an automotive engine. Student performance will be assessed by instructor observation of the student's ability to perform the tasks according to commonly accepted industry standards.

Method

Exams/Tests

Integration

Students will be given tests or exams designed to assess their understanding of the operation of the various components that make up the engine lower or bottom end. Evaluation will be based upon the accuracy and detail of the student's answers.

Method

Quizzes

Integration

Quizzes will be administered at the end of the various sections of the course. The quizzes will be designed to determine the degree and accuracy of the student's understanding of the theory of operation of the components of the lower end of an engine.

Method
Research Projects

Integration
Students will present a 2-3 page paper categorizing the employment opportunities available to individuals who possess the knowledge and skills taught in this course, with a particular emphasis placed on equity in employment and compensation for women, displaced homemakers and dislocated workers. Assessment will be based on the correct identification of the ways in which the profession has become more inclusive with the passage of time; for instance, identification should be made of how much of an increase has there been in employment for members of traditionally excluded populations with a special emphasis on women, displaced homemakers and dislocated workers.

Assignments

Assignment Type
Writing

In-class and/or outside of class
In-class

Formative or Summative
Formative

Assignment
Prepare a repair order according the the standards prescribed by the State of California's Bureau of Automotive Repair (BAR). The repair order will display required items of information about both the customer and the vehicle being inspected or repaired. The repair order will also include an information section in which the customer complaint or complaints will be summarized in a form referred to in our industry as the "3Cs"--a brief summary of the customer complaint, a description of the cause of that complaint, and an explanation of the correction of that complaint. The assignment is intended to encourage students to utilize a logical process when performing diagnosis and repair. The assignment will be evaluated by how well it meets BAR and the other standards presented above.

Assignment Type
Reading

In-class and/or outside of class
Outside of class

Formative or Summative
Formative

Assignment
Read the textbook chapters which are assigned before class so that you gain a good understanding about how the various components of the internal combustion engine are designed to work together. For example, one of the textbook chapters will describe the purpose of the crankshaft in the internal combustion engine, which is to convert the reciprocating motion of the pistons into the rotating motion necessary to provide the motive power for the vehicle. It will also describe the crankshaft's role in determining the displacement of the engine and its relationship to the camshafts.

Assignment Type
Other

In-class and/or outside of class
In-class

Formative or Summative
Summative

Assignment

Prepare a presentation about the components and the theory of operation of one of the sub-systems of an internal combustion engine (ICE) mechanical or electronic system and the relationship of that system to the overall operation of the ICE. The presentation can be made in person, take the form of a PowerPoint presentation or you can make a short video presentation using the Canvas studio feature. The presentation must explain the sub-system in terms that a beginning automotive student would be able to understand. The evaluation of your performance of this assignment will be based on the accuracy of the information presented and the professionalism with which it is prepared.

Assignment Type

Writing

In-class and/or outside of class

Outside of class

Formative or Summative

Formative

Assignment

Prepare a short 2-3 page paper discussing the employment opportunities available to individuals who possess knowledge and skills related to the operation of internal combustion engines. Emphasis will be placed on equity in hiring and compensation for women, displaced homemakers and dislocated workers.

Assignment Type

Other

In-class and/or outside of class

In-class

Formative or Summative

Formative

Assignment

Perform precision measurements on components of the engine block to determine the readiness of the block for reassembly. Typical measurements would include cylinder bore wear and taper, which are measured with a cylinder bore gauge, crankshaft journal wear and taper, which is measured with an outside micrometer, and crankshaft bore alignment, which is measured with a straightedge and feeler gauges.

Course Materials

Textbooks

Duffy, James. (2021) Auto Engine Repair 7th Edition Goodheart and Willcox ISBN: 978-1-64564-070-7
Gilles, T. (2019). Automotive Engines: Diagnosis, Repair and Rebuilding 8th Cengage. ISBN: 9781337567480

Other Resources

ALLDATA and Mitchell ProDemand Automotive Service Information Online Databases.

Class Size Information

Class Size

25

Class Size Category

J - Specialty lab

Diversity and Inclusion

Explain how diversity and inclusion(e.g., gender, culture/race, sexuality, etc.) is infused into the course.

The concepts of diversity and inclusion have been infused into the content of this course by placing special emphasis on the way that the demands required by the required tasks has changed as time has passed; in other words, this part of the profession has changed so that it is more "user friendly". For example, the materials that the modern internal combustion engine are constructed with are much lighter and easier to work with than those used even thirty years ago, and this means that the work that needs to be performed on them can be competed by individuals who might lack a lot of physical strength. This would include disabled individuals along with those who do not traditionally enter the automotive technology career path.
Most of the instructional materials used for this course, such as the safety and pollution prevention training materials provided by the S/P2 organization, are presented in both a fully accessible format and in different languages as well.
Finally, much of the diagnostic and repair equipment used as part of the lab exercises for this course, such as the diagnostic scan tools used to determine the cause of various engine performance problems, are much more user friendly than they were in previous years, which makes the successful completion of the lab tasks easier for individuals representing diverse racial or gender backgrounds with a particular emphasis on women, displaced homemakers and dislocated workers.

Describe how assignments, instruction, evaluation, course content, and interactions are contextualized for diverse learners promoting an equitable course.

The assignments related to this course divide neatly into three separate classifications: (1) Lectures and reading assignments that introduce students to the technical terms and specifications they need to be familiar with, such as proper torque sequences and techniques, (2) the lab assignments that give students the opportunity to apply the material presented as a part of the lecture content, and , (3) exams and final performance evaluations designed to assess the student's understanding of the course material. This presentation scheme is intended to provide students with different learning styles and abilities with equitable opportunities for success in the class.

Student lab assignments have been altered in a number of different ways in order to accommodate individuals with differing levels of physical strength and agility; for example, new tools have been purchase which increase the amount of leverage provided by the tool itself. In addition, students perform their lab exercises in teams of four people; every effort is made to diversify these teams as much as possible and encourage teamwork so that the students are best able to support one another's efforts.

Evaluations are made on the basis of student performance on quizzes, exams, the ability to physically identify components and verbally discuss their function, and evaluation of actual performance of the lab exercises, including a final performance evaluation of a student's ability to perform a precision measurement of various components of the cylinder block. This combination of written, oral, visual and performance evaluations are intended to provide as equitable an opportunity as possible so that students who possess a variety of different learning styles can be accommodated fairly.

While the Automotive Department has been making progress in attracting more women to take advantage of its training opportunities, we are still facing a considerable shortfall. As a result, this course makes a particular effort to increase awareness of the many job opportunities available to women, displaced homemakers and dislocated workers who are familiar with the components and understand the functions of the internal combustion engine. The available openings are not limited to technical positions, but also include career paths as service advisors, service managers, and various positions offered by vehicle manufacturers.

Interactions

Explain how the course will incorporate student-to-student interaction.

Because the number of workstations that we can provide in the lab setting is necessarily limited, students are generally encouraged to work in teams of four or five individuals. The tasks that are required in order to successfully complete the course require a considerable amount of teamwork on the part of the students. Engine repair involves a great deal of what is referred to in the industry as heavy-duty work, and this is performed ideally by multiple technicians, in this case student technicians, working together as a team to get the required tasks accomplished. The responsibilities required by the course will rotate between different individuals or pairs of students from one laboratory exercise to another. The students will need positive interaction with one another in order to successfully perform the task at hand.

Explain how the course will incorporate instructor-to-student interaction.

The instructor will interact with the students in a number of different ways. The Instructor's primary responsibility is to explain the operation of various automotive engine mechanical, cooling and lubrication systems; the Automotive Department utilizes a combination of visual presentations, instruction using specialized automotive trainer units and physical demonstration of diagnostic and repair procedures on an actual vehicle. In addition, the instructor will act as a coach to either encourage the students when they are performing their work correctly or suggest that they use better methods when they are not. Finally, the instructor will provide feedback about the cumulative value of student performance on lab exercises.

Explain how the course will incorporate student-to-content interaction.

The course content is delivered in a progressive fashion--first, students are instructed to identify the component parts of an internal combustion engine (ICE) and are then asked to label those components on a worksheet. After this is completed successfully, the theory of operation of various ICE designs will be discussed; the students will generally be asked to perform an experiment and complete a worksheet on one of our specialized automotive systems trainer units or on an engine mock-up. That experiment will allow the students to practice and to improve their skills in applying the course content. Finally, students are generally asked to demonstrate their ability to perform system diagnosis and repair on an actual vehicle, which requires that they be able to apply the content of the course to an actual situation.

Explain how the course will incorporate student-to-self interaction (metacognitive).

Student-to-self interaction will take place in this course during the process of diagnosing a mechanical problem in an internal combustion engine. Students will perform various operations, including making precision measurements and checking the integrity of metal parts by magna-fluxing them; their mission in this course is to match a defect to a customer complaint. Students are then encouraged to look for the root cause of the issue. For example, an engine may have a defective plain bearing that causes a knock; the plain bearing needs to be replaced, of course, but the student will also be asked to determine why that bearing failed. Bearing failure can have a number of different causes, and it will be up to the student, under the supervision of the instructor, to perform some detective work until the correct root cause is located. The hunt for the root cause of the problem will provide more than adequate student-to self, or metacognitive, interaction.

Key: 389