



South Portland, Maine 04106

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| Title: <b>Introduction to Engine Performance &amp; Repair</b> | Catalog Number: <b>AUTO-210</b>                        |
| Credit Hours: <b>4</b>  | Lecture (or Lab): <b>2 hours lecture / 2 hours lab</b> |
| Instructor: <b>Joe Moore</b>                                  | Total Contact Hours: <b>30 / 60</b>                    |
| Office: <b>207-741-5859</b>                                   | E-mail: <b>jmoore2@smccme.edu</b>                      |

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## Course Syllabus

### Course Description

The first of a two course sequence addressing automotive engines and engine performance, this course will introduce the theory, operation and repair of the four stroke cycle gasoline engine found in today's automobiles. Students will perform compression tests, cylinder leakage tests; and vacuum tests to identify failed areas of the engine and required service procedures. Students will disassemble engines and identify internal components and their function within the engine. Students will learn to make measurements of bearing journals, cylinder bores, pistons, camshafts and other internal components necessary to determine failures and the appropriate repair and service procedures. Prerequisite / co-requisite: AUTO-260.

### Course Objectives

After completing this course, the student will be familiar with all tasks listed below. He or she must perform all high priority tasks to manufacturer's specifications and document the completion of each task.

### NATEF TASKS FOR THIS COURSE:

#### ENGINE REPAIR

For every task in Engine Repair, the following safety requirement must be strictly enforced:

Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

#### I. ENGINE REPAIR

## **A. General: Engine Diagnosis; Removal and Reinstallation (R & R)**

1. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.

P-1

2. Research applicable vehicle and service information, such as internal engine operation, vehicle service history, service precautions, and technical service bulletins.

P-1

3. Verify operation of the instrument panel engine warning indicators.

P-1

4. Inspect engine assembly for fuel, oil, coolant, and other leaks; determine necessary action.

P-1

5. Install engine covers using gaskets, seals, and sealers as required.

P-1

6. Remove and replace timing belt; verify correct camshaft timing.

P-1

7. Perform common fastener and thread repair, to include: remove broken bolt, restore internal and external threads, and repair internal threads with thread insert.

P-1

8. Inspect, remove and replace engine mounts.

P-2

9. Identify hybrid vehicle internal combustion engine service precautions.

P-3

10. Remove and reinstall engine in an OBDII or newer vehicle; reconnect all attaching components and restore the vehicle to running condition.

P-3

## **I. ENGINE REPAIR**

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

1. Remove cylinder head; inspect gasket condition; install cylinder head and gasket; tighten according to manufacturer's specifications and procedures.

P-1

2. Clean and visually inspect a cylinder head for cracks; check gasket surface areas for warpage and surface finish; check passage condition.

P-1

3. Inspect pushrods, rocker arms, rocker arm pivots and shafts for wear, bending, cracks, looseness, and blocked oil passages (orifices); determine necessary action.

P-2

4. Adjust valves (mechanical or hydraulic lifters).

P-1

5. 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.

P-1

6. Establish camshaft position sensor indexing.

P-1

7. Inspect valve springs for squareness and free height comparison; determine necessary action.

P-3

8. Replace valve stem seals on an assembled engine; inspect valve spring retainers, locks/keepers, and valve lock/keeper grooves; determine necessary action.

P-3

9. Inspect valve guides for wear; check valve stem-to-guide clearance; determine necessary action.

P-3

10. Inspect valves and valve seats; determine necessary action.

P-3

11. Check valve spring assembled height and valve stem height; determine necessary action.

P-3

12. Inspect valve lifters; determine necessary action.

P-2

13. Inspect and/or measure camshaft for runout, journal wear and lobe wear.

P-2

14. Inspect camshaft bearing surface for wear, damage, out-of-round, and alignment; determine necessary action.

P-3

## **I. ENGINE REPAIR**

### **C. Engine Block Assembly Diagnosis and Repair**

1. Remove, inspect, or replace crankshaft vibration damper (harmonic balancer).

P-2

2. Disassemble engine block; clean and prepare components for inspection and reassembly.

P-1

3. Inspect engine block for visible cracks, passage condition, core and gallery plug condition, and surface warpage; determine necessary action.

P-2

4. Inspect and measure cylinder walls/sleeves for damage, wear, and ridges; determine necessary action.

P-2

5. Deglaze and clean cylinder walls.

P-2

6. Inspect and measure camshaft bearings for wear, damage, out-of-round, and alignment; determine necessary action.

P-3

7. 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 necessary action.

P-1

8. Inspect main and connecting rod bearings for damage and wear; determine necessary action.

P-2

9. Identify piston and bearing wear patterns that indicate connecting rod alignment and main bearing bore problems; determine necessary action.

P-3

10. Inspect and measure piston skirts and ring lands; determine necessary action.

P-2

11. Determine piston-to-bore clearance.

P-2

12. Inspect, measure, and install piston rings.

P-2

13. Inspect auxiliary shaft(s) (balance, intermediate, idler, counterbalance or silencer); inspect shaft(s) and support bearings for damage and wear; determine necessary action; reinstall and time.

P-2

14. Assemble engine block.

P-1

## **I. ENGINE REPAIR**

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

1. 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 necessary action.

P-1

2. Identify causes of engine overheating.

P-1

3. Inspect, replace, and adjust drive belts, tensioners, and pulleys; check pulley and belt alignment.

P-1

4. Inspect and test coolant; drain and recover coolant; flush and refill cooling system with recommended coolant; bleed air as required.

P-1

5. Inspect, remove, and replace water pump.

P-2

6. Remove and replace radiator.

P-2

7. Remove, inspect, and replace thermostat and gasket/seal.

P-1

8. Inspect and test fan(s) (electrical or mechanical), fan clutch, fan shroud, and air dams.

P-1

9. Perform oil pressure tests; determine necessary action.

P-1

10. Perform engine oil and filter change.

P-1

11. Inspect auxiliary coolers; determine necessary action.

P-3

12. Inspect, test, and replace oil temperature and pressure switches and sensors.

P-2

13. Inspect oil pump gears or rotors, housing, pressure relief devices, and pump drive; perform necessary action.

P-2

### **Topical Outline of Instruction**

Four Cycle Theory and Operation

#### **1. INTAKE STROKE**

A. Piston Movement causing atmospheric Pressure vs. vacuum Relationship

#### **2. COMPRESSION STROKE**

A. Pressure vs. Temperature relationship

B. Compression Ratio

#### **3. POWER STROKE**

- A. Fuel Burn, lean mixture, rich mixture, Stoichiometric Air Fuel Ratio
- B. Relationship of Fuel Burn to Pressure, Temperature, and Push on Piston

#### **4. EXHAUST STROKE**

- A. Valve Overlap and Scavenger Effect

#### **5. ENGINE DESIGN AND EFFECTS ON FOUR CYCLES**

- A. Cam Speed vs. Crank Speed
- B. Multi Valve Engines
- C. Double Overhead cam engines vs. single Over head cam
- D. Clearance vs. Non Clearance Engines, reduction of quench areas.
- E. Turbo vs. Non Turbo Designs
- F. Variable Valve Timing

#### **6. ENGINE TESTING PROCEDURES**

- A. Vacuum Gauge Readings, normal vs. abnormal
- B. Cylinder Compression Tests, Performing, Interpreting, Wet vs. Dry
- C. Cylinder Leakage Tests, Performing and Interpreting
- D. Block Test to Identify Combustion Chamber Leakage into cooling system
- E. Power Balance Tests
- F. Oil Pressure Tests analysis, interpretations and failure identification

#### **7. SHOP ENGINE TEARDOWN OBJECTIVES**

- A. Perform Proper Disassembly Procedures
- B. Identify Internal Engine Components and Functions
- C. Identify Internal Engine Failures, to include gasket and seal failures
- D. Perform Internal Engine Measurements
  - a. crank journal diameters
  - b. journal to bearing clearances
  - c. cylinder bore diameter, bore taper, bore out of round
  - d. piston diameter, piston failures
  - e. piston to cylinder clearances
- E. CYLINDER HEAD INSPECTION
  - a. Measure Cylinder Head Gasket Surface for warping and surface defects
  - b. Inspect Valves and Valve Seat, stem to guide clearance
  - c. Inspect Rocker arms, pivots, shafts
  - d. hydraulic and mechanical lifters function, failures

e. Inspect Cam Drives, belts, chains and tensioners

#### F. ENGINE ASSEMBLY

a. utilize proper engine assembly procedures lower end

b. install cylinder heads to manufacturer specifications, proper torque procedure and sequence, understanding torque to yield bolts

c. installation of timing belts, chains and tensioners

d. Proper gasket, seal installation

e. understand sealers and their uses, aerobic vs. non aerobic

#### **Course Requirements**

- Students will successfully complete homework, quizzes and tests.
- Students will successfully complete shop projects as assigned and approved by instructors and maintain documentation of completion.

#### **Student Evaluation and Grading**

10%: Attendance and Participation

10%: Homework

20%: Quizzes

30%: Tests

30%: Practice of Safety and Shop Participation

Electude modules will be assigned periodically through the course. Each module will be counted as a quiz grade and if not completed by the due date will result in a zero for that quiz. Electude involves some time commitment do not wait to the last minute.

#### **Attendance Policy**

**Students will be dropped a letter grade from their final grade for 10% of total hours. Students will be dropped an additional letter grade at 13%. (For example: Received A for class but 10% absences now translates to a B for the final grade. 13% absence would translate to a C.) Students missing 15 % of the total hours for the course, tardy or absent will result in an administrative failure (AF) for the class. For this course meeting 3 hours per day twice a week, means 15% is 13.5 hours. Tardies will count as .5 hours no matter time missed unless greater than .5 hours which then will be counted as time missed.**

**Tardies are considered not seated at the time of the start of class. Tardies will add up. Students will be removed with an AF if 3 consecutive absences.**

**Example A final grade**

|            |                   |                      |
|------------|-------------------|----------------------|
| <b>10%</b> | <b>9 hours</b>    | <b>B final grade</b> |
| <b>13%</b> | <b>11.7 hours</b> | <b>C final grade</b> |
| <b>15%</b> | <b>13.5 hours</b> | <b>AF</b>            |

**Text, Tools and/or Supplies**

- Automotive Technology: Principles, Diagnosis, and Service, 4<sup>th</sup> Edition, by James Halderman (ISBN 9780132811057)
- Each student must supply and maintain his or her own set of tools as listed on the “SMCC Automotive Technology Required Student Tool List,”
- Personal protective equipment must be worn at all times in lab. Leather, steel-toe work boots; clear safety glasses with side shields; and a uniform are required for this course.

**Office Hours**

Appointments can be made to accommodate student needs.

**End-of-Course Evaluation**

In order to gain access to final course grades, students must complete evaluations for each course attended at SMCC. Evaluations are submitted online and can be accessed through the student portal site. Students can access the course evaluation report beginning two weeks before the end of classes. The deadline for submission of evaluations occurs 24 hours after the last day of classes each semester. Instructors will announce when the online course evaluation is available.

**ADA Syllabus Statement**

Southern Maine Community College is an equal opportunity/affirmative action institution and employer. For more information, please call 207-741-5798.

If you have a disabling condition and wish to request accommodations in order to have reasonable access to the programs and services offered by SMCC, you must register with the disability services coordinator, Mark Krogman, who can be reached at 741-5629. There will be some documentation for your teachers that must be

supplied before accommodations can be given. Further information about services for students with disabilities and the accommodation process is available upon request at this number.

### **SMCC Pay-for-Print Policy**

Students can print 150 pages per semester free of charge. If you print over 150 pages, you will be charged 10 cents per page to your student billing account for tuition and fees.

Leftover pages from each semester will not be rolled over to the following semester.

The College's pay-for-print system monitors printing on all public printers (i.e. those in general access labs, library printers, the Academic Achievement Center, Noisy Lounge and technology labs). Each time you log-in to the system, the print station displays the remaining print quota. Once the printing quota has been exceeded, users will be charged \$ 0.10 per page or \$.05 per side if the printer prints on both sides on their student accounts on a monthly basis. Color printouts will be charged at 11 page units. This means each color printout will count as 11 pages toward the quota and will cost \$1.10.

### **Add-Drop Policy**

Students who drop a course during the one-week "add/drop" period in the fall and spring semesters and the first three days of summer sessions receive a 100% refund of the tuition and associated fees for that course. Please note any course that meets for less than the traditional semester length, i.e., 15 weeks, has a pro-rated add/drop period. There is no refund for non-attendance.

### **Withdrawal Policy**

A student may withdraw from a course only during the semester in which s/he is registered for that course. The withdrawal period is the second through twelfth week of the fall and spring semesters and the second through ninth week of twelve-week summer courses. This period is pro-rated for shorter-length courses. To withdraw from a course, a student must complete and submit the appropriate course withdrawal form, available at the Enrollment Service Center (no phone calls, please). The designation "W" will appear on the transcript after a student has officially withdrawn. A course withdrawal is an uncompleted course and may adversely affect financial aid eligibility. Failure to attend or ceasing to attend class does not constitute withdrawal from the course. There is no refund associated with a withdrawal.

### **Plagiarism Statement**

Adherence to ethical academic standards is obligatory. Cheating is a serious offense, whether it consists of taking credit for work done by another person or doing work for which another person will receive credit.

Taking and using the ideas or writings of another person without clearly and fully crediting the source is plagiarism and violates the academic code as well as the Student Code of Conduct. If it is suspected that a student in any course in which s/he is enrolled has knowingly committed such a violation, the faculty member should refer the matter to the College's Disciplinary Officer and appropriate action will be taken under the Student Code of Conduct. Sanctions may include suspension from the course and a failing grade in the course. Students have the right to appeal these actions to the Disciplinary Committee under the terms outlined in the Student Code of Conduct.