

## Course Modification Summary

Course Description: Theory of the construction, operation and repair of two-stroke, four-stroke, rotary, and diesel engines. Includes principles of lubrication systems, cooling systems, fuel, and exhaust systems. This course may be used in preparation for the Automotive Service Excellence (ASE) A1 certification test.

**Rationale:** Rewriting the course description to reflect the latest changes in technology.

Last updated: 3/99

SAN BERNARDINO VALLEY COLLEGE  
COURSE OUTLINE

I. CATALOG DESCRIPTION:

Division: TECHNICAL Department: AUTOMOTIVE

Course ID Number: AUTO 091

Course Title: ENGINE THEORY

Hours: Lecture 3 Hours/Week

Units: 3

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Prerequisite(s)/Corequisite(s): None

II. NUMBER OF TIMES COURSE MAY BE TAKEN FOR CREDIT: One

III. EXPECTED OUTCOMES FOR STUDENTS:

Upon completion of this course, students will be able to:

- A. 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 in accordance with local, state, and federal safety and environmental regulations including, but not limited to, the regulatory departments such as the Occupational Safety and Health Act (OSHA), Bureau of Automotive Repair (BAR), South Coast Air Quality Control Board (SCAQCB), Environmental Protection Agency (EPA).
- B. Apply knowledge and skills attained to pass the Automotive Service Excellence (ASE) National Test.
- C. Complete National Automotive Technicians Education Foundation (NATEF) Task List:
  1. General Engine Diagnosis; Removal and Reinstallation (R & R)
    - a. Interpret and verify complaint; determine needed repairs. P-1
    - b. Inspect engine assembly for fuel, oil, coolant, and other leaks; determine needed repairs. P-2
    - c. Listen to engine noises; determine needed repairs. P-2
    - d. Diagnose the cause of excessive oil consumption, unusual engine exhaust color, odor, and sound; determine needed repairs. P-2
  2. Cylinder Head and Valve Train Diagnosis and Repair
    - a. Inspect and test valve springs for squareness, pressure, and free height comparison; replace as needed. P-2
    - b. Inspect valve spring retainers, locks, and valve grooves. P-2
    - c. Inspect valve guides for wear; check valve guide height and stem-to-guide clearance; recondition or replace as needed. P-2
    - d. Inspect valves; resurface or replace. P-3
    - e. Inspect valve seats; resurface or replace. P-3

- f. Inspect pushrods, rocker arms, rocker arm pivots and shafts for wear, bending, cracks, looseness, and blocked oil passages (orifices); repair or replace. P-2
- g. Inspect hydraulic or mechanical lifters; replace as needed. P-2
- h. Inspect and replace camshaft drives (including gear wear and backlash, sprocket and chain wear, overhead cam drive sprockets, drive belts, belt tension, and tensioners). P-2
- I. Inspect camshaft for runout; measure journals and lobes for wear. P-3
- j. Inspect and measure camshaft bearings for wear, damage, out-of-round, and alignment; determine needed repairs. P-3

#### IV. CONTENT:

- A. Automotive Engines
  - 1. Purpose and locations of engines
  - 2. Engine types
  - 3. Spark ignition and compression ignition
  - 4. Basic engine systems
  - 5. Fuel system
  - 6. Ignition system
  - 7. Lubricating system
  - 8. Cooling system
  - 9. Other engine systems
- B. Piston engine operation
  - 1. Internal combustion engines
  - 2. Piston engine construction
  - 3. Pistons and piston rings
  - 4. Reciprocating to rotary motion
  - 5. Engine valves
  - 6. Engine operation
  - 7. Intake stroke
  - 8. Compression stroke
  - 9. Power stroke
  - 10. Exhaust stroke
  - 11. Operating the valves
  - 12. Pushrod valve train
  - 13. Multiple cylinder engines
  - 14. Flywheel and drive plate
- C. Engine Types and Classifications
  - 1. Engine classifications
  - 2. Number and arrangement of cylinders
  - 3. Three cylinder engines
  - 4. Four cylinder engines
  - 5. Five cylinder engines
  - 6. Six cylinder engines
  - 7. V-8 engines
  - 8. Variable displacement engines
  - 9. Twelve and sixteen cylinder engines
  - 10. Firing order
  - 11. Valve and valve-train arrangements
  - 12. Classification by cooling
  - 13. Classification by cycles
  - 14. Comparison of two cycle and four cycle engines

15. Classification by type of fuel
  16. Diesel engines
  17. Adiabatic engines
  18. Rotary engines
  19. Gas turbine engines
  20. Wankel engine
  21. Stratified Charge Engines
  22. Future Automotive Engines
- D. Engine construction: Cylinder blocks, heads, crankshafts, and bearings
1. Engine construction
  2. Cylinder block
  3. Machining the block
  4. Parts attached to an in-line block
  5. Parts attached to a v-type block
  6. Aluminum cylinder blocks
  7. Sleeveless aluminum cylinder blocks
  8. Air cooled engine construction
  9. Oil pan
  10. Gaskets
  11. Formed in place gaskets
  12. RTV silicone rubber sealants
  13. Anaerobic sealant
  14. Cylinder head
  15. Swirl type combustion chambers
  16. Diesel engine cylinder head
  17. Head gaskets
  18. Exhaust manifold
  19. Intake manifold
  20. Crankshaft
  21. Vibration damper
  22. Engine bearings
  23. Thrust bearing
  24. Bearing lubrication
  25. Bearing oil clearances
  26. Bearing requirements
  27. Engine mounts
- E. Engine Construction: Pistons and Piston Rings
1. Connecting rod
  2. Lubricating piston pins
  3. Purpose of pistons
  4. Piston rings
  5. Compression rings
  6. Ring shapes
  7. Ring coatings
  8. Intermediate compression rings
  9. Oil control rings
  10. Effect of speed on oil control
  11. Effect of engine wear on oil control
  12. Oil consumption
  13. Replacement rings
  14. Piston construction
  15. Piston shapes
  16. Piston clearance
  17. Expansion control in pistons
  18. Piston head shapes
  19. Piston pin offset

- 20. Ring groove fortification
- 21. High performance pistons
- 22. Low friction pistons
- F. Engine Construction: Valves and Valve Trains
  - 1. Purpose of valves
  - 2. Operation of valve train
  - 3. Driving the camshaft
  - 4. Valves
  - 5. Valve design
  - 6. Valve cooling
  - 7. Valve seats
  - 8. Valve and seat angles
  - 9. Valve spring attachment
  - 10. Valve stem oil seals
  - 11. Rocker arms
  - 12. Valve rotation
  - 13. Free type valve rotator
  - 14. Positive valve rotator
  - 15. Valve lifters
  - 16. Roller tappets
  - 17. Hydraulic valve lifters
  - 18. Valve timing
  - 19. Variable intake valve timing
  - 20. High-performance camshafts
- G. Engine Cooling Systems
  - 1. Purpose of engine cooling system
  - 2. Cold engine operation
  - 3. Liquid cooled engines
  - 4. Water jackets
  - 5. Water pump
  - 6. Engine fan
  - 7. Variable speed fan
  - 8. Flexible blade fan
  - 9. Drive belts
  - 10. Electric fan
  - 11. Radiator
  - 12. Expansion tank
  - 13. Radiator pressure cap
  - 14. Thermostat
  - 15. Car heater
  - 16. Transmission fluid cooler
  - 17. Antifreeze
  - 18. Air cooled engines
  - 19. Temperature indicators
  - 20. Cooling system troubles
- H. Engine Lubricating Systems
  - 1. Purpose of lubricating system
  - 2. Purpose of lubricating oil
  - 3. Properties of engine lubricating oil
  - 4. Oil contaminants and sludge formation
  - 5. Service ratings of oil
  - 6. Oil pumps
  - 7. Relief valve
  - 8. Engine oil cooler
  - 9. Oil filter
  - 10. Oil pressure indicators
  - 11. Oil level indicators

12. Lubricating system service
13. Changing oil and oil filter
- I. Engine Trouble Diagnosis
  1. Need for logical procedure
  2. Engine trouble diagnosis chart
  3. Engine will not crank
  4. Engine cranks slowly but will not start
  5. Engine cranks at normal speed but will not start
  6. Engine runs but misses
  7. Engine is sluggish, stumbles, lacks power, acceleration, or high speed performance
  8. Engine overheats
  9. Engine idles roughly
  10. Engine stalls
  11. Engine backfires
  12. Engine run-on, or dieseling
  13. High levels of HC and CO in exhaust gas
  14. Excessive oil consumption
  15. Low oil pressure
  16. Excessive fuel consumption
  17. Engine noises
- J. Engine Service: Valves and Valve Trains
  1. Cleanliness
  2. Valve service
  3. Valve troubles
  4. Valve trouble diagnosis chart
  5. Valve sticking
  6. Cleaning valve stems with chemical cleaner
  7. Valve burning
  8. Valve breakage
  9. Valve face wear
  10. Valve seat recession
  11. Valve deposits
  12. Valve lifter clearance
  13. Pushrod engine with mechanical valve lifters
  14. Free type valve rotators
  15. Pushrod engine with hydraulic valve lifters
  16. Ford pushrod engines with hydraulic valve lifters
  17. Plymouth pushrod engines with hydraulic valve lifters
  18. Chevrolet pushrod engines with hydraulic valve lifters
  19. Overhead camshaft-engine valve adjustments
  20. Jet valve adjustment
  21. Steps in complete valve job
  22. Removing, cleaning, and installing cylinder heads
  23. Rocker arm stud service
  24. Servicing rocker arm assemblies
  25. Pushrod service
  26. Valve removal
  27. Valve inspection
  28. Servicing valves
  29. Valve installation
  30. Valve guide service
  31. Valve seat service
  32. Valve spring inspection
  33. Installing valve stem seals and shields
  34. Camshaft service
  35. Servicing valve lifters

36. Removing and installing intake manifolds
- K. Engine Service: Connecting Rods, Rod Bearings, Pistons, and Rings
  1. Types of engine service jobs
  2. Preparing to remove rods
  3. Removing ring ridge
  4. Removing and installing oil pan
  5. Removing piston and rod assemblies
  6. Separating rods from pistons
  7. Checking connecting rods
  8. Checking piston pin bushings in rods
  9. Attaching rods to pistons
  10. Checking connecting rod bearing condition
  11. Analysis of bearing failures
  12. Installing connecting rod bearings
  13. Checking connecting rod bearing clearance
  14. Checking connecting rod side clearance
  15. Piston service
  16. Piston cleaning
  17. Piston inspection
  18. Ring groove repair
  19. Selecting new pistons
  20. Fitting piston pins in pistons
  21. Checking rod and piston alignment
  22. Selecting new piston rings
  23. Installing piston rings
  24. Cautions on installing piston rings
  25. Installing piston and rod assemblies
- L. Engine Service: Crankshafts and Cylinder Blocks
  1. Servicing crankshafts and cylinder blocks
  2. Servicing engine mounts
  3. Removing the engine
  4. Crankshaft and bearing service
  5. Removing main bearing caps
  6. Checking crankshaft journals
  7. Inspecting main bearings
  8. Measuring main bearing clearance
  9. Measuring crankshaft end play
  10. Installing main bearings
  11. Replacing rear main bearing oil seal
  12. Removing the crankshaft
  13. Inspecting and cleaning crankshaft
  14. Grinding crankshafts
  15. Cleaning and inspecting cylinder blocks
  16. Checking bearing bores
  17. Line boring bearing bores
  18. Inspecting cylinder walls
  19. Refinishing cylinders
  20. Cleaning cylinders
  21. Installing cylinder sleeves
  22. Repairing cylinder block cracks or porosity
  23. Replacing expansion core plugs
  24. Installing thread inserts
  25. Engine short block

- V. METHODS OF INSTRUCTION:  
The methods of instruction will include; classroom lecture,

classroom discussion, video presentations, filmstrips, and overhead projector presentations.

VI. TYPICAL ASSIGNMENTS:

- A. Read assigned chapters and answer questions at the end of each chapter.  
Typical Questions:
  - 1. Explain the four-stroke cycle operation of a gasoline engine.
  - 2. Explain the difference oil additives and their use.
- B. Reports on a selected automotive engine.
- C. Research paper on the operation of variable valve timing systems.
- 4. Students will demonstrate college level writing competency by writing a comprehensive report on a selected engine component.

VII. EVALUATION:

- A. Methods of Evaluation:
  - 1. Oral and written tests
  - 2. Graded reports
  - 3. Comprehensive written final examTypical Questions:
  - a. Explain the four-cycles of the rotary engine.
  - b. Explain the purpose of hydraulic valve lifters.
- B. Frequency of Evaluation:
  - 1. Minimum of four (4) tests
  - 2. Minimum of two (2) written reports
  - 3. One (1) final examination

VIII. TYPICAL TEXT(s):

Title:	Automotive Engines
Author:	Crouse & Anglin
Publisher:	McGraw Hill
Date of Publication:	1996

IX. OTHER SUPPLIES REQUIRED OF STUDENTS:

- 1. Notebook
- 2. Safety glasses