AUT 116 (A1)
ENGINE REPAIR

COURSE DESCRIPTION:

Prerequisites: None
Corequisites: None

This course covers the theory, construction, inspection, diagnosis, and repair of internal combustion engines and related systems. Topics include fundamental operating principles of engines and diagnosis, inspection, adjustment, and repair of automotive engines using appropriate service information. Upon completion, students should be able to perform basic diagnosis, measurement and repair of automotive engines using appropriate tools, equipment, procedures, and service information. Course Hours per Week: Class, 2; Lab, 3. Semester Hours Credit, 3.

SAFETY DISCLAIMER:

Automotive work presents many hazards. A moment's carelessness can cause injury to oneself or to others. Such mishaps can occur quickly due, in part, to the nature of the industrial tools used in automotive work. The weight of automobiles and the equipment used to fix them can even cause fatal injuries. Therefore, great care must always be taken in checking out equipment before use, and in using that equipment to work on automobiles.

As we work to insure the safety of everyone in the DTCC automotive lab, it is the instructor's responsibility to introduce students to equipment and to advise them on its safe operation. Those health and safety procedures are also presented in each textbook for each course in the automotive program. **Students are responsible for mastery of that safety information.** DTCC holds each student in every class responsible for reading and applying all of the information regarding personal and public safety and personal and public health in the required text.

While working in the DTCC automotive lab, safety glasses must be worn by everyone. However, safety glasses are only one small requirement so that students remain injury free. All safety recommendations in the text book and from the instructor must be followed. A student with any questions about a safety procedure should immediately ask an instructor for clarification.

Any student using equipment in the automotive lab must be responsible for using that equipment in a safe manner. Durham Technical Community College holds each student in automotive classes responsible for acting to ensure a safe environment and to ensure both the student's own safety and the safety of his classmates.

LEARNING OUTCOMES:

a. Analyze engine noise and determine needed repairs.
b. Diagnose excess oil consumption and unusual exhaust color.
c. Remove and inspect cylinder head condition. .
d. Inspect and replace camshaft timing mechanism.
e. Measure and analyze camshaft journal and lobes.
f. Inspect engine block for cracks, warpage, passage, and gallery plug condition.
g. Inspect and repair damaged threads.
h. Inspect and measure cylinder walls for damage and wear.
i. Inspect and repair oil and coolant leaks.
j. Inspect/measure main and rod bearing clearance and select proper bearings.
k. Inspect, measure, or replace piston rod assembly.
l. Inspect, measure, and install piston rings. .
m. Reassemble engine parts.
n. Torque assembled engine parts to specifications.
o. Use correct gaskets and sealants.
p. Inspect/service engine lubrication system

OUTLINE OF INSTRUCTION:

I. Introduction to Engines
- A Engine Construction
- B Engine Classifications
- C Design Features
  1) Operational Cycles
  2) Number of Cylinders
  3) Cylinder Arrangement
  4) Valve Train Type
  5) Ignition type
  6) Cooling System
  7) Fuel Type

II. Automotive engine designs and diagnosis
- A Four-Stroke Gasoline Engine
  1) Intake Stroke
  2) Compression Stroke
  3) Power Stroke
  4) Exhaust Stroke
- B Two-Stroke Gasoline Engine
- C Characteristics of Four-Stroke Engine Design
  1) In-Line Engine
  2) V-Type and W-Type Engines
  3) Slant Cylinder Engine
  4) Opposed Cylinder Engine

D Valve and Camshaft Placement Configurations
1) Overhead Valve (OHV)
2) Overhead Cam (OHC)
E Valve and Camshaft Operation
F Engine Location
1) Front Engine Longitudinal
2) Front Engine Transverse
3) Mid-Engine Transverse
G Preliminary Engine Diagnosis
1) Engine vacuum
2) Cylinder power balance
3) Perform cranking compression test determine necessary action
4) Perform cylinder leakage test determine necessary action
5) Diagnose the cause of excessive oil consumption, unusual engine exhaust color, odor, and sound, determine necessary
6) Test cooling system for leaks and proper operation
H Noise Diagnosis
1) Using a Stethoscope
2) Common Noises
3) Ring Noise
4) Piston Sla
5) Piston Pin Knock
6) Ridge Noise
7) Rod-Bearing Noise
8) Main or Thrust Bearing Noise
9) Tappet Noise
10) Abnormal Combustion Noises

III. Other Engine Designs
A Diesel Engine
B Rotary Engine
C Stratified Charge Engine
D Miller-Cycle Engines
E Hybrid Vehicles

IV. Lubrication
A Oil types
1) ISLAC Oil Ratings
2) Synthetic Oils
B Oil Consumption

V. Lubricating Systems
A Oil Pump
B Oil Pump Pickup
C Oil Pan or Sump
D Pressure Relief Valve
E Oil Filter
F Engine Oil Passages or Galleries

G Engine Bearings/Clearance
H Oil Pressure Indicator
I Oil Seals and Gaskets
J Dipstick

VI. Oil Pump
A Types of Oil Pumps
1) Rotor-type
2) Gear-type
B Pressure Regulation
C Oil Pump Inspection and Service
D Installing the Oil Pump

VII. Lubrication System Servicing
A Perform oil and filter change

VIII. Cooling Systems
A Coolant
1) Types (manufacturer specific)
2) Chemical Treatments
B Thermostat
1) Effects on Drivability
C Water Pump
1) Coolant flow
2) Drive system
3) Hoses
a. Water Outlet
b. Water Jackets
4) Hose Clamps
D Radiator
1) Types
2) Oil Cooler
E Radiator Pressure Cap
1) Expansion Tank
F Cooling Fans
1) Electric Cooling Fans
2) Mechanical
3) Hydraulic
G Temperature Indicators
1) Temperature Sensors
H Heater System

IX. Cooling System Servicing
A Coolant Condition
B Testing the Cooling System for Leaks
C Repairing Radiators
D Testing the Radiator Pressure Cap
E Testing the Thermostat

F Checking and Replacing Hoses
G Water Pump Service
1) Replacing the Water Pump
H Checking Fans and Fan Clutches

I Checking Belts
1) Belt Replacement
2) Belt Tension
J Coolant Recovery and Recycle System
K Flushing Cooling Systems
L Refilling and Bleeding

X. Removing an Engine
A FWD Vehicles
1) Removing the Engine through the Hood Opening
2) Removing the Engine from Under the Vehicle
B RWD Vehicles

XI. Engine Disassembly and Inspection
A Cylinder Head Removal
B Cylinder Head Disassembly
C Cylinder Block Disassembly

XII. Cleaning Engine Parts
A Types of Soil Contaminants
1) Water-Soluble Soils
2) Organic Soils
a. Petroleum By-Products
b. By-Products of Combustion
c. Coatings
3) Rust
4) Scale
B Cleaning with Chemicals
1) Chemical Cleaning Machines
a. Parts Washers
b. Soak Tanks
c. Hot Spray Tanks
C Thermal Cleaning
D Abrasive Cleaners
1) Abrasive Cleaning Methods
a. Abrasive Blaster
b. Parts Tumbler
c. Vibratory Cleaning
d. Cleaning by Hand
E Alternative Cleaning Methods
1) Ultrasonic Cleaning
2) Citrus Chemicals
3) Salt Bath

XIII. Crack Detection and Repair
- A Furnace Welding Crack Repairs
- B Repairing Aluminum Heads
  - 1) Cracks between the Valve Seat Rings
  - 2) Cracks Coming from the Coolant Passages
  - 3) Cracks across the Main Oil Galley
  - 4) Detonation Damage
  - 5) Meltdown Damage
  - 6) Coolant-related Metal Erosion

XIV. Cylinder Block
- A Lubrication and Cooling
- B Core Plugs
- C Cylinder Sleeves

XV. Cylinder Block Reconditioning
- A Deck Flatness
- B Cylinder Walls
- C Cylinder Bore Inspection
  - 1) Taper
  - 2) Out-of-Roundness
- D Cylinder Bore Surface Finish
  - 1) Cylinder Deglazing
  - 2) Cylinder Boring
  - 3) Cylinder Honing
- E Lifter Bores
- F Checking Crankshaft Saddle Alignment
- G Installing Core Plugs
  - 1) Disc- or Dished-Type
  - 2) Cup-Type
  - 3) Expansion-Type

XVI. Camshaft
- A Timing Mechanisms
  - 1) Gear Drive
  - 2) Chain Drive
  - 3) Belt Drive
- B Valve Lifters
  - 1) Operation of Hydraulic Valve Lifters
- C Camshaft Bearings
- D Balance Shafts

XVII. Inspection of Camshaft and Related Parts
- A Timing Components
- B Lifters
- C Camshaft

XVIII. Installing the Camshaft and Related Parts
- A Camshaft Bearings
- B Camshaft

XIX. Crankshaft
- A Vibration Damper
- B Flywheel and cast crankshafts

XX. Crankshaft Inspection and Rebuilding
- A Crankshaft Reconditioning
- B Checking Crankshaft Straightness
- C Flywheel Inspection
- D Crankshaft Bearings
- E Bearing Materials
- F Bearing Spread
- G Bearing Crush
- H Bearing Locating Devices
- I Oil Grooves
- J Oil Holes
- K Oil Clearance
- L Bearing Failure and Inspection

XXI. Installing Main Bearings and Crankshaft
- A Crankshaft Endplay
- B Connecting Rod

XXII. Piston and Piston Rings
- A Pistons
  1) Head or Dome
  2) Rings Lands
  3) Piston Pin
- B Piston Rings
  1) Compression Rings
  2) Oil Control Rings

XXIII. Installing Pistons and Connecting Rods

XXIV. Crankshaft and Camshaft Timing
- A Camshaft end Play
- B Lifters

XXV. Combustion Chamber
- A Wedge Chamber
- B Hemispherical Chamber

XXVI. Intake and Exhaust Valves
- A Poppet Design
- B Valve Face
- C Margin

D Important Valve Components of Four-Stroke Engines
1) Valve Guides
2) Valve Springs, Retainers, and Seals
3) Valve Rotators
4) Camshaft Bearings
5) Pushrods
6) Pushrod Guide Plates
7) Rocker Arms

E Multivalve Engines

F Variable Valve Timing
1) Valvetronic System

XXVII. Inspection of Cylinder Head and Valve Train
A Timing Components
B Rocker Arms
C Pushrods
D Cam Followers and Lash Adjusters
E Retainers and Keepers
F Valve Rotators
G Valve Springs
H Cylinder Heads
I Camshaft and Bearings
J Valves

XXVIII. Aluminum Cylinder Heads
A Reconditioning Aluminum Cylinder Heads

XXIX. Resurfacing Cylinder Heads
A Surface Finish
1) Resurfacing Machines
a. Belt Surfacers
b. Milling Machines
c. Broaching Machines
d. Surface Grinders
2) Stock Removal Guidelines
a. Combustion Chamber
b. Compression Ratio
c. Piston/Valve Interference and Misalignment

XXX. Grinding Valves

XXXI. Valve Guide Reconditioning
A Knurling
B Reaming and Oversized Valves
C Thin-Wall Guide Liners
D Valve Guide Replacement
1) Integral Guides
2) Insert Guides

XXXII. Reconditioning Valve Seats
- A Installing Valve Seat Inserts
- B Reconditioning Integral Seats
- C Grinding Valve Seats
- D Cutting Valve Seats
- E Machining Valve Seats

XXXIII. Valve Stem Seals
- A Installing Positive Valve Seals
- B Installing Umbrella-Type Valve Seals
- C Installing O-Rings
- D Valve Springs
  1) Freestanding Height Test
  2) Spring Squareness Test
  3) Open/Close Spring Pressure Test

XXXIV. Assembling the Cylinder Head
- A Torque Principles
  1) Elasticity
  2) Torque-to-yield (T-T-Y)
  3) Thread Repair
- B Gaskets
  1) Gasket Materials
  2) General Gasket Installation Procedures
  3) Cylinder Head Gaskets
- C. Bimetal Engine Requirements
  1) Manifold Gaskets
  2) Valve Cover Gaskets
  3) Oil Pan Gaskets

XXXV. Engine sealing and reassembly
- A Adhesives, Sealants, and Other Chemical Sealing Materials
  1) Adhesives
  2) Sealants
     a. General-Purpose Sealants
     b. Flexible Sealants
     c. Silicone Formed-in-Place Sealants
     d. Anaerobic Formed-in-Place Sealants
- B Antiseize Compounds
- C Oil Seals
  1) Timing Cover Oil Seals
  2) Rear Main Bearing Oil Seals
  3) Other Seals

XXXVI. Engine Reassembly
- A Installing the Cylinder Head and Valve Train
  1) Torque Angle Gauge
- B Timing Belts

C Adjusting Valves
D Final Reassembly Steps
1) Install the Timing Cover
2) Install the Vibration Damper
3) Install the Valve Cover
4) Install Oil Pan
5) Install Intake Manifold
6) Pre-lubrication
7) Install the Thermostat and Water Outlet Housing
8) Install Exhaust Manifold
9) Install Flywheel or Flex Plate
10) Install Clutch Parts
11) Install Torque Converter
12) Install Motor Mounts

XXXVII. Installing the Engine
A Installing the Engine into a FWD Vehicle
B Installing an Engine in a RWD Vehicle
C Starting Procedure
D Break-In Procedure
E Relearn Procedures

XXXVIII. Emerging Engine Technologies

REQUIRED TEXTBOOKS AND MATERIALS:

To be announced by Instructor.

NATEF

This course fulfills 80 of the 120 hours required by **NATEF** for A1. See COE 111.