Automotive Technology 5th Edition
Chapter 18 Gasoline Engine Operation, Parts, & Specifications
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 5th text provides complete coverage of automotive components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and NATEF and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Real World Fixes, Videos, Animations, and NATEF Task Sheet references.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain the chapter learning objectives to the students as listed: 1. Discuss engine construction and energy and power of an engine. 2. Explain engine parts and systems. 3. Explain four-stroke cycle operation. 4. Discuss engine classification and construction. 5. Explain engine bore and stroke measurements. 6. Discuss compression ratio, torque, and horsepower.
Establish the Mood or Climate	Provide a ***WELCOME,*** Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

NOTE: This lesson plan is based on the 5th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 18: ATE5 Chapter Images

ICONS	CH18 GASOLINE ENGINE OPERATION

1. **SLIDE 1 CH18 GASOLINE ENGINE OPERATION, PARTS, & SPECIFICATIONS**

Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/

WEB SITE IS CONSTANTLY UPDATED

Gasoline Engine Videos

2. **SLIDE 2 EXPLAIN FIGURE 18-1** SHOWS rotating assembly for a V-8 engine that has eight pistons and connecting rods and one crankshaft
3. **SLIDE 3 EXPLAIN FIGURE 18-2** head with 4 valves per cylinder, 2 intake valves (larger) & 2 exhaust valves (smaller).
4. **SLIDE 4 EXPLAIN FIGURE 18-3 C**oolant temperature is controlled by thermostat, which opens & allows coolant to flow to radiator when temperature reaches rating temperature of the thermostat.
5. **SLIDE 5 EXPLAIN FIGURE 18-4** typical lubrication system, showing the oil pan, oil pump, oil filter, and oil passages.
6. **SLIDE 6 EXPLAIN FIGURE 18-5** downward movement of piston draws air-fuel mixture into cylinder through the intake valve on intake stroke. On compression stroke, mixture is compressed by upward movement of piston with both valves closed. Ignition occurs at beginning of power stroke, and combustion drives piston downward to produce power. On exhaust stroke, upward-moving piston forces burned gases out open exhaust valve.

Show 4-STROKE CYCLE ANIMATION:
4-Stroke Cycle (View) (Download)

7. **SLIDE 7 EXPLAIN Figure 18-6** Cutaway of an engine showing cylinder, piston, connecting rod, and crankshaft

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	DISCUSSION 4-STROKE CYCLE: Ask students to explain the four-stroke cycle operation
	Many newer engines are using GASOILINE direct injection due to its approximately 10% efficiency increase
INTAKE STROKE	**INTAKE STROKE:** starts with piston at top dead center (TDC). Lobe on camshaft opens intake valve Piston moves down in bore due to crankshaft rotation. As piston moves down, it pulls outside air through air cleaner and into the intake manifold past open intake valve and into cylinder. Downward movement of piston creates a low-pressure area above piston (volume increases, pressure decreases). Air rushes in to fill space left by PISTON downward movement, because atmospheric pressure is greater than pressure in cylinder. Piston tries to inhale a volume equal to its own displacement. Fuel-air mixture is homogeneous. During intake stroke, an air-fuel ratio is inducted. Throttle controls air mass that enters cylinder. Energy needed to move piston from TDC downward comes from either flywheel or overlapping power strokes. As piston nears BDC it slows down nearly to a stop. When piston reaches BDC, intake valve closes sealing cylinder & compression stroke begins.
COMPRESSION STROKE The internal energy of gas is increased as heat is added to gas. Near end of compression stroke, a spark plug will ignite	**COMPRESSION STROKE:** Turning crankshaft now forces piston upward. Both valves are closed; there is no way (except past rings) for air to get out. Volume is decreasing as piston rises, so air-fuel gas mixture is compressed. Pressure is inversely proportional to volume according to Boyle's law. In compression of a gas, volume decreases & pressure and temperature rise as external work is done on gas. Compression ratio is ratio of volume at BDC to volume at TDC (clearance volume). Higher compression ratio means higher thermal efficiency or that portion of heat supplied

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the mixture	to engine that is turned into work. As compression ratio increases, expansion ratio also increases; thus, thermal efficiency increases.
VOLUME BDC VOLUME TDC	**COMPRESSION RATIO**
POWER STROKE	**COMBUSTION (POWER STROKE):** The power stroke begins shortly after fuel-air gas mixture is ignited by spark plug. The high pressures in cylinder push down on the piston. This pressure forces the piston down in the bore, which causes crankshaft to rotate (translation to rotation). Pressure falls as volume increases. Temperature falls, as gas does external work. Arc ignites air-fuel mixture in combustion chamber & fuel (reactant) burns supported by Oxygen. Nitrogen expands and pushes piston down during power stroke. As piston continues downward, these gases in cylinder expand and cool as they give up their energy. Power stroke is only stroke in which energy is used from fuel & cylinder pressure is highest.
EXHAUST STROKE	**EXHAUST STROKE:** As piston nears bottom of its travel, exhaust valve begins to open. Piston begins to rise in cylinder, beginning exhaust stroke. Upward movement of piston forces spent gases past exhaust valve & out of cylinder. As piston nears top of its movement, camshaft lobe again opens intake valve & cycle repeats itself. Exhaust valve is allowed to close, by spring pressure, shortly after piston begins-its downward movement. This is a stroke that produces no work but expends a quantity of energy to push exhaust gases from cylinder. In a spark-ignited gasoline-fueled engine, we have *flame speed*, which is nearly proportional or increases when engine speed increases. Therefore, number of crank angles occupied by combustion process is nearly independent of RPM.

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7. **SLIDE 7 EXPLAIN FIGURE 18-8** Automotive engine cylinder arrangements.
8. **SLIDE 8 EXPLAIN FIGURE 18-9** horizontally opposed engine design helps to lower vehicle's center of gravity.
9. **SLIDE 9 EXPLAIN FIGURE 18-10** longitudinally mounted engine drives the rear wheels through a transmission, driveshaft, and differential assembly.
10. **SLIDE 10 EXPLAIN FIGURE 18-11** Two types of front-engine, front-wheel drive mountings.

DISCUSSION: Ask the students to discuss why an 8-cylinder engine will operate more smoothly than a 4-cylinder engine.

DEMONSTRATION: Show students the difference between a longitudinal & transverse engine.

DISCUSSION: Ask the students what is drawn into the cylinder in a typical non-direct fuel injection engine. (Answer: Fuel and air.)

DISCUSSION: Ask the students to discuss the difference between a naturally aspirated (NA) engine and a supercharged or turbocharged engine.

Most internal combustion engines achieve only about 20% efficiency.

Most manufacturers do not allow fuels with methanol to be used in their vehicles. Some OEMS allow a small percentage (no more than 5%).

11. **SLIDE 11 EXPLAIN FIGURE 18-12** Cutaway of an overhead valve (OHV) V-8 engine showing the lifters, pushrods, roller rocker arms, and valves
12. **SLIDE 12 EXPLAIN FIGURE 18-13** SOHC engines usually require additional components, such as a rocker arm, to operate all of the valves. DOHC engines often operate the valves directly.

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	13. **SLIDE 13 EXPLAIN FIGURE 18-14** DOHC engine uses a camshaft for the intake valve and a separate camshaft for the exhaust valves in each cylinder head 14. **SLIDE 14 EXPLAIN FIGURE 18-15** supercharger on a Ford V-8. 15. **SLIDE 15 EXPLAIN FIGURE 18-16 turbine wheel is turned by the expanding exhaust gases** 16. **SLIDE 16 EXPLAIN FIGURE 18-17** A rotary engine operates on the four-stroke cycle but uses a rotor instead of a piston and crankshaft to achieve intake, compression, power, and exhaust stroke
	**Show ROTARY ENGINE OP ANIMATION** **Rotary Engine (View) (Download)**
	17. **SLIDE 17 EXPLAIN FIGURE 18-18** The bore and stroke of pistons are used to calculate an engine's displacement 18. **SLIDE 18 EXPLAIN FIGURE 18-19** The distance between the centerline of the main bearing journal and the centerline of the connecting rod journal determines the stroke of the engine. This photo is a little unusual because it shows a V-6 with a splayed crankshaft used to even out the impulses on a 90-degree, V-6 engine design.
	**DEMONSTRATION: Show the students how to determine bore & stroke of an engine using service information.**
	**HANDS-ON TASK: Have students look up engine displacement using service information for SEVERAL LAB vehicles. Since all specs are now metric, have the students calculate equivalent size in cubic inches.**
	**DEMONSTRATION CID:Show the students how to calculate the cubic inch displacement of an engine given bore & stroke.**
	19. **SLIDE 19 EXPLAIN FIGURE 18-20** Compression ratio is the ratio of the total cylinder volume (when the piston is at the bottom of its stroke) to the clearance volume (when the piston is at the top of its stroke).

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	DISCUSSION: **Ask the students how a build-up of carbon on top of the pistons would affect compression ratio. (Answer: It would increase compression ratio.)**
	Modern gasoline engines have a compression ratio of 8 to 10:1, diesel engines have a compression ratio of 20 to 22:1.
	20. **SLIDE 20 EXPLAIN FIGURE 18-21** Torque is a twisting force equal to the distance from the pivot point times the force applied expressed in units called pound-feet (lb-ft) or Newton-meters (N-m).
	DEMONSTRATION: **Show the students examples of various torque wrenches and demonstrate their proper use.**
	HANDS-ON TASK: **Have the students look up the torque specs for various engine fasteners.**
	ON-VEHICLE NATEF TASK A1A4: **Gasoline Engine Identification (A1-A-4) PAGE 39** **General Engine Specifications (A1-A-4) PAGE 40**
	HANDS-ON TASK: **SEARCH INTERNET to find out difference between a four-stroke engine and two-stroke engine.**
	HOMEWORK **CROSSWORD PUZZLE (MICROSOFT WORD) (PDF)** **WORD SEARCH PUZZLE (MICROSOFT WORD) (PDF**

Crossword