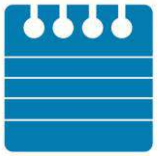
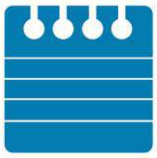
Advanced Engine Performance Diagnosis 6/E
Chapter 2 Engine Systems
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class provides complete coverage of the 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. Prepare for ASE Engine Performance (A8) certification test content area "A" (General Diagnosis). 2. Explain how a four-stroke cycle gasoline engine operates. 3. List the engine systems. 4. Define torque and horsepower. 5. Explain the purpose and function of superchargers and turbochargers.
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 Advanced Engine Performance Diagnosis 6/E Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 02: Chapter Images

ICONS	CH2 ENGINE SYSTEMS
	**1. SLIDE 1 CH2 ENGINE SYSTEMS**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **Gasoline Engine Videos**
	**At the beginning of this class, you can download the crossword puzzle & Word Search from the links below to familiarize your class with the terms in this chapter & then discuss them** **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF)**
	
	**2. SLIDE 2 EXPLAIN FIGURE 2-1** SHOWS rotating assembly for a V-8 engine that has eight pistons and connecting rods and one crankshaft **3. SLIDE 3 EXPLAIN FIGURE 2-2** head with 4 valves per cylinder, 2 intake valves (larger) & 2 exhaust valves (smaller).
	**4. SLIDE 4 EXPLAIN FIGURE 2-3 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 2-4** typical lubrication system, showing the oil pan, oil pump, oil filter, and oil passages.
	**6. SLIDE 6 EXPLAIN FIGURE 2-5** 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.

ICONS	CH2 ENGINE SYSTEMS
      **INTAKE STROKE**	**Show 4-STROKE CYCLE ANIMATION:** **4-Stroke Cycle (View) (Download)** 7. **SLIDE 7 EXPLAIN Figure 2-6** A pressure–volume diagram showing where additional work is generated by the delayed closing of the intake valve. Point "S" is where the spark occurs **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** **DISCUSS FREQUENTLY ASKED QUESTION** **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.**

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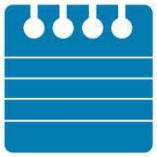
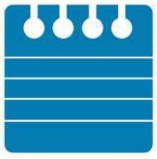
 **COMPRESSION STROKE** **The internal energy of gas is increased as heat is added to gas. Near end of compression stroke, a spark plug will ignite the mixture**	**COMPRESSION STROKE: Turning crankshaft now forces piston upward. Both valves are closed; there is no way (except past rings) for air to get 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 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,**

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	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.
	**8. SLIDE 8 EXPLAIN FIGURE 2-7** bore and stroke of pistons are used to calculate an engine's displacement.
	**DISCUSSION: Ask the students to discuss why an 8-cylinder engine will operate more smoothly than a 4-cylinder engine.**
	**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.**
	**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.**

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	**DEMONSTRATION CID:Show the students how to calculate the cubic inch displacement of an engine given bore & stroke.**
	9. **SLIDE 9 EXPLAIN FIGURE 2-8** distance between the centerline of the main bearing journal and the centerline of the connecting rod journal determines stroke of engine
	**DISCUSS FREQUENTLY ASKED QUESTION**
	10. **SLIDE 10 EXPLAIN FIGURE 2-9** Torque is twisting force equal to distance from pivot point times 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.**
	11. **SLIDE 11 EXPLAIN FIGURE 2-10** more air and fuel that can be packed in a cylinder, the greater the density of the air–fuel charge. 12. **SLIDE 12 EXPLAIN FIGURE 2-11** bypass actuator opens the bypass valve to control boost pressure. 13. **SLIDE 13 EXPLAIN FIGURE 2-12** turbocharger uses some of the heat energy that would normally be wasted.
	14. **SLIDE 14 EXPLAIN FIGURE 2-13** A turbine wheel is turned by the expanding exhaust gases 15. **SLIDE 15 EXPLAIN FIGURE 2-14** exhaust drives the turbine wheel on the left, which is connected to the impeller wheel on the right through a shaft
	**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.**