Automotive Technology 5th Edition
Chapter 69 Ignition System Components & Operation
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 learning objectives to students as listed below: 1. Explain how the ignition system and ignition coils work. 2. Discuss crankshaft position sensor and pickup coil operation. 3. Describe the operation of distributor ignition. 4. Describe the operation of waste-spark and coil-on-plug ignition systems. 5. Discuss knock sensors and ignition control circuits.
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 69: ATE5 Chapter Images

ICONS	Ch69 Ignition System Operation

1. **SLIDE 1 CH69 IGNITION SYSTEM COMPONENTS & OPERATION**
2. **SLIDE 2 EXPLAIN Figure 69-1** point-type distributor from a hot rod being tested on a distributor machine.

Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/
WEB SITE IS CONSTANTLY UPDATED

Videos

DEMONSTRATION: Show a point-type distributor. Review its major components & SHOW HOW TO SET AIR GAP. Show major components of a distributor ignition system.

HANDS-ON TASK: Pass around the point-type distributor & have students SET AIR GAP

3. **SLIDE 3 EXPLAIN Figure 69-2** primary ignition system is used to trigger and therefore create the secondary (high-voltage) spark from ignition coil. Some ignition coils are electrically connected, called married (top figure) whereas others use separated primary and secondary windings, called divorced (lower figure)

DISCUSSION: Have the students talk about the primary & secondary ignition circuits. How do the 2 circuits function independently and how do they interact? FIGURE 69-2

4. **SLIDE 4 EXPLAIN Figure 69-3** steel laminations used in an E coil helps increase the magnetic field strength, which helps the coil produce higher energy output for a more complete combustion in the cylinders.
5. **SLIDE 5 EXPLAIN Figure 69-4** primary windings are inside secondary windings on this General Motors coil.
6. **SLIDE 6 EXPLAIN Figure 69-5** primary ignition system is used to trigger and therefore create the secondary (high-voltage) spark from the ignition coil.

ICONS	Ch69 Ignition System Operation
	DISCUSSION: Have the students talk about **ignition coil operation**. What process does an ignition use to produce a high-voltage spark from an ignition coil?
	DISCUSSION: Have the students discuss the construction of an ignition coil. What is at the core of an ignition coil? What is the purpose of core? **FIGURES 69-3. 4, & 5**
	HANDS-ON TASK: Have students **disassemble old coils**. Have them identify internal components and point out electrical connections. **OPTION:** students draw or describe the primary and secondary circuits. **Refer to Figures 69–3, 69–4, and 69–5 as needed.**
	DEMONSTRATION: Review with students how to use a **hand-held oscilloscope (GMM)**, including setup and interpreting waveform patterns. Then show them how to check pickup on an electronic ignition system using an **oscilloscope: DEMO SNAP-ON MODUS HERE**
	SNAP-ON MODIS uses advanced OBD II diagnostic capabilities including Domestic and Asian Import Vehicle Communication Software, plus Fast-Track Troubleshooter. Integrates experience-based information with scan tool instrumentation. 4-channel lab scope with multiple secondary ignition capabilities & Digital Graphing Multimeter (GMM) built into a common architecture with expandable ports. Fast-Track Component Tests combine MODIS scope & DMM with information from ASE-certified technicians
	DISCUSSION: Using an ignition system wiring diagram, have the students **locate triggering device**. How does this triggering device work?
	55. **SLIDE 55 EXPLAIN Figure 69-6** Operation of a typical pulse generator (pickup coil). At the bottom is a line drawing of a typical scope pattern of the output voltage of a pickup coil. The ICM receives this voltage from the pickup coil and opens the ground circuit to the ignition coil when the voltage starts down from its peak

ICONS	Ch69 Ignition System Operation

(just as the reluctor teeth start moving away from the pickup coil).

DEMONSTRATION: Using oscilloscope (MODUS), show waveform pattern of a pulse generator. Compare pattern with Figure 69–6

8. **SLIDE 8 EXPLAIN Figure 69-7** A magnetic sensor uses a permanent magnet surrounded by a coil of wire. The notches of the crankshaft (or camshaft) create a variable magnetic field strength around the coil. When a metallic section is close to the sensor, the magnetic field is stronger because metal is a better conductor of magnetic lines of force than air.
9. **SLIDE 9 EXPLAIN Figure 69-8** A Hall-effect sensor produces an on-off voltage signal whether it is used with a blade or a notched wheel.
10. **SLIDE 10 EXPLAIN Figure 69-9** Some Hall-effect sensors look like magnetic sensors. This Hall-effect camshaft reference sensor and crankshaft position sensor have an electronic circuit built in that creates a 0 to 5 volt signal as shown at the bottom. These Hall-effect sensors have three wires: a power supply (8 volts) from computer (controller), a signal (0 to 5 volts), and a signal ground.

DEMONSTRATION: Using an DSO show waveform patterns of magnetic sensor & Hall-effect sensor. Compare these scope patterns with FIGURES 69–7 and 69–8

DISCUSSION: discuss Hall Effect. How is Hall-effect switch different from magnetic pulse generator? FIGURES 69-7 & 8

11. **SLIDE 11 EXPLAIN Figure 69-10 (a)** Typical optical distributor.
12. **SLIDE 12 EXPLAIN Figure 69-10 (b)** Cylinder I slit signals the computer the piston position for cylinder I. The 1-degree slits provide accurate engine speed information to the PCM.

HANDS-ON TASK: Have students remove a distributor from a vehicle with Optical Sensor, first review OEM SVC INFO. Have them identify distributor components & test crank angle sensor. Have them disassemble distributor, removing shaft and noting bushing/bearing & seal areas:

ICONS	Ch69 Ignition System Operation
	FIGURES 69-9 & 10
	**DEMONSTRATION: Show how to inspect a torque converter drive plate. Highlight importance of a thorough inspection to avoid a driveability condition. FIGURE 69-9**
	**DEMONSTRATION: Show how to replace Crankshaft (CKP)/camshaft position sensors (CMP) & make adjustments using a gauging tool. Show how to monitor crankshaft/camshaft position sensors using scan tool**
	**DEMONSTRATION: Review importance of camshaft & crankshaft timing. Use opened timing cover to emphasize timing markings and what is happening to piston & and valve positions**
	13. **SLIDE 13 EXPLAIN FIGURE 69-11** light shield being installed before the rotor is attached. 14. **SLIDE 14 EXPLAIN Figure 69-12** firing order is cast or stamped on the intake manifold on most engines that have a distributor ignition.
	**HANDS-ON TASK: Have students identify Proper Firing Order for a selected vehicle in the shop. Then have them verify the spark plug wire routing. Grade them on their understanding of where to find the firing order and location of the spark plug wires. FIGURE 69-12**
	Hall Effect Sensor (View) (Download) Waste Spark Ignition System 1 (View) (Download) Waste Spark Ignition System 2 (View) (Download) Cylinder Deactivation System (View)
	15. **SLIDE 15 EXPLAIN Figure 69-13** waste-spark system fires one cylinder while its piston is on the compression stroke and into paired or companion cylinders while it is on the exhaust stroke. In a typical engine, it requires only about 2 to 3 kV to fire the cylinder on the exhaust stroke. The remaining coil energy is available to fire the spark plug under compression (typically about 8 to 12 kV).
	**DEMONSTRATION: DEMO WASTE-SPARK IGNITION SYSTEM OPERATION: FIGURE 69-13**

ICONS	Ch69 Ignition System Operation

16. **SLIDE 16 EXPLAIN Figure 69-14** Typical wiring diagram of V-6 waste-spark ignition system. PCM is in control of ignition timing based on information from various engine sensors including RPM, MAP & engine coolant temperature (ECT). Timing signal is sent to module through electronic spark timing (EST) wire
17. **SLIDE 17 EXPLAIN Figure 69-15** The slight (5 microsecond) difference in the firing of the companion cylinders is enough time to allow the PCM to determine which cylinder is firing on the compression stroke. The compression sensing ignition (CSI) signal is then processed by the PCM which then determines which cylinder is on the compression stroke.

DISCUSSION: Have the students talk about WASTE-SPARK IGNITION SYSTEMS. Review reverse polarity that is occurring in a DIS. What is the path of the current? FIGURE 69-13, 14, 15

HANDS-ON TASK: OPTIONAL Atech DIS Trainer (1772); Activities 1-12

DISCUSSION: Have the students review the purpose of a crankshaft sensor (CKP). Why is there adjustment on some engines?

DEMONSTRATION: Using ignition oscilloscope, show students typical connecting procedure for obtaining ignition patterns.

DEMONSTRATION: Show LAB vehicle with an ignition module under coil pack. Remove ignition module & DEMO testing pin locations.

You should not check for spark by pulling plug wire on running engine. In addition to risking personal injury, you could damage or shorten electronic ignition components life. Method of checking for cylinder firing was used on older systems.

Coil-On-Plug Ignition System (View) (Download)

ICONS	Ch69 Ignition System Operation

Cylinder Deactivation System (View)

18. **SLIDE 18 EXPLAIN Figure 69-16** A typical coil-on-plug ignition system showing the triggering and the switching being performed by the PCM via input from the crankshaft position sensor.
19. **SLIDE 19 EXPLAIN Figure 69-17** An overhead camshaft engine equipped with variable valve timing on both the intake and exhaust camshafts and the coil-on-plug ignition.
20. **SLIDE 20 EXPLAIN Figure 69-18** A Chrysler Hemi V-8 that has two spark plugs per cylinder. The coil on top of one spark plug fires that plug and, through a spark plug wire, fires a plug in the companion cylinder.

DISCUSSION: Have students study and discuss Figure 69–16. What does the coil-on-plug (COP) ignition system eliminate?

DEMONSTRATION: Show the students COP ignition systems with 2 & 3 primary wires and explain the differences.

DISCUSSION: Have students study and discuss Figure 69–16. What does the coil-on-plug (COP) ignition system eliminate?

21. **SLIDE 21 EXPLAIN Figure 69-19** A DC voltage is applied across the spark plug gap after the plug fires and the circuit can determine if the correct air-fuel ratio was present in the cylinder and if knock occurred. The applied voltage for **ION** sensing does not jump spark plug gap but rather determines the conductivity of the ionized gases left over from the combustion process.

HANDS-ON TASK: Have students draw wiring diagrams of 2 & 3 wire COP primary ignition systems. Grade them on accuracy

DISCUSSION: study FIGURE 69–19 discuss ion-sensing ignition systems. What is the purpose of measuring electricity conducted by the ionized combustion flame?

ICONS	Ch69 Ignition System Operation
	22. **SLIDE 22 EXPLAIN Figure 69-20** A typical knock sensor on the side of the block. Some are located in the "V" of a V-type engine and are not noticeable until the intake manifold has been removed.
	DEMONSTRATION: Show location of knock sensor and demonstrate testing procedure. Discuss knock sensor's purpose. FIGURE 69–20 **USE LAB VEHICLE OR ATEC TRAINER**
	HANDS-ON TASK: Have the students test knock sensors on shop vehicles using SNAP-ON MODUS (OR GMM & SCAN TOOL). Have them draw waveforms they detect to start building a library of known-good knock sensor waveforms. **FIGURE 69–20**
	23. **SLIDE 23 EXPLAIN Figure 69-21** A typical waveform from a knock sensor during a spark knock event. This signal is sent to the computer which in turn retards the ignition timing. This timing retard is accomplished by an output command from the computer to either a spark advance control unit or directly to the ignition module.
	DISCUSSION: Have the students talk about what happens with some engine computers when they detect knock sensor signals at idle speed. Why should knock sensors be checked at off idle in order to isolate a true engine knock condition?
	24. **SLIDE 24 EXPLAIN Figure 69-22** A SPOUT connector on a Ford that is equipped with a distributor ignition. This connector has to be disconnected to separate the PCM in order to set base ignition timing.
	DISCUSSION: Have the students discuss bypass ignition control. What controls timing?
	DISCUSSION: Have the students discuss up-integrated ignition control. What is difference between a bypass ignition control circuit and Upintegrated Ignition?

ICONS	Ch69 Ignition System Operation
	ON-VEHICLE NATEF TASK Research applicable vehicle and service information, such as Ignition System Identification (P-1) Pg 225 Crossword Puzzle (Microsoft Word) (PDF) Word Search Puzzle (Microsoft Word) (PDF)