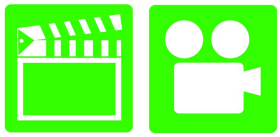
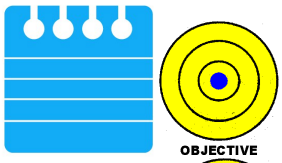
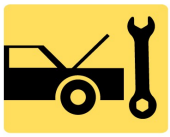
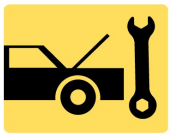
A8 Engine Performance 4th Edition

Chapter 16 Ignition System Components & Operation

Opening Your Class

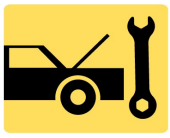
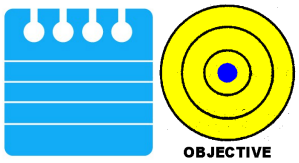
KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **Automotive Engine Performance.** It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge 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. 1. Prepare for ASE Engine Performance (A8) certification test content area "B" (Ignition System Diagnosis and Repair). 2. Explain how ignition coils create 40,000 volts. 3. Discuss crankshaft position sensor and pickup coil operation. 4. Describe the operation of waste-spark and coil-on-plug ignition systems.
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.

ICONS	Ch16 Ignition System Components & OP
	1. SLIDE 1 CH16 Ignition System Components & Operation
	Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/ WEB SITE REGULARLY UPDATED
	POWER POINTS DONE BY INDIVIDUAL LEARNING OBJECTIVES, SO THERE IS POWER POINT FILE FOR EACH LEARNING OBJECTIVE
	2. SLIDE 2 EXPLAIN OBJECTIVE CH16 AEP_LO1 3. SLIDES 3 EXPLAIN Ignition System Operation
	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 POINT-TYPE DISTRIBUTOR & HAVE STUDENTS SET AIR GAP
	DISCUSSION: DISCUSS THE PRIMARY & SECONDARY IGNITION CIRCUITS. HOW DO 2 CIRCUITS FUNCTION INDEPENDENTLY & HOW DO THEY INTERACT?
	4. SLIDES 4-5 EXPLAIN Ignition Coils: Purpose and Function
	6. SLIDE 6 EXPLAIN FIGURE 16–1 Internal construction of an oil-cooled ignition coil. Notice that the primary winding is electrically connected to the secondary winding. The polarity (positive or negative) of a coil is determined by the direction in which the coil is wound. 7. SLIDES 7-9 EXPLAIN Ignition Coils: Coil Construction

ICONS	Ch16 Ignition System Components & OP
	10. **SLIDE 10 EXPLAIN FIGURE 16–2** Typical air-cooled epoxy-filled E coil 11. **SLIDE 11 EXPLAIN FIGURE 16–3** Cutaway of a General Motors Type II distributorless ignition coil. Note that the primary windings are inside of the secondary windings. 12. **SLIDES 12-14 EXPLAIN** Ignition Coils: Self-Induction 15. **SLIDES 15-16 EXPLAIN** Ignition Coils: Mutual Induction 17. **SLIDE 17 EXPLAIN FIGURE 16–4** Typical primary and secondary electronic ignition using a ballast resistor and a distributor. To protect the ignition coil from overheating at lower engine speeds, many electronic ignitions do not use a ballast resistor but use electronic circuits within the module. 18. **SLIDE 18 EXPLAIN** Ignition Coils: Primary Ignition Circuit 19. **SLIDE 19 EXPLAIN** Ignition Coils: Secondary Ignition Circuit 20. **SLIDE 20 EXPLAIN FIGURE 16–5** A tapped-(married) type ignition coil where the primary winding is tapped (connected) to the secondary winding
	**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?**
	**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.**
	**SHOW ANIMATION: IGNITION OPERATION WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A16_ANIMATION/CHAPTER56_FIG_56_4/INDEX.HTM

ICONS	Ch16 Ignition System Components & OP
	2. SLIDE 2 EXPLAIN OBJECTIVE CH16 AEP_LO2 Discuss crankshaft position sensor and pickup coil operation 3. SLIDES 3-4 EXPLAIN Primary Circuit Operation
	5. SLIDE 5 EXPLAIN FIGURE 16–6 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 module receives this voltage from the pickup coil and opens the ground circuit to the ignition coil when the voltage starts down from its peak (just as reluctor teeth start moving away from pickup coil)
	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
	DISCUSSION: USING AN IGNITION SYSTEM WIRING DIAGRAM, HAVE THE STUDENTS LOCATE TRIGGERING DEVICE. HOW DOES THIS TRIGGERING DEVICE WORK?
	ANIMATION: SIGNAL GENERATION FORM PERMANENT MAGNET WWW.MYAUTOMOTIVELAB.COM HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A1_ANIMATION/CHAPTER18_FIG_18_7/INDEX.HTM
	DEMONSTRATION: USING OSCILLOSCOPE, SHOW WAVEFORM PATTERN OF PULSE GENERATOR. COMPARE PATTERN WITH FIG 8–6
	VIDEO: 5 MIN RANDOM MISFIRE DETECTION WWW.MYAUTOMOTIVELAB.COM HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYLABS/AKAMAI/TEMPLATE/VIDEO640X480.PHP?TITLE=CASE%20STUDY%203%20RANDOM%20MISFIRE%20DETECTED&CLIP=PANDC/CHET/2012/AUTOMOTIVE/OBD2_FORD/ST15_CS3.MOV&CAPTION=CHET/CHET_MYLABS/AKAMAI/2012/AUTOMOTIVE/OBD2_FORD/XML/ST15_CS3.XML
	VIDEO: 8 MIN DTC P0300 MISFIRE DIAG. WWW.MYAUTOMOTIVELAB.COM HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYLABS/AKAMAI/TEMPLATE/VIDEO640X480.PHP?TITLE=CASE%20STUDY%201%20DIAGNOSING%20&%20ENGINE%20MISFIRE%20PO300&CLIP=PANDC/CHET/2012/AUTOMOTIVE/OBD2_GM/CS1.MOV&CAPTION=CHET/CHET_MYLABS/AKAMAI/2012/AUTOMOTIVE/OBD2_GM/XML/CS1.XML

ICONS	Ch16 Ignition System Components & OP
	VIDEO: 6 MIN SINGLE CYLINDER MISFIRE DIAG. WWW.MYAUTOMOTIVELAB.COM HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYLABS/AKAMAI/TEMPLATE/VIDEO640X480.PHP?TITLE=CASE%20STUDY%203%20SINGLE%20CYLINDER%20MISFIRE&CLIP=PANDC/CHET/2012/AUTOMOTIVE/OBD2_CHRYSLER_CORP/ST16CS3.MOV&CAPTION=CHET/CHET_MYLABS/AKAMAI/2012/AUTOMOTIVE/OBD2_CHRYSLER_CORP/XML/ST16CS3.XML
	6. **SLIDE 6 EXPLAIN FIGURE 16–7** The varying voltage signal from the pickup coil triggers the ignition module. The ignition module grounds and ungrounds the primary winding of the ignition coil, creating a high-voltage spark 7. **SLIDE 7 EXPLAIN FIGURE 16–8** Hall-effect switches use metallic shutters to shunt magnetic lines of force away from a silicon chip and related circuits. All Hall-effect switches produce a square wave output for every accurate triggering. 8. **SLIDE 8 EXPLAIN FIGURE 16–9** Shutter blade of a rotor as it passes between the sensing silicon chip and the permanent magnet. 9. **SLIDE 9 EXPLAIN FIGURE 16-10** 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 bottom. These Hall-effect sensors have three wires: a power supply (8 volts) from the computer (controller), a signal (0 to 5 volts), and a signal ground.
DEMO	**DEMONSTRATION: USING AN OSCILLOSCOPE SHOW WAVEFORM PATTERNS OF MAGNETIC SENSOR & HALL-EFFECT SENSOR. COMPARE THESE SCOPE PATTERNS WITH FIGURES 8–7 AND 8–8**
QUESTION	**DISCUSSION: DISCUSS HALL EFFECT. HOW IS HALL-EFFECT SWITCH DIFFERENT FROM MAGNETIC PULSE GENERATOR? FIG 8-7 & 8**
	10. **SLIDE 10 EXPLAIN FIGURE 16–11** 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.
DEMO	**DEMONSTRATION: SHOW HOW TO REPLACE CRANKSHAFT (CKP)/CAMSHAFT POSITION SENSORS (CMP) & MAKE ADJUSTMENTS USING A GAUGING TOOL. SHOW HOW TO MONITOR**

ICONS	Ch16 Ignition System Components & OP
	CRANKSHAFT/CAMSHAFT POSITION SENSORS USING SCAN TOOL
DEMO	**DEMONSTRATION: REVIEW IMPORTANCE OF CAMSHAFT & CRANKSHAFT TIMING. USE OPENED TIMING COVER TO EMPHASIZE TIMING MARKINGS AND WHAT IS HAPPENING TO PISTON & AND VALVE POSITIONS**
	11. **SLIDE 11 EXPLAIN FIGURE 16–12** A typical magnetic crankshaft position sensor. 12. **SLIDE 12 EXPLAIN FIGURE 16–13** (a) Typical optical distributor. (b) Cylinder 1 slit signals the computer the piston position for cylinder 1. The 1-degree slits provide accurate engine speed information to the computer. 13. **SLIDE 13 EXPLAIN FIGURE 16–14 (a)** An optical distributor on a Nissan 3.0 L V-6 shown with the light shield removed. (**b**) A light shield being installed before the rotor is attached.
	**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**
	2. **SLIDE 2 EXPLAIN OBJECTIVE CH16 AEP_LO3** **Inspect and test ignition primary circuit wiring and solid state components.** **REPEAT AEP_LO2 POWER POINT SLIDES: Figures 16-6 to 16-14**
	3. **SLIDES 3-4 EXPLAIN Primary Circuit Operation**
	5. **SLIDE 5 EXPLAIN FIGURE 16–6** 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 module receives this voltage from the pickup coil and opens the ground circuit to the ignition coil when the voltage starts down from its peak (just as reluctor teeth start moving away from pickup coil)

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 	2. **SLIDE 2 EXPLAIN OBJECTIVE CH16 AEP_LO4** 3. **SLIDES 3-4 EXPLAIN Distributor Ignition: General Motors HEI Electronic Ignition**
	5. **SLIDE 5 EXPLAIN FIGURE 16–15** HEI distributor

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	6. **SLIDE 6 EXPLAIN FIGURE 16–16** GM HEI coil installed in distributor cap. When coil/distributor cap is replaced, check that ground clip is transferred from old distributor cap to the new. Without proper grounding, coil damage is likely. There are 2 designs of HEI coils. One uses red & white wire as shown, other design, which has reversed polarity, uses red/yellow for COIL primary 7. **SLIDE 7 EXPLAIN FIGURE 16–17** This distributor ignition system uses a remotely mounted ignition coil 8. **SLIDES 8-9 EXPLAIN** Distributor Ignition: Ford Electronic Ignition 10. **SLIDE 10 EXPLAIN FIGURE 16–18** Wiring diagram of a typical Ford electronic ignition. 11. **SLIDES 11-13 EXPLAIN** Distributor Ignition: Ford Electronic Ignition 14. **SLIDE 14 EXPLAIN FIGURE 16–19** Schematic of a Ford TFI-IV ignition system. The SPOUT connector is unplugged when ignition timing is being set. 15. **SLIDES 15-16 EXPLAIN** Distributor Ignition: Chrysler Distributor Ignition 17. **SLIDE 17 EXPLAIN FIGURE 16–20** A Chrysler electronic ignition distributor. This unit is equipped with a vacuum advance mechanism that advances the ignition timing under light engine load conditions.
 	2. SLIDE 2 EXPLAIN **OBJECTIVE CH16 AEP_LO5** 3. **SLIDES 3-5 EXPLAIN Waste-Spark Ignition Systems**
	**ANIMATION: WASTE SPARK WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A16_ANIMATION/CHAPTER56_FIG_56_21/INDEX.HTM **Waste Spark Ignition System 1** **Waste Spark Ignition System 2**
	6. **SLIDE 6 EXPLAIN FIGURE 16–21** A waste-spark system fires one cylinder while its piston is on compression stroke and into paired or companion cylinders while it is on exhaust stroke. In a typical engine, it requires only about 2 to 3 kV to fire the cylinder on the exhaust strokes. The remaining coil energy is available to fire the spark plug under compression (typically about 8 to 12 kV). 7. **SLIDE 7 EXPLAIN FIGURE 16–22** left-hand rule states

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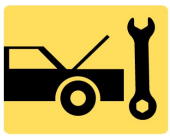
	if a coil is grasped with left hand, fingers point in direction of current flow & thumb will point toward north pole.
DEMO	**DEMONSTRATION: DEMO WASTE-SPARK IGNITION SYSTEM OPERATION: FIGURE 16-21**
	8. **SLIDE 8 EXPLAIN FIGURE 16–23** Typical Ford EDIS 4-cylinder ignition system. The crankshaft sensor, called a variable-reluctance sensor (VRS), sends crankshaft position and speed information to the EDIS module. A modified signal is sent to the computer as a profile ignition pickup (PIP) signal. The PIP is used by the computer to calculate ignition timing, and the computer sends a signal back to the EDIS module as to when to fire the spark plug. This return signal is called spark angle word (SAW) signal
QUESTION	**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?**
QUESTION	**DISCUSSION: HAVE THE STUDENTS REVIEW THE PURPOSE OF A CRANKSHAFT SENSOR (CKP). WHY IS THERE ADJUSTMENT ON SOME ENGINES?**
DEMO	**DEMONSTRATION: USING IGNITION OSCILLOSCOPE, SHOW STUDENTS TYPICAL CONNECTING PROCEDURE FOR OBTAINING IGNITION PATTERNS.**
DEMO	**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.
	SHOW ANIMATION: COIL-ON-PLUG OP WWW.MYAUTOMOTIVELAB.COM HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A1_ANIMATION/CHAPTER18_FIG_18_16_B/INDEX.HTM **COIL-ON-PLUG IGNITION SYSTEM**

ICONS	Ch16 Ignition System Components & OP
	9. SLIDES 9-11 EXPLAIN Coil-On-Plug Ignition 12. SLIDE 12 EXPLAIN FIGURE 16–25 A coil-on-plug ignition system.
	13. SLIDE 13 EXPLAIN FIGURE 16–26 A typical coil-on-plug (COP) ignition system on a V-8 with a separate coil for each cylinder 14. SLIDE 14 EXPLAIN FIGURE 16–27 Individual coils with modules shown on the General Motors 4.2-L inline 6-cylinder light-truck engine. Note the aluminum cooling fins (heat sink) on top of each assembly. 15. SLIDE 15 EXPLAIN Coil-on-Plug Ignition
	**DISCUSSION: HAVE STUDENTS STUDY AND DISCUSS FIGURE 16–26. WHAT 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 16–26. 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.**
	**HANDS-ON TASK: HAVE STUDENTS DRAW WIRING DIAGRAMS OF 2 & 3 WIRE COP PRIMARY IGNITION SYSTEMS. GRADE THEM ON ACCURACY**
	**DISCUSSION: DISCUSS ION-SENSING IGNITION SYSTEMS. WHAT IS PURPOSE OF MEASURING ELECTRICITY CONDUCTED BY IONIZED COMBUSTION FLAME?**
	**DEMONSTRATION: SHOW LOCATION OF KNOCK SENSOR AND DEMONSTRATE TESTING PROCEDURE. DISCUSS KNOCK SENSOR'S PURPOSE**

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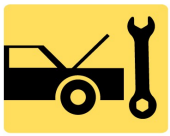	HANDS-ON TASK: HAVE THE STUDENTS TEST KNOCK SENSORS ON SHOP VEHICLES USING GMM & SCAN TOOL. HAVE THEM DRAW WAVEFORMS THEY DETECT TO START BUILDING A LIBRARY OF KNOWN-GOOD KNOCK SENSOR WAVEFORMS.
	DISCUSSION: HAVE THE STUDENTS TALK ABOUT WHAT HAPPENS WITH SOME ENGINE COMPUTERS WHEN THEY DETECT KNOCK SENSOR SIGNALS AT IDLE SPEED. WHY SHOULD KNOCK SENSORS BE CHECKED AT OFF IDLE IN ORDER TO ISOLATE A TRUE ENGINE KNOCK CONDITION?
	DISCUSSION: HAVE STUDENTS DISCUSS BYPASS IGNITION CONTROL. WHAT CONTROLS TIMING?
	DISCUSSION: DISCUSS UP-INTEGRATED IGNITION CONTROL. WHAT IS DIFFERENCE BETWEEN A BYPASS IGNITION CONTROL CIRCUIT AND UPINTEGRATED IGNITION?
	ON-VEHICLE NATEF TASK RESEARCH APPLICABLE VEHICLE AND SERVICE INFORMATION, SUCH AS IGNITION SYSTEM IDENTIFICATION