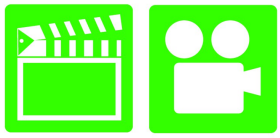
Automotive Maintenance and Light Repair, 1ST Edition

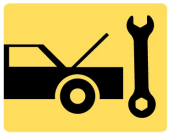
Chapter 41 Fuel Injection Systems

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers **Automotive Maintenance and Light Repair.** 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. ⁀ Prepare for ASE Engine Performance (A8) certification test content area "C" (Fuel, Air Induction, and Exhaust Systems Diagnosis and Repair). ⁀ Describe how a port fuel-injection system works. ⁀ Discuss the purpose and function of the fuel-pressure regulator. ⁀ List the types of fuel-injection systems. ⁀ Describe the parts and operation of a gasoline direct injection system.
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	Ch41 Fuel Injection Systems
	**1. SLIDE 1 CH41 Fuel Injection Systems** **2. SLIDES 2-3 EXPLAIN OBJECTIVES**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE REGULARLY UPDATED**
	**4. SLIDE 4-6 EXPLAIN** Electronic Fuel-Injection
	7. SLIDE 7 EXPLAIN Figure 41-1 Typical port fuel-injection system, indicating the location of various components. Notice that the fuel-pressure regulator is located on the fuel return side of the system. The computer does not control fuel pressure. But does control the operation of the electric fuel pump (on most systems) and the pulsing on and off of injectors
	**DISCUSSION: DISCUSS HOW PCM CONTROLS FUEL INJECTION SYSTEM. WHAT ARE SOME COMMON COMPONENTS OF AN ELECTRONIC FUEL-INJECTION SYSTEM? FIGURE 41-1**
	**DISCUSSION: DISCUSS 2 TYPES OF ELECTRONIC FUEL-INJECTION SYSTEMS. WHICH TYPE IS MORE EFFICIENT? DISCUSS DIAGRAM SHOWN IN FIG 19–1. WHY IS THE PRESSURE REGULATOR POSITIONED AFTER THE INJECTORS?**
	**Electronic Fuel Injection, EFI 1** **Electronic Fuel Injection, EFI 2**
	**8. SLIDE 8 EXPLAIN Figure 41-2** dual-nozzle TBI unit on GM 4.3-L V-6 engine. Fuel is squirted above throttle plate where fuel mixes with air before entering intake manifold.
	9. SLIDE 9 EXPLAIN Figure 41-3 typical port fuel-injection system squirts fuel into low pressure (vacuum) of intake manifold, about 2-3 in. (70-100 mm) from intake valve
	**DEMONSTRATION: SHOW FUEL INJECTORS. SHOW INJECTORS FOR PFI/TBI DISCUSS INJECTOR SIMULARITY FIGURES 41-1 TO 41-7**

ICONS	Ch41 Fuel Injection Systems
	**DISCUSSION:** DISCUSS **SPEED-DENSITY FUEL-INJECTION SYSTEMS**. ASK THEM TO DISCUSS THE IMPORTANCE OF COOLANT TEMPERATURE & AMBIENT AIR TEMPERATURE ON THESE SYSTEMS.
	**DEMONSTRATION:** SHOW 2 VEHICLES, ONE WITH PORT FUEL INJECTION & OTHER WITH THROTTLE-BODY FUEL INJECTION. ASK STUDENTS TO EXPLAIN DIFFERENCES BETWEEN 2 SYSTEMS.
	**DISCUSSION:** HAVE THE STUDENTS TALK ABOUT THE **FIRING ORDER** OF A SEQUENTIAL FUEL INJECTION SYSTEM. CAN FUEL INJECTOR FIRING TIME BE ADJUSTED LIKE IGNITION TIMING?
	**DEMONSTRATION:** SHOW **INTAKE MANIFOLDS** ON PORT FUEL-INJECTED VEHICLES. ALLOW THEM TO SEE LENGTHS OF THE RUNNERS. POINT OUT THAT ALL RUNNERS CAN BE THE SAME LENGTH AND CAN BE TUNED FOR OPTIMUM PERFORMANCE.
	4-CYLINDER ENGINES ARE GOOD EXAMPLES FOR AN INTAKE MANIFOLD DEMONSTRATION. THESE VEHICLES USUALLY HAVE MANIFOLD RUNNERS THAT ARE EASIER TO VIEW.
	**DEMONSTRATION:** SHOW **SEQUENTIAL FUEL INJECTION**. POINT OUT DIFFERENCE IN THE **COLOR OF WIRES** TO INJECTORS.
	**DISCUSSION:** DISCUSS GROUPED DOUBLE-FIRE, SIMULTANEOUS DOUBLE-FIRE, & SEQUENTIAL INJECTION FIRING CHARACTERISTICS. WHICH ONE IS THE MOST EFFICIENT?
	10. SLIDE 10 EXPLAIN FIGURE 41-4 typical **DIRECT-INJECTION SYSTEM USES 2 PUMPS**—one low-pressure electric pump in fuel tank & other a high-pressure pump driven by camshaft. High pressure fuel system operates at pressure as low as 500 PSI during light load & as high as 2,900 PSI under heavy loads
	**ANIMATION: GASOLINE DIRECT FUEL INJECT:WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A16_ANIMATION/CHAPTER59_FIG_59_10/INDEX.HTM

ICONS	Ch41 Fuel Injection Systems
	**DIRECT FUEL INJECTION, MECHANICAL**
	**DISCUSSION: DISCUSS THE OPERATION OF A GASOLINE DIRECT INJECTION SYSTEM. WHAT ARE ADVANTAGES & DISADVANTAGES OF THIS TYPE OF INJECTION SYSTEM? ARE DISADVANTAGES ENOUGH TO LIMIT ITS USE?**
	**SAFETY HIGH-PRESSURE FUEL SYSTEMS ARE VERY DANGEROUS. HIGH PRESSURE FUEL CAN PENETRATE SKIN. IT ALSO CAN SEVERELY INJURY THE EYES OR CAUSE BLINDNESS.**
	11. SLIDE 11 EXPLAIN FUEL INJECTORS 12. SLIDE 12 EXPLAIN FIGURE 41-5 Cross-section of a typical port fuel-injection nozzle assembly. These injectors are serviced as an assembly only; no part replacement or service is possible except for replacement of external O-ring seals
	**DEMONSTRATION: SHOW THE STUDENTS HOW TO USE A STETHOSCOPE TO LISTEN FOR NOISES.**
	**HANDS-ON TASK: HAVE THEM USE STETHOSCOPE TO LISTEN TO FUEL INJECTORS ON RUNNING ENGINE.**
	**DEMONSTRATION: SHOW FUEL INJECTORS NOTE STRAINER SCREEN, SEALS, & FUEL DISCHARGE NOZZLE. SHOW CENTRAL PORT-INJECTION ASM FROM A GM VEHICLE & POINT OUT CENTRAL INJECTOR, FUEL DISTRIBUTION TUBES, & POPPET VALVES IN EACH TUBE NOZZLE**
	**DISCUSSION: HAVE STUDENTS DISCUSS FUEL INJECTORS DESIGN. DO INJECTORS THAT HAVE DISTINCTIVE SPRAY PATTERNS HAVE TO BE INSTALLED IN A SPECIFIC WAY? WHY ARE DEPOSIT-RESISTANT FUEL INJECTORS USED IN SOME APPLICATIONS?**

ICONS	Ch41 Fuel Injection Systems
	13 SLIDES 13-14 EXPLAIN **Fuel-Pressure Regulator** 15. SLIDE 15 EXPLAIN **Figure 41-6** typical port fuel-injected system showing a vacuum-controlled fuel-pressure regulator
	**DEMONSTRATION: SHOW FUEL PRESSURE REGULATORS FOR THROTTLE-BODY & PFI. POINT OUT VACUUM HOSE FITTING ON THE PORT FUEL INJECTION REGULATOR.**
	**DEMONSTRATION: EXPLAIN HOW A LEAKING DIAPHRAGM CAN ALLOW FUEL TO ENTER ENGINE & CAUSE A RICH CONDITION. SHOW HOW TO REMOVE VACUUM LID TO CHECK FOR PRESENCE OF FUEL**
	**DISCUSSION: DISCUSS DIFFERENCES BETWEEN FUEL-PRESSURE REGULATORS AND VACUUM BIASED FUEL-PRESSURE REGULATORS. WHY IS A SECONDARY CONTROL SOURCE (VACUUM) USED WITH PORT INJECTION?**
	**DEMONSTRATION: SHOW HOW TO CALCULATE INJECTOR SIZE REQUIRED FOR AN ENGINE. WORK THROUGH CALCULATIONS WITH THEM**
	**ANIMATION: IAC OPERATION WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A16_ANIMATION/CHAPTER59_FIG_59_24/INDEX.HTM **IDLE AIR CONTROL, IAC**
	16. SLIDE 16 EXPLAIN **Idle Control**
	17. SLIDE 17 EXPLAIN **FIGURE 41-7** idle control unit has four wires and it uses a reversible stepper motor to regulate the amount of air bypassing the throttle plate.
	**DISCUSSION: HAVE THE STUDENTS TALK ABOUT THE NEED FOR AN IDLE CONTROL SYSTEM ON FUEL-INJECTED ENGINE. WHAT OTHER FUNCTION CAN THIS CONTROL PERFORM? DISCUSS STEPPER MOTORS & SOLENOIDS USED FOR IDLE AIR CONTROL. WHICH OF THESE IS MORE ACCURATE? FIGURE 41-7**

ICONS	Ch41 Fuel Injection Systems
	**DEMONSTRATION: WHILE MONITORING DATA ON SCAN TOOL, START ENGINE & ALLOW STUDENTS TO SEE STEPS OR % OF IDLE AIR CONTROL PERFORMED BY PCM. SHOW EXAMPLES OF IDLE AIR CONTROL VALVES OR STEPPER MOTORS USED ON FUEL-INJECTED ENGINES.**
	18. **SLIDE 18 EXPLAIN Idle Control Electronic Throttle Control** 19. **SLIDE 19 EXPLAIN FIGURE 41-8** throttle pedal is connected to the accelerator pedal position (APP) sensor. The electronic throttle body includes a throttle position sensor to provide throttle angle feedback to the vehicle computer. Some systems use a throttle actuator control (TAC) module to operate the throttle blade (plate).
	**NATEF MLR TASK A8A1: ELECTRONIC THROTTLE CONTROL IDENTIFICATION: RESEARCH APPLICABLE VEHICLE AND SERVICE INFORMATION, VEHICLE SERVICE HISTORY, SERVICE PRECAUTIONS, AND TECHNICAL SERVICE BULLETINS**
	**Electronic Throttle Control**