Automotive Technology 5th Edition
Chapter 78 Fuel-Injection 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 the operation of electronic fuel-injection systems and compare speed-density and mass airflow fuel-injection systems. 2. Describe how throttle-body injection and port fuel-injection systems work. 3. Discuss the function of the fuel-pressure regulator and describe a vacuum-biased fuel-pressure regulator. 4. Differentiate between electronic and mechanical returnless fuel systems and discuss demand delivery systems. 5. List the types of fuel-injection systems and explain their modes of operation. 6. Explain the use of idle control and stepper motors in fuel-injection 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.

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

LINK CHP 78: ATE5 Chapter Images

ICONS	Chapter 78 Fuel-Injection Components & Operation
	1. SLIDE 1 CH78 FUEL-INJECTION COMPONENTS & OPERATION
	Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/ WEB SITE IS CONSTANTLY UPDATED
	**Videos**
	2. **SLIDE 2 EXPLAIN Figure 78-1** 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: Have the students discuss how the PCM controls fuel injection system. What are some common components of an electronic fuel-injection system? FIGURE 78-1**
	**DISCUSSION: Have the students discuss the two types of electronic fuel-injection systems. Which type is more efficient? Discuss diagram shown in FIGURE 78–1. Why is the pressure regulator positioned after the injectors?**
	3. **SLIDE 3 EXPLAIN Figure 78-2** A dual-nozzle TBI unit on a Chevrolet 4.3-L V-6 engine. The fuel is squirted above the throttle plate where the fuel mixes with air before entering the intake manifold.
	4. **SLIDE 4 EXPLAIN Figure 78-3** typical port fuel-injection system squirts fuel into the low pressure (vacuum) of the intake manifold, about 2 to 3 in. (70 to 100 mm) from the intake valve
	**DEMONSTRATION: Show examples of fuel injectors. Show them injectors for a port-injection system and throttle-body injection. Discuss similarity of injectors. FIGURES 78-1 to 78-7**

ICONS	Chapter 78 Fuel-Injection Components & Operation
	**DISCUSSION:** Discuss **Speed-Density Fuel-Injection Systems**. Ask them to discuss the importance of coolant temperature & ambient air temperature on these systems.
	**DISCUSSION:** Have the students talk about the **Mass Airflow Fuel-Injection System** & how it works. How is it different from speed-density system?
	5. SLIDE 5 EXPLAIN Figure 78-4 tension of spring in the fuel-pressure regulator determines the operating pressure on a throttle-body fuel-injection unit 6. SLIDE 6 EXPLAIN Figure 78-5 injectors receive fuel & supported by fuel rail 7. SLIDE 7 EXPLAIN Figure 78-6 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 2 vehicles, one with port fuel injection & other with throttle-body fuel injection. Ask students to explain differences between the 2 systems. 8. SLIDE 8 EXPLAIN Figure 78-7 Port fuel injectors spray atomized fuel into the intake manifold about 3 inches (75 mm) from the intake valve 9. SLIDE 9 EXPLAIN Figure 78-8 port fuel-injected engine that is equipped with long, tuned intake manifold runners
	**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 the runners can be the same length and can be tuned for optimum performance. **FIGURE 78-8**

ICONS	Chapter 78 Fuel-Injection Components & Operation
	**4-cylinder ENGINES are good examples for an intake manifold demonstration. These vehicles usually have manifold runners that are easier to view.**
	**DISCUSSION: Have the students talk about the sensors that affect fuel pulse width. What can happen if a sensor gives a false reading?**
	**DEMONSTRATION: Show the students a car with Sequential Fuel Injection. Point out difference in the color of wires to injectors.**
	**DISCUSSION: Have the students discuss the grouped double-fire, simultaneous double-fire, & sequential injection firing characteristics. Which one is the most efficient?**
	10. SLIDE 10 EXPLAIN Figure 78-9 A typical port fuel-injected system showing a vacuum-controlled fuel-pressure regulator. 11. SLIDE 11 EXPLAIN Figure 78-10 typical fuel-pressure regulator that has a spring that exerts 46 pounds of force against fuel. If 20 inches of vacuum are applied above the spring, the vacuum reduces the force exerted by the spring on the fuel, allowing the fuel to return to the tank at a lower pressure.
	**DEMONSTRATION: Show examples of fuel pressure regulators for throttle-body and port fuel injection. Point out vacuum hose fitting on the port fuel injection regulator. FIGURES 78-9 &10**
	**DISCUSSION: Have the students discuss the differences between fuel-pressure regulators and vacuum biased fuel-pressure regulators. Why is a secondary control source (vacuum) used with port injection? FIGURES 78-9 & 10**
	**DEMONSTRATION: Explain how a leaking diaphragm can allow fuel to enter the engine & cause a rich condition. Show how to remove vacuum lid to check for presence of fuel. FIGURE 78-11**

ICONS	Chapter 78 Fuel-Injection Components & Operation
	12. **SLIDE 12 EXPLAIN FIGURE 78-11** A lack of fuel flow could be due to a restricted fuel-pressure regulator 13. **SLIDE 13 EXPLAIN Figure 78-12 The fuel-pressure sensor and fuel-temperature sensor are often constructed together in one assembly to help give the PCM the needed data to control the fuel-pump speed** 14. **SLIDE 14 EXPLAIN Figure 78-13 mechanical returnless fuel system. The bypass regulator in the fuel filter controls fuel line pressure.**
	**DISCUSSION: talk about mechanical returnless fuel systems FIGURE 78-13. How are these systems different from electronic returnless systems? What are their limitations? Discuss why there is no pressure regulator in an electronic returnless fuel system. What takes its place?**
	15. **SLIDE 15 EXPLAIN Figure 78-14 A demand delivery system uses a fuel pressure regulator attached to the fuel pump assembly**
	**DISCUSSION: Discuss Demand Delivery System of fuel delivery. How does it differ from other systems of fuel delivery? FIGURE 78-14**
	**DEMONSTRATION: Show examples of round & rectangular cross-section fuel rails. Explain how rectangular-shaped fuel rail can help control pulsations and noise: FIGURE 78-15**
	**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.**
	16. **SLIDE 16 EXPLAIN FIGURE 78.15** rectangular-shaped fuel rail is used to help dampen fuel system pulsations and noise caused by injectors opening and closing 17. **SLIDE 17 EXPLAIN Figure 78-16 A multiport fuel injector. Notice that the fuel flows straight through and does not come in contact with the coil windings.**

ICONS	Chapter 78 Fuel-Injection Components & Operation
	18. **SLIDE 18 EXPLAIN Figure 78-17** Each of 8 injectors shown are producing a correct spray pattern for the applications. While all throttle-body injectors spray a conical pattern, most port fuel injections do not.
	**Electronic Fuel Injection, EFI 1 (View) (Download)** **Electronic Fuel Injection, EFI 2 (View) (Download)** **Electronic Fuel Injection, EFI 1 (View) (Download)** **Electronic Fuel Injection, EFI 2 (View) (Download)**
	**DEMONSTRATION: Show Examples of fuel injectors, having them note the strainer screen, the seals, and the fuel discharge nozzle. Show the students a central port-injection assembly from a GM vehicle & point out central injector, Fuel distribution tubes, & poppet valves in each tube nozzle. FIGURES 78-16, 17 & 18**
	**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? FIGURES 78-16, 17 & 18**
	**DEMONSTRATION: Show how to calculate injector size required for an engine. Work through calculations with them. SEE FREQUENTLY ASKED QUESTION, Pg. 884 @ SLIDE 89**
	19. **SLIDE 19 EXPLAIN Figure 78-18** central port fuel-injection system. 20. **SLIDE 20 EXPLAIN Figure 78-19** factory replacement unit for a CSFI unit that has individual injectors at ends that go into the intake manifold instead of poppet valves
	**EGR & crankcase ventilation vapors are usually introduced near throttle blade to be distributed equally among all the cylinders. This combination of hot exhaust and oily vapor can create deposits on fuel injectors, altering or restricting fuel flow.**
	**DISCUSSION: Have the students discuss Fuel Injector Modes Of Operation. What actually controls these modes of operation?**

ICONS	Chapter 78 Fuel-Injection Components & Operation
	**DEMONSTRATION: Demonstrate clear flood mode operation to the students. Try this before class to make sure the vehicle will comply.**
	Idle Air Control, IAC (View) (Download) Idle Air Control, IAC (View) (Download)
	21. **SLIDE 21 EXPLAIN Figure 78-20** The small arrows indicate the air bypassing the throttle plate in the closed throttle position. This air is called minimum air. The air flowing through the IAC (blue arrows) is the airflow that determines the idle speed
	**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 78-20**
	22. **SLIDE 22 EXPLAIN Figure 78-21** Most stepper motors use four wires, which are pulsed by the computer to rotate the armature in steps
	**DEMONSTRATION: While monitoring data on a scan tool, start engine & allow students to see steps or percentage of idle air control performed by PCM. Show examples of idle air control valves or stepper motors used on fuel-injected engines.**
	Crossword Puzzle (Microsoft Word) (PDF) Word Search Puzzle (Microsoft Word) (PDF)