Automotive Technology 6th Edition
Chapter 99 HYDRAULIC VALVES & SWITCHES
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 6th text provides complete coverage of automotive components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and ASEEducation (NATEF) and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Case Studies, Videos, Animations, and ASEEducation (NATEF) Task Sheets.
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. Describe the operation of a pressure-differential switch and a brake fluid level sensor switch. 2. Describe the operation of the proportioning valve. 3. Discuss the need and use of a metering valve. 4. List the components included in a combination valve. 5. Describe how a brake light switch works. 6. This chapter will help you prepare for the Brakes (A5) ASE certification test content area "A" (Hydraulic, Power Assist, and Parking Brake Systems Diagnosis and Repair)
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: Lesson plan is based on 6th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

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NOTE: You can use Chapter Images or possibly Power Point files:

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 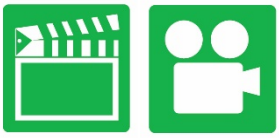    	**1. SLIDE 1 CH99 HYDRAULIC VALVES & SWITCHES** . **Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **http://www.jameshalderman.com/automotive_principles.html** **DOWNLOAD** **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF** **Videos** 2. **SLIDE 2 EXPLAIN FIGURE 99–1** red brake warning lamp. 3. **SLIDE 3 EXPLAIN FIGURE 99–2** leak in hydraulic system causes unequal pressures between two different brake circuits. This difference in pressures causes plunger inside the pressure-differential switch to move, which completes the electrical circuit for red brake warning lamp. **DISCUSS FREQUENTLY ASKED QUESTION: What Is a Residual Check Valve? A residual check valve was used on some drum brake systems to keep a slight amount of pressure (5 to 12 PSI) in entire hydraulic system for drum brake wheel cylinders. • SEE FIGURE 99–3. This residual check valve is located in master cylinder at outlet for drum brakes. The check ball and spring in residual check valve permit all brake fluid to return to master cylinder until the designated pressure is reached. This slight pressure prevents air leaks from entering into hydraulic system in the event of a small hole or leak. With a low pressure kept on the hydraulic system, any small hole causes fluid to leak out, rather than permits air to enter system. This slight pressure also keeps wheel cylinder**

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	sealing cups tight against the inside wall of wheel cylinder. Residual check valves are normally not used on newer vehicles equipped with front disc/rear drum brakes. The residual check valve has been eliminated by equipping wheel cylinder internal spring with a sealing cup expander to prevent sealing cup lip collapse.
	4. **SLIDE 4 EXPLAIN FIGURE 99–3** Most residual check valves are located under tubing seals in master cylinder outlet ports
	**DISCUSS FREQUENTLY ASKED QUESTION:**
	**DISCUSS CASE STUDY:**
	**DEMONSTRATION: Show students an example of a residual check valve and discuss how it maintains slight pressure on the entire hydraulic systems for drum brakes. How does this pressure prevent air from entering the hydraulic system if there is a small hole or leak?**
	5. **SLIDE 5 EXPLAIN FIGURE 99–4** A movable contact brake fluid level switch. 6. **SLIDE 6 EXPLAIN FIGURE 99–5** magnetic brake fluid level switch.
	**EXPLAIN TECH TIP: Check Service Information for the Red Brake Light Input. Older vehicles control the red brake warning lamp using straight wiring and switches. It is becoming more common for this function to be controlled by onboard computers and data systems instead. Brake fluid level switch is often an input to a body control module (BCM) and dash lamp is output. • SEE FIGURE 99–6.**
	7. **SLIDE 7 EXPLAIN FIGURE 99–6** A wiring diagram of a typical red brake warning light circuit showing that the park brake switch is an input to the body control module (BCM) and brake fluid level switch is an input directly to

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	instrument panel cluster (IPC). The command to turn on red brake warning light is sent from BCM to IPC through data lines, shown by two parallel arrows..
	**DEMONSTRATION: Show students an example of a pressure-differential switch and talk about how it works to warn the driver of loss of pressure on dual master-cylinder systems**
	**DISCUSSION: Ask students to discuss the actions they should take if the brake warning lamp remains illuminated after the hydraulic system has been repaired and bled.**
	8. **SLIDE 8 EXPLAIN Figure 99-7** movable contact brake fluid level switch. When the brake fluid level and float drop, the rod-mounted contact completes the electrical circuit which turns on the red brake warning lamp.
	9. **SLIDE 9 EXPLAIN FIGURE 99–8** Typical proportioning valve pressure relationship. Note that, at low pressures, the pressure is the same to the rear brakes as is applied to the front brakes. After split point, only a percentage (called the slope) of master cylinder pressure is applied to rear brakes**.**
	10. **SLIDE 10 EXPLAIN FIGURE 99–9** These two proportioning valves are found under vehicle on this Dodge minivan.
	11. **SLIDE 11 EXPLAIN FIGURE 99–10** vehicle with a diagonal split braking system often uses a one-piece proportioning valve with two pistons, one for each rear wheel.
	12. **SLIDE 12 EXPLAIN FIGURE 99–11** proportioning valve piston can travel within range shown without reducing pressure to the rear brakes.
	13. **SLIDE 13 EXPLAIN FIGURE 99–12** At split point, proportioning valve piston closes fluid passage through valve.
	**DEMONSTRATION: Show example of a proportioning valve and discuss how it helps to improve brake balance during a hard stop by distributing different forces to front & rear brakes.**
	14. **SLIDE 14 EXPLAIN FIGURE 99–13** A height-sensing proportioning valve provides the vehicle with variable brake balance. The valve allows higher pressure to be applied to the rear brakes when the vehicle is heavily loaded and less pressure when vehicle is lightly loaded.

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	**15. SLIDE 15 EXPLAIN FIGURE 99–14** A stepped cam is used to alter the split point of this height-sensing proportioning valve..
	DISCUSSION: Ask students to discuss why vehicles with front disc and rear drum brakes require a proportioning valve. How does the proportioning valve determine how to allocate pressure to the front and rear brakes?
	Brake Combination Valve (View) (Download) Metering Valve (View) (Download) Pressure Differential Switch/Valve (View) (Download) Proportioning Valve (View) (Download)
	**EXPLAIN TECH TIP:. *Always Inspect Both Front and Rear Brakes* If a vehicle tends to lock up the rear brakes during a stop, many technicians may try to repair the problem by replacing proportioning valve or servicing the rear brakes. Proportioning valves are simple spring-loaded devices that are usually trouble-free. If rear brakes lock up during braking, carefully inspect rear brakes, looking for contaminated linings or other problems that can cause rear brakes to grab. Do not stop there—always inspect front brakes, too. If front brakes are rusted or corroded, they cannot operate efficiently and greater force must be exerted by the driver to stop the vehicle. Even if proportioning valve is functioning correctly, the higher brake pedal pressure by the driver could easily cause the rear brakes to lock up. A locked wheel has less traction with the road than a rotating wheel. As a result, if the rear wheels become locked, rear of vehicle often "comes around" or "fishtails," causing the vehicle to skid. Careful inspection of entire braking system is required to be assured of a safe vehicle.**
	**16. SLIDE 16 EXPLAIN FIGURE 99–15** proportioning valve pressure test can be performed using two pressure gauges—one to register the pressure from master cylinder and the other gauge to read the pressure being applied to the rear brakes. This test has to be repeated in order to read pressure to each rear wheel.

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	17. **SLIDE 17 EXPLAIN FIGURE 99–16** ABS control module performs the functions of metering and proportioning valves on most ABS-equipped vehicles. 18. **SLIDE 18 EXPLAIN FIGURE 99–17** The metering valve may be a separate component or part of the combination valve..
	**DEMONSTRATION: Show students a height sensing proportioning valve on a mini van. How would the load change on this type of vehicle?**
	**DISCUSSION: Have students talk about what kind of vehicles they may service that would have a height sensing proportioning valve.**
	**If a vehicle equipped with floating calipers pulls to one side during braking, opposite-side caliper is not floating properly.**
	**HANDS-ON TASK: Using pressure gauges have students follow the procedures to test a defective proportioning valve. Select a student to present the results to the class.**
	**DEMONSTRATION: Show students an example of an electronic brake-proportioning system and discuss how it uses the ABS solenoids to reduce the pressure to the rear-wheel brakes when the wheel deceleration rates are different.**
	19. **SLIDE 19 EXPLAIN FIGURE 99–18** metering valve when the brakes are not applied. Notice brake fluid can flow through the metering valve to compensate for brake fluid expansion and contraction that occurs with changes in temperature. 20. **SLIDE 20 EXPLAIN FIGURE 99-19** metering valve under light brake pedal application. 21. **SLIDE 21 EXPLAIN FIGURE 99-20** metering valve during a normal brake application
	**DEMONSTRATION: Show students a metering valve and discuss how it works to prevent the front disc calipers from being in contact with the discs until rear drum brake shoes have been engaged.**

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     	**HANDS-ON TASK:** Have students diagnose and test a defective metering valve by first performing a visual inspection and then using pressure gauges. Select a student to present the results, suggest possible causes, and offer solutions **DISCUSSION:** Ask students to discuss why front-wheel drive systems do not use metering valves. **ON-VEHICLE ASEEDUCATION TASK:** Inspect, test, and/or replace metering (hold-off), proportioning (balance), pressure differential, and combination valves. **EXPLAIN TECH TIP:** ***Push-In or Pull-Out Metering Valve?*** Whenever bleeding the air out of the hydraulic brake system using pressure bleeding equipment, the metering valve should be bypassed. The metering valve stops the passage of brake fluid to front wheels until pressure exceeds about 125 PSI (860 kPa). To bypass metering valve, service technician has to push or pull a small button located on metering valve. An easy way to remember whether to push in or to pull out is to inspect button itself. • If button is rubber coated, then push in. • If button is steel, then pull out. Special tools allow the metering valve to be held in the bypass position. Failure to remove the tool after bleeding the brakes can result in premature application of the front brakes before the rear drum brakes have enough pressure to operate. 22. **SLIDE 22 EXPLAIN FIGURE 99–21** This combination valve contains the pressure differential valve, the metering valve, and the proportioning valve.. 23. **SLIDE 23 EXPLAIN Figure 99-22** Combination valve containing metering, pressure-differential (warning switch), and proportioning valves all in one unit. This style is often called a “pistol grip” design because the proportioning valve section resembles the grip section of a handgun.

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	24. **SLIDE 24 EXPLAIN FIGURE 99–23** Typical two-function combination valves.
	**DEMONSTRATION: Show students an example of a combination valve and discuss how it combines the functions of the pressure-differential switch, metering valve, and proportioning valve.**
	**DISCUSSION: Have students talk about the kinds of customer complaints they may encounter if the combination valve was not operating properly**
	**DEMONSTRATION: how students the proper way to adjust the brake light switch**
	25. **SLIDE 25 EXPLAIN FIGURE 99–24** brake pedal position (BPP) sensor (switch) and arm mounts to brake pedal, under the dash. 26. **SLIDE 26 EXPLAIN FIGURE 99–25** With plunger pressed in (pedal up), the meter should show an open circuit (switch open). 27. **SLIDE 27 EXPLAIN FIGURE 99–26** With the plunger released (pedal down), switch should show very low resistance (switch closed)..
	**EXPLAIN TECH TIP: *No Valves Can Cause a Pull to One Side* When diagnosing a pull to one side during braking, some technicians tend to blame metering valve, proportioning valve, pressure-differential switch, or master cylinder itself. Just remember that if a vehicle pulls during braking, problem has to be due to an individual wheel brake or brake line. The master cylinder and all valves control front or rear brakes together or diagonal brakes and cannot cause a pull if not functioning correctly.**
	**DISCUSSION: Have students talk about the problems that could arise from an improperly adjusted brake light switch.**

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     	**ON-VEHICLE ASEEDUCATION TASK B5:** Diagnose poor stopping, pulling or dragging concerns caused by malfunctions in the hydraulic system; determine needed action. **ON-VEHICLE ASEEDUCATION TASK B10:** Inspect, test and/or replace components of brake warning light system. B11. Identify components of hydraulic brake warning light system. **ON-VEHICLE TASK:** Check operation of brake stop light system and determine necessary action. **HOMEWORK:** Have students use Internet to research the field of fluid mechanics, which provides the theoretical foundation for hydraulics. Ask students to explain 2 engineering applications of fluid properties during the next class