ATE5 Chapter 128 Hydraulic Components & Control Systems

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. Discuss the different types of automatic transmission fluid. 2. Explain the function of automatic transmission fluid coolers and pumps. 3. Discuss bands, multi-plate clutches, and one-way clutches. 4. Explain the construction of a valve body and discuss the operation of hydraulically- controlled transmission valves. 5. Explain electronically controlled transmissions and discuss the typical torque flow in these transmissions.
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 128: ATE5 Chapter Images

ICONS	Chapter 128 Hydraulic Components
	1. SLIDE 1 CH128 HYDRAULIC COMPONENTS AND CONTROL SYSTEMS
	Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/ WEB SITE IS CONSTANTLY UPDATED
	**Videos**
	**DISCUSSION:** Have the students' count how many different types of fluid are listed in **Chart 128–1.** What type of ATF do their own vehicles use? Talk with the students about how vital it is to use the correct ATF for a vehicle.
	**DISCUSSION:** Have the students talk about all of the purposes and functions that automatic transmission fluid has. What is viscosity?
	**DEMONSTRATION:** Show the students samples of several different types of ATF such as type F, Dexron, Dexron VI, and Mercon V.
	**HANDS-ON TASK:** Have the students check the transmission fluid level in several lab vehicles
	**ON-VEHICLE NATEF TASK:** Inspect engine for fuel, oil, coolant and other leaks; determine necessary action. **Page 38**
	**ON-VEHICLE NATEF TASK:** Service transmission/transaxle; perform visual inspection; replace fluid and filter. **Page 428**
	**OPTIONAL HANDS-ON TASK (TIME PERMITTING):** Have the students do an experiment proving that lubricant reduces friction. Attach a fishing scale, or a similar scale, to a small piece of wood. Have students measure amount of "weight" required to pull piece of wood over another

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	**piece of wood. Then have them coat wood with ATF and measure pull required. Have students compare and discuss the results.** 2. **SLIDE 2 EXPLAIN Figure 128-1** Automatic transmission fluid is routed from torque converter, where most of the heat is generated, to radiator where it is cooled. The fluid then returns to transmission/transaxle to lubricate the bearings and bushings.
	**DEMONSTRATION: Show examples of a transmission cooler built in a radiator and an example of a liquid-to-air cooler that goes in front of the radiator**
	**Point out to students that an overheated transmission can cause major engine damage by causing torque converter to balloon. This could cause crankshaft thrust bearing to wear very quickly, damaging crankshaft & block.**
	**DISCUSSION: Discuss fact that a liquid-to-liquid transmission cooler, such as that located in the radiator, doubles as a heater when the temperature is very cold. What happens to oil when it is cold?**
	3. **SLIDE 3 EXPLAIN Figure 128-2** cutaway of a typical radiator showing the automatic transmission cooler. The heat from the automatic transmission fluid is released to the engine coolant. The engine coolant also warms the fluid as soon as the coolant flows through the radiator.
	**DEMONSTRATION/DISCUSSION: Show transmission cooler CUTOUT located in the radiator, or refer to Figure 128–2. What would happen if the cooler failed and coolant contaminated ATF?**
	4. **SLIDE 4 EXPLAIN Figure 128-3** Engine coolant from the engine block flows through the passages in the cooler /warmer, and then out through the thermo valve to the upper radiator tank. The thermo valve uses a wax element–type valve to control the flow of engine coolant through the case-mounted cooler/warmer. The thermo valve improves the ATF warm-up times and maintains ATF temperature within the optimum operating range between 170° and 190° F (77 and 88° C).

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	**HANDS-ON TASK: Have the students research the functions and possible problems of an automatic transmission cooler.**
	**ON-VEHICLE NATEF TASK: Inspect, leak test, and flush cooler lines. Page 443**
	**DEMONSTRATION: Show a pump from an automatic transmission. Show them how torque converter drives the pump.**
	5. **SLIDE 5 EXPLAIN Figure 128-4 (a)** Gear-type pump. 6. **SLIDE 6 EXPLAIN Figure 128-4 (b)** Geroter-type pump. 7. **SLIDE 7 EXPLAIN Figure 128-4 (c)** Vane-type pump
	**Basic Hydraulic System (View) (Download)** **Pressure Regulator Valve (View) (Download)** **EPC Solenoid (View) (Download)**
	**DISCUSSION: Using Figure 128–4, have the students identify different types of pumps used in a transmission. What are the differences and similarities?**
	**DISCUSSION: Talk with the students about the need to regulate hydraulic pressure. What would happen if pressure was not regulated?**
	**DEMONSTRATION: Show an example of a balance valve. What will happen if the spring breaks or is weak?**
	8. **SLIDE 8 EXPLAIN Figure 128-5** When pressure on the face of the pressure regulator valve overcomes spring force, the valve moves to open the exhaust port. 9. **SLIDE 9 EXPLAIN Figure 128-6** variable pump is at the maximum output position until the regulator valve moves enough to decrease volume by rotating the slide against the force of the priming spring. The position of the pump constantly varies depending on the needs of the transmission/ transaxle and the driving conditions
	**DISCUSSION: Have the students refer to Figure 128–6 and discuss variable displacement pumps. What are the advantages of using this type of pump in an automatic transmission?**

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	10. **SLIDE 10 EXPLAIN Figure 128-7** pressure control solenoid controls the mainline pressure, which is in turn controlled by the powertrain control module (PCM) or the transmission control module (TCM), by applying pressure to the spring side of the pressure regulator valve.
	**DISCUSSION: Have the students talk about the advantages of electronic pressure regulation versus mechanical pressure regulation. What are the disadvantages?**
	**HANDS-ON TASK: Show the students pictures of different types of hydraulic pumps used in automatic transmissions and have them identify the different types. Then have them describe ways to regulate pump pressure. Grade students on correct identification of the pumps and accuracy of their explanations.**
	**DEMONSTRATION: Show examples of APPLY DEVICES such as a transmission band, multiple-plate clutch, & one-way clutch. Then install a band around a drum and show the students how it will hold a drum and change the reaction member in a planetary gearset.**
	**DISCUSSION: Have the students discuss normal line pressure. What would cause line pressure to be low?**
	11. **SLIDE 11 EXPLAIN Figure 128-8** Gear set members are attached to a drum and are held stationary when the band applies. 12. **SLIDE 12 EXPLAIN Figure 128-9** Transmission bands come in several designs and thicknesses.
	**HANDS-ON TASK: Have the students raise vehicle on a lift using proper safety procedures. Ask them to determine whether the bands can be adjusted with the transmission in vehicle.**
	**Auto Transmission Band & Servo Operation (View) (Download)** **Accumulator (View) (Download)**

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	13. **SLIDE 13 EXPLAIN Figure 128-10** A servo uses hydraulic pressure to move a piston, which applies a band. 14. **SLIDE 14 EXPLAIN Figure 128-11** One end of a band is held stationary and the other end is attached to the servo.
	**DEMONSTRATION: Show an example of a Servo. If one is not available, refer to Figure 128–10. What would happen if the servo spring were broken, or if fluid were to leak past piston?**
	15. **SLIDE 15 EXPLAIN Figure 128-12** An exploded view of a multiple-plate clutch pack assembly.
	**Electronic Clutch Control (View) (Download)** **Electronic/Hydraulic Shift Control (View) (Download)**
 	**DISCUSSION: Have the students discuss how a clutch pack applies and releases. What will happen if the clutch releases too slowly?**
	16. **SLIDE 16 EXPLAIN Figure 128-13** A typical clutch pack assembly. 17. **SLIDE 17 EXPLAIN Figure 128-14** Hydraulic fluid under pressure enters the clutch housing and exerts a force on the clutch piston. The clutch piston forces steel plates and the friction plates together, creating a shift.
 	**DISCUSSION: discuss how fluid travels around the transmission through various passages to accomplish different tasks. What would happen if there were no fluid passages? FIGURE 128-14**
	**DEMONSTRATION: Show friction plate and a steel plate, noting that the friction plate's splines are on the inner edge, and the steel plate's splines are on the outer edge. FIGURE 128-14**
	**DEMONSTRATION: Show the students examples of Holding Clutch & Driving Clutch. FIGURE 128-15**
	**DEMONSTRATION: Show the students a disassembled clutch pack and identify a friction plate and a steel plate.**

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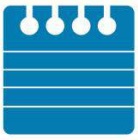
	**HANDS-ON TASK: Have the students disassemble a clutch pack and remove clutch plates. What will happen if the seals on piston do not seal? Have the students reassemble the clutch pack. Have the students use a feeler gauge to measure clearance between clutch plates & drum. have the students identify its parts (friction and steel plate, piston, drum, snap ring, and spring). Grade them on accurate identification of the parts**
	**A plastic playing card makes a great clutch pack piston seal installer**
	**19. SLIDE 19 EXPLAIN Figure 128-16** An integral accumulator is combined with a servo in a single bore in the transmission housing.
	**DISCUSSION: Have the students talk about the purpose of an accumulator. What might happen to a clutch or a band if there were no accumulator?**
	**DISCUSSION: Have students study Figure 128–16 and discuss how an integral accumulator works. Explain the advantages of having the servo and accumulator in same bore.**
	**Accumulator (View) (Download)**
	**One Way Roller Clutch (View) (Download)**
	**20. SLIDE 20 EXPLAIN Figure 128-17** (a) Roller one-way clutch in the locked (held) position. Note how the rollers are wedged into the ramp that is machined into the outer support. (b) Roller one-way clutch in released (free) position. When the inner roller clutch race rotates faster than the outer support, the rollers move out of wedge and are free to rotate, thereby unlocking the one-way clutch.
	**DEMONSTRATION: Show one-way clutch. Show them how it turns one way, but not the other. What will happen if the one-way clutch fails?**

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	21. **SLIDE 21 EXPLAIN Figure 128-18** (a) The sprag in the holding (locked) position. Note how the long portion of the sprag is wedged between the inner and outer race. (b) The sprag in the released position. The inner race is free to rotate faster than the outer race.
	**DISCUSSION: Have the students compare Figure 128–17 & Figure 128–18 to see the difference between a sprag and a roller one-way clutch. Is one better than the other?**
	**Sprag Clutch (View) (Download)**
	22. **SLIDE 22 EXPLAIN Figure 128-19** partially cutaway valve body from a General Motors 4T40-E transaxle.
	**DEMONSTRATION: Show a valve body and various parts, such as the separator plate & valves. What is Valve Body's Purpose? Talk about the functions of check balls and separator plate. What if the valve body was warped or were not torqued correctly? What effect would dirty fluid have on valve body operation? Figure 128–19**
	**Simple Hydraulic Shifts (View) (Download)**
	Simple Electronic Controlled Shifts (View) (Download)
	23. **SLIDE 23 EXPLAIN Figure 128-20** A typical upper valve body showing the fluid passages ("worm holes").
	**HANDS-ON TASK: Have the students trace several wormhole paths through the transmission. Can they tell where the fluid is being directed & what it will do?**
	**DEMONSTRATION: Show the students an example of a one-way valve. Show them how it works by moving the check ball against spring. What would happen if the valve were stuck open?**

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	24. **SLIDE 24 EXPLAIN Figure 128-21** Electronically controlled automatic transmissions/ transaxles use solenoids located in the valve body to control line pressure and to open and close passages in the valve body to control shifts.
	**Orifice with Check Valve (View) (Download)** **Orifice (View) (Download)**
	**DEMONSTRATION: Show an electronically controlled valve body. If one is not available, refer to Figure 128–21. What is one way in which a solenoid can be tested?**
	25. **SLIDE 25 EXPLAIN Figure 128-22** Check balls are used in the valve body to allow hydraulic circuits to share a common passage.
 	**DISCUSSION: Have the students discuss purpose of check valves in a valve body. What advantages do steel check valves have? What would happen if a check valve got stuck?**
	Figure 128–22
	**Orifice with Check Valve (View) (Download)** **Orifice (View) (Download)** **Mechanical Diode (View) (Download)**
	**DEMONSTRATION: Show how to disassemble and clean a valve body**
 	**ON-VEHICLE NATEF TASK: Inspect and service valve body assembly. Page 440**
	26. **SLIDE 26 EXPLAIN Figure 128-23** rooster comb is detent that helps retain the manual valve in the various positions in the valve body.
	**DEMONSTRATION: Show manual valve Figure 128–23 and how it works in a valve body. What will happen if shift linkage were out of adjustment?**

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	**DEMONSTRATION: Show how a spool valve operates in a valve body Figure 128–24. Demonstrate close tolerance that the valve has with the bore. Emphasize that smooth valve movement is vital for proper operation.**
	**Manual Valve (View (Download)** **Manual Lever Position Switch (MLPS) (View) (Download)**
	27. **SLIDE 27 EXPLAIN Figure 128-24** manual valve is a spool valve that is moved by the shift linkage 28. **SLIDE 28 EXPLAIN Figure 128-25** throttle valve (TV) cable on a 4T-60. 29. **SLIDE 29 EXPLAIN Figure 128-26** vacuum modulator moves modulator valve depending on vacuum of the engine. A heavy load on engine causes vacuum to be lower than when engine is operating under a light load. Spool valve applies mainline pressure to boost sleeve of the pressure regulator valve which causes mainline pressure to increase.
	**DISCUSSION: Have the students study Figure 128–26 and talk about the vacuum modulator. Explain how vacuum modulator changes mainline pressure and that if it is not working correctly, serious transmission damage can occur as result of low mainline pressure.**
	**Vacuum Modulator Valve (View) (Download)**
	**DEMONSTRATION: Show how the vacuum modulator controls a shift by connecting one to a mighty vacuum pump and simulator modulator valve movement.**
	**DISCUSSION: Have students review purpose of vacuum modulator. Remind them how it affects shift quality and timing. What are steps to take to check for proper operation of vacuum modulator?**
	**HANDS-ON TASK: Have the students use a hydraulic diagram and trace the operation of a vacuum modulator**

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	**DISCUSSION: Have the students discuss the fact that valves and springs control all shift functions in a hydraulically controlled transmission. What problems can dirt or contaminated fluid cause?**
	30. **SLIDE 30 EXPLAIN Figure 128-27** A governor assembly is used on older hydraulically controlled automatic transmissions/transaxles to control shift points based on vehicle speed.
	**DISCUSSION: Have the students discuss how governor pressure varies with vehicle speed. High speed = high pressure. Low speed = low pressure. Make sure students understand that throttle valve pressure & governor pressure oppose each other to control upshifts and downshifts.**
	**Governor Operation (View) (Download)**
	**DISCUSSION: Have the students talk about the fact that the governor in an automatic transmission is a mechanical device. What will happen if the governor sticks?**
	31. **SLIDE 31 EXPLAIN Figure 128-28** Shift valves move when there is a difference in pressure. In a hydraulically controlled automatic transmission/transaxle, shift valves compare governor pressure force against throttle valve (TV) pressure force to determine when to upshift or downshift.
	**DEMONSTRATION: Show shift valve in a valve body. Explain that shift valve causes transmission to shift based on throttle valve and governor pressures. Refer to Figure 128–28 so that the students can understand how it Works.**
	**Shift Valve Forces (View) (Download)** **Shift Valve (View) (Download)** **Shuttle Valve (View) (Download)** **Simple Electronic Controlled Shifts (View) (Download)** **Simple Hydraulic Shifts (View) (Download)**

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	**HANDS-ON TASK:** Have the students adjust the throttle valve linkage on a vehicle so equipped. Make sure the students have proper procedure to correctly adjust linkage. Have the vehicle test driven before and after the procedure to compare the upshift timing.
	**ON-VEHICLE NATEF TASK:** Inspect and adjust linkages and cables **Page 434**
	**Electronic Transmission Control (View) (Download)**
	**DISCUSSION:** discuss how power flow is same in a hydraulically controlled transmission and an electrically controlled transmission. What is the difference in these transmissions?
	32. **SLIDE 32 EXPLAIN Figure 128-29** transmission range switch on a rear-wheel-drive automatic transmission mounted directly to the side of the case of the unit and accessible from underneath the vehicle
	33. **SLIDE 33 EXPLAIN Figure 128-30** Speed sensors are used by the powertrain control module (PCM) or the transmission control module (TCM) to control shifts and detect faults such as slippage when the two speeds do not match the predetermined ratio for each gear commanded.
	**DISCUSSION:** Discuss the difference between a TCM (Transmission Control Module) and PCM (powertrain control module). What are the advantages and disadvantages of these designs? What is CAN?
	**DEMONSTRATION:** Point out the location of various **PCM inputs** such as throttle position, crankshaft position, mass airflow, and manifold absolute pressure. Will a poorly running engine affect transmission operation?
	**HANDS-ON TASK:** Have the students download a wiring diagram for an electronically controlled transmission or transaxle and trace PCM or TCM transmission control circuits

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	34. **SLIDE 34 EXPLAIN Figure 128-31 (a)** example of a solenoid valve installed in a valve body assembly
	**DISCUSSION:** Have the students talk about the advantages that an electronically controlled transmission has over a hydraulically controlled transmission.
	**DEMONSTRATION:** Show examples of electronic shift solenoids. Apply voltage to the solenoids so that the students can see exactly how solenoid moves a valve. How can a shift solenoid be tested?
	**OPTIONAL HANDS-ON TASK:** Have the students use a hydraulic flow chart and colored pencils to indicate where fluid flow causes a 3-4 upshift in a 4L60-E
	**OPTIONAL HANDS-ON TASK:** Have the students use a scan tool to monitor critical PCM & TCM inputs. Have the students make note of five key input values at idle.
	**ON-VEHICLE NATEF TASK:** Diagnose electronic transmission control system using a scan tool. Page 436
	**DISCUSSION:** Have the students talk about what **LIMP-IN or LIMP HOME mode** is. If neither solenoid is engaged, what happens? Let the students know that sometimes problems in other vehicle systems also can cause this condition.
	**DISCUSSION:** Have the students talk about the importance of understanding power flow in an automatic transmission. How can power flow help to diagnose problems?
	**HANDS-ON TASK:** Using **Chart 128–4**, have students note which gears neither one-way clutch was holding. Have them document what gear and what range the selector valve is in.
	**DISCUSSION:** discuss power flow in a **4L60-E in park & neutral**. What can happen if the vehicle is towed with the engine not running?

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	35. **SLIDE 35 EXPLAIN Figure 128-32** GM 4L60-E torque (power) flow in overdrive first gear. 36. **SLIDE 36 EXPLAIN Figure 128-33** A GM 4L60-E torque (power) flow in overdrive second gear.
	**DISCUSSION: Have the students use Figure 128–32 & FIGURE 128-33 to discuss what clutches and bands are involved in power flow so that they understand how to use power flow chart**
	**HANDS-ON TASK: Have the students use a planetary gear set to duplicate what happens in first gear. Have students identify input member, reaction member, & output member.**
	37. **SLIDE 37 EXPLAIN Figure 128-34** A GM 4L60-E torque (power) flow in overdrive third gear.
	38. **SLIDE 38 EXPLAIN Figure 128-35** GM 4L60-E torque (power) flow in overdrive fourth gear.
	**DISCUSSION: Have students compare Figures 128–34 & 128–35 and talk about the power flow differences in third gear & fourth gear. What clutches are applied during both gears?**
	**HANDS-ON TASK: Using a planetary gear set, have the students hold the reaction member, drive the input member, and observe output member to duplicate the planetary action in both the input and reaction planetary gear sets while transmission is in fourth gear: FIGURE 128-35**
	39. **SLIDE 39 EXPLAIN Figure 128-36** GM 4L60-E torque (power) flow in reverse.
	**DISCUSSION: discuss how the power flow in reverse differs from what it is in all forward gears. Remind them that mainline pressure has to be higher in reverse. ASK WHY? ANS: opposing torque.** **FIGURE 128-36**
	**Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF)**