Automotive Chassis Systems 7e
Chapter 30 Power-Assisted Steering Operation & Service
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **Automotive Chassis Systems.** 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 learning objectives to students as listed below: 1. Describe working of power steering hydraulic systems. 2. Discuss components and operation of power steering pumps. 3. Explain purpose and function of integral power steering. 4. Discuss purpose and function of variable-effort steering systems 5. Discuss purpose and function of electric power steering systems. 6. Discuss power steering diagnosis and troubleshooting. **This chapter will help prepare for ASE Suspension and Steering (A4) certification test content area "A" (Steering System 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: This lesson plan is based on Automotive Chassis Systems 7th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 30: Chapter Images

ICONS	Chapter 30 Power Steering OP & SVC
	**1. SLIDE 1 CH30 POWER-ASSISTED STEERING**
	**Check for VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **Steering System (62 Links)**
	**At the beginning of this class, you can download the crossword puzzle & Word Search from the links below to familiarize your class with the terms in this chapter & then discuss them** **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF)**
	**2. SLIDE 2 EXPLAIN Figure 30-1** Hydraulic fluid transmits the same force whether it passes through a single chamber or two chambers connected by a narrow passage.
	3. SLIDE 3 EXPLAIN Figure 30-2 A fluid applies a force equal to the applied force on a surface that is equal in size to the applying surface. If the surface is half the size, then the fluid exerts half the force: if the surface is twice as large, the fluid exerts twice the force.
	**DISCUSSION: discuss the difference between pressure and force: FIGURE 30-1**
	**4. SLIDE 4 EXPLAIN Figure 30-3** typical integral power steering pump when mounted inside the reservoir. **5. SLIDE 5 EXPLAIN Figure 30-4** Typical remote reservoir. **6. SLIDE 6 EXPLAIN FIGURE 30–5** Typical power steering pump assemblies. **7. SLIDE 7 EXPLAIN Figure 30-6** GM vane-type pump **8. SLIDE 8 EXPLAIN Figure 30-7** Vane pump operation. Phase 1, rotor moves past opposed suction ports, & vanes move out to maintain contact with ring. Creates low-pressure area, drawing fluid into cavities formed by vanes. As rotor continues to move during phase 2, vanes follow contour of ring. Contour of ring forms larger cavity between vanes.

This increases the suction and draws more fluid into the pump.

DEMONSTRATION: Show components of a typical integral power steering pump and remote reservoirs **FIGURE 30-5**

DEMONSTRATION: Show internal parts of a vane pump. **FIGURE 30-8, 9**

9. **SLIDE 9 EXPLAIN Figure 30-8** Vane pump operation—continued. At phase 3, the vanes are at the end of the intake port of the pump and the cavity has reached its maximum volume. In phase 4, the rotor moves into alignment with the opposed discharge ports.
10. **SLIDE 10 EXPLAIN Figure 30-9** Vane pump operation—continued. As the rotor continues to move during phase 5, the volume of the cavity decreases, which increases the discharge pressure. At phase 6, the last phase, the contour of the ring results in the minimum cavity volume, and the discharge of fluid is completed.
11. **SLIDE 11 EXPLAIN Figure 30-10** Flow control valve.
12. **SLIDE 12 EXPLAIN Figure 30-11** pressure-relief check ball unseats, allowing fluid to flow back into the pump inlet if the pressure rises above a certain limit.

DEMONSTRATION: Show examples of flow control valves. Show components of a typical pressure-relief valve. Show examples of power steering pressure & return hoses. **FIGURE 30-10**

13. **SLIDE 13 EXPLAIN Figure 30-12** power steering fluid cooler, if used, is located in the return hose. Often the "cooler" is simply a length of return metal line that is arranged in a loop and routed near front of vehicle. The airflow past return line helps reduce temperature of fluid.

Power Steering Hydraulics

Power Steering Pump Fill (View) (Download)

DISCUSSION: Ask the students to discuss why not all power steering units have a power steering fluid cooler **FIGURE 30-12**

ICONS	Chapter 30 Power Steering OP & SVC
	Power Steering Gear (View) (Download)
	14. **SLIDE 14 EXPLAIN Figure 30-13** Forces acting on the rack piston of an integral power steering gear. 15. **SLIDE 15 EXPLAIN Figure 30-14** rotary valve consists of inner and outer elements. The worm gear is part of the outer element and torsion bar is part of inner element. A pin attaches the worm gear to the bottom of the torsion bar to join the two elements together. 16. **SLIDE 16 EXPLAIN Figure 30-15** When the steering wheel is in straight-ahead position, all of ports in a rotary valve are open equally to pressure and return circuits.
DEMO	**DEMONSTRATION: Show examples of rotary control valves and discuss their inner and outer elements FIGURE 30-15, 16**
	Be careful when working on power steering systems. These systems can reach peak pressures of over 1,000 PSI.
	17. **SLIDE 17 EXPLAIN Figure 30-16** During a left turn, inner element turns so that left-turn circuits are open to pressure and right-turn circuits are open to return circuit. 18. **SLIDE 18 EXPLAIN Figure 30-17** During a left turn, the high-pressure fluid helps push piston along worm gear, thereby reducing the steering effort from driver. 19. **SLIDE 19 EXPLAIN Figure 30-18** During right turn, inner element turns so that right-turn outlets are open to pressure and left-turn outlets are open to return circuit. 20. **SLIDE 20 EXPLAIN Figure 30-19** During right turn, high-pressure fluid pushes piston up worm gear, moving sector shaft & pitman arm to provide assist during right turn.
DEMO	**DEMONSTRATION: Show examples of seals, O-rings, and fluid lines in a rack-and-pinion steering unit**
	21. **SLIDE 21 EXPLAIN Figure 30-20** During a left turn, the control valve directs pressure into the left-turn fluid line and the rack moves left. (See inset.) Fluid pushed out of the right-turn fluid chamber travels back through the right-turn fluid line and control valve to return circuit.

ICONS	Chapter 30 Power Steering OP & SVC
	**DEMONSTRATION:** Show the students examples of control valves and check valves. **FIGURE 30-20**
	**DISCUSSION:** Ask the students to discuss how to determine whether the check valve is not operating properly.
	**Fluid in bellows covering the inner tie rod indicates a bad seal in rack:**
	**HANDS-ON TASK:** Have the students label fluid lines on a power steering rack. Have the students use sticky notes or masking tape **FIGURE 30-21**
	22. **SLIDE 22 EXPLAIN Figure 30-21** control valve routes high-pressure fluid to left-hand side of power piston, which pushes the piston and assists in moving the rack toward the right when the steering wheel is turned right. 23. **SLIDE 23 EXPLAIN Figure 30-22** Low-speed flow control. 24. **SLIDE 24 EXPLAIN Figure 30-23** High-speed flow control operation. 25. **SLIDE 25 EXPLAIN Figure 30-24** Pressure-relief mode. In this mode the steering gear has blocked the flow of fluid from the pump and the pressure rises, which unseats the pressure-relief valve. Now fluid flows back to the inlet through the pressure-relief orifice and passage
	**DEMONSTRATION:** Show an Electronic Variable Orifice (EVO) actuator assembly. **FIGURE 30-25**
	**DISCUSSION:** Ask students to discuss whether an Electronic Variable Orifice (EVO) system or Two-Flow Electronic (TFE) system is better
	26. **SLIDE 26 EXPLAIN Figure 30-25** EVO actuator assembly. 27. **SLIDE 27 EXPLAIN Figure 30-26** Integrated with the pinion shaft is a spool valve that senses the level of torque in the shaft and applies hydraulic pressure to the steering rack whenever assistance is needed. The electromagnet acts in parallel with the input shaft from the steering wheel to

open or close the spool valve. The electromagnet generates variable torque, which can either increase or decrease the amount of steering torque that is needed to open the spool valve.

28. **SLIDE 28 EXPLAIN Figure 30-27** Magnasteer system.

DISCUSSION: Ask the students to discuss what could happen if the electromagnetic coil in a Magnasteer system goes bad FIGURE 30-26

DEMONSTRATION: Show the students how to use the ON-LINE service manual (or database) component locator

HANDS-ON TASK: Have the students use ON-LINE service manual (or database) component locator to find the EVO actuator assembly

DEMONSTRATION: Show various used belts & describe different types of wear. Show how to use a belt tension gauge. Show OEM recommendations on how to properly set the tension on the accessory drive belt of a power steering unit

HANDS-ON TASK: Have the students inspect a vehicle's accessory drive belt for wear

29. **SLIDE 29 EXPLAIN Figure 30-28** typical service manual illustration showing the method to use to properly tension the accessory drive belt.

HANDS-ON TASK: Have the students adjust the tension of accessory drive belt to factory specifications by using a belt tension gauge

DEMONSTRATION: Show the students power steering fluid, both new and used. Students should know look and smell. FIGURE 30-38

30. **SLIDE 30 EXPLAIN FIGURE 30–29** A check of the power steering fluid should include inspecting not only the level but the condition and color of the fluid, which could indicate a possible problem with other components in the steering system

ICONS	Chapter 30 Power Steering OP & SVC
 	**ON-VEHICLE NATEF TASK** **Determine proper fluid and flush power steering system** 31. **SLIDE 31 EXPLAIN Figure 30-30** Some power steering fluid is unique to the climate, such as this **cold climate fluid** recommended for use in General Motors vehicles when temperatures are low. 32. **SLIDE 32 EXPLAIN Figure 30-31** Inspect both high-pressure and return power steering hoses. Make sure the hoses are routed correctly and not touching sections of the body to prevent power steering noise from being transferred to the passenger compartment. 33. **SLIDE 33 EXPLAIN Figure 30-32** drawing showing how to connect power steering pressure gauge to system.
	**DEMONSTRATION: Show examples of power steering analyzers**
	**DEMONSTRATION: Show the students how to connect a power steering analyzer to a power steering system FIGURE 30-32**
	**HANDS-ON TASK: Have students connect a power steering analyzer to a power steering system**
	34. **SLIDE 34 EXPLAIN Figure 30-33** A power steering analyzer that measures both pressure and volume. The shut-off valve is used to test the maximum pressure of the pump. 35. **SLIDE 35 EXPLAIN Figure 30-34** Typical power steering pump showing order of assembly. High-pressure (outlet) hose attaches to fitting (#16). Flow control valve can be removed from pump by removing fitting. 36. **SLIDE 36 EXPLAIN Figure 30-35** Typical tools required to remove and install a drive pulley on a power steering pump. NOTE: Most replacement pumps are not equipped with a pulley. The old pulley must be removed and installed on the new pump. The old pulley should be carefully inspected for dents, cracks, or warpage. If the pulley is damaged, it must be replaced.

ICONS	Chapter 30 Power Steering OP & SVC
	**Power Steering System Bleed (View) (Download)** **Power Steering System Pulley Remove and Replace (View) (Download)** **Power Steering Pump Remove and Replace (View) (Download)** **Power Steering System Vacuum (View) (Download)** **Remove and Replace Drive Belt (View) (Download)**
	**DEMONSTRATION: Show the students how to remove and replace a power steering pump pulley.**
	**HANDS-ON TASK: Have the students remove and replace a power steering pump pulley**
	**FIGURE 30-35** 37. **SLIDE 37 EXPLAIN Figure 30-36** typical submerged-type power steering pump. The pump is housed inside the fluid reservoir 38. **SLIDE 38 EXPLAIN Figure 30-37** punch is used to dislodge the retaining ring. 39. **SLIDE 39 EXPLAIN Figure 30-38** driveshaft attaches to the drive pulley at one end and is splined to the pump rotor at the other end. The vanes are placed in the slots of the rotor. 40. **SLIDE 40 EXPLAIN Figure 30-39** pump ring must be installed correctly. If it is installed upside down, the internal passages will not line up and the pump will have no output.
	41. **SLIDE 41 EXPLAIN Figure 30-40** The shaft seal must be chiseled out. A thin metal shim stock should be used to protect the shaft from damage. Some technicians drill a small hole in seal, then thread in self-tapping sheet metal screw. Then pliers are used to pull out old seal.
	42. **SLIDES 42-59 OPTIONAL EXPLAIN POWER STEERING RACK REMOVAL AND INSTALLATION**
	**ON-VEHICLE NATEF TASK Remove, inspect, replace, and adjust power steering pump belt and pump; press fit pump pulley**
	**ON-VEHICLE NATEF TASK Inspect and replace power steering hoses and fittings**

ICONS	Chapter 30 Power Steering OP & SVC
  	**ON-VEHICLE NATEF TASK Diagnose, test and diagnose components of electronically controlled steering systems using scan tool** **ON-VEHICLE NATEF TASK Inspect and test electric power assist steering.** **SEARCH INTERNET: Have students search Internet to research tilt mechanisms and telescoping steering columns. Divide the students into two debate groups. Have the first group defend the tilt-mechanism steering column as the best choice, based on its features. Have the second group defend the telescoping steering column is best choice, based on features.**