Automotive Steering, Suspension, & Alignment 7e
Chapter 16 DRIVE AXLE SHAFTS & CV JOINTS
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **Automotive Steering and Suspension Systems with Wheel Alignment and Drive Axles.** 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 driveshaft design and balance. 2. Describe function and operation of U-joints. 3. Describe how CV joints work. 4. Discuss working and various types of CV joints. **This chapter will help prepare for ASE Suspension and Steering (A4) certification test content area "C" (Related Suspension and Steering Service).**
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 Steering, Suspension, & Alignment 7th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com
LINK CHP 16: Chapter Images

ICONS	Chapter 16 Drive Axle Shafts & CV Joints
	1. SLIDE 1 Chapter 16 Drive Axle Shafts & CV Joints
	Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/ WEB SITE IS CONSTANTLY UPDATED **Drive Axle (41 Links)** **Drive Shaft (27 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 16-1 Typical rear-wheel-drive powertrain arrangement. The engine is mounted longitudinal (lengthwise).
	**RWD Driveshaft Operation** **RWD Drivetrain**
	DISCUSSION: Ask the students to discuss the advantages and disadvantages of aluminum driveshafts.
	DEMONSTRATION: Show how universal joints on both ends of a driveshaft let it rotate even though two ends of the shaft are out of alignment.
	3. SLIDES 3 EXPLAIN Figure 16-2 Typical front-wheel-drive powertrain arrangement. The engine is usually mounted transversely (sideways). 4. SLIDES 4 EXPLAIN Figure 16-3 Typical driveshaft (also called a propeller shaft). The driveshaft transfers engine power from the transmission to the differential.
	DEMONSTRATION: Show the students a driveshaft made of steel and another one made of aluminum. Show them parts of driveshaft, including tube, slip

ICONS	Chapter 16 Drive Axle Shafts & CV Joints
	yoke, end yoke, & balance weights.
	**DEMONSTRATION:** Show the students how the universal joints on both ends of a driveshaft let it rotate even though the two ends of the shaft are out of alignment.
	**RWD Driveshaft Operation**
	5. **SLIDE 5 EXPLAIN Figure 16-4** This driveshaft failed because it had a slight dent caused by a rock. When engine torque was applied, the driveshaft collapsed, twisted, and then broke.
	**DISCUSSION:** Ask the students to discuss the effects of an out-of-balance driveshaft. (Examples: Driver complaints and damage to other parts)
	**HANDS-ON-TASK & DISCUSSION:** Have the students use the Internet to research the life of *Girolamo Cardano*. Ask them to discuss includes information about his life and his invention of the *Cardan joint,* a type of universal joint in a shaft that enables the joint to rotate when out of alignment.
	6. **SLIDE 6 EXPLAIN Figure 16-5** A center support bearing is used on many vehicles with long driveshafts such as long trucks. 7. **SLIDE 7 EXPLAIN Figure 16-6** Some driveshafts use rubber between an inner and outer housing to absorb vibrations and shocks to the driveline.
	**DISCUSSION:** Ask the students to discuss why some driveshafts have a center support bearing.
	**DEMONSTRATION:** Show an example of a center support bearing for a two-piece driveshaft.
	**DEMONSTRATION:** Show the students how to balance a driveshaft using hose clamps.
	**HANDS-ON-TASK** Have the students locate the service information to balance a driveshaft then balance the drivesaft on a lab vehicle

ICONS	Chapter 16 Drive Axle Shafts & CV Joints
	**8. SLIDE 8 EXPLAIN Figure 16-7** A simple universal joint (U-joint).
	SEARCH INTERNET: Have the students research other innovations that Cord automobiles used in the 1920s. Have the students explain the innovations they find.
	**9. SLIDE 9 EXPLAIN Figure 16-8** How speed difference on output of a typical U-joint varies with speed and angle of U-joint. At bottom of chart, input speed is a constant 1000 RPM, while output speed varies from 900-1100 RPM when angle difference in joint is only 10°. At top part of chart, input speed is a constant 1000 RPM, yet output speed varies from 700-1200 RPM when angle difference in joint is changed to 30°
	**DISCUSSION: Ask the students to discuss the information shown in Figure 16–8. Have them discuss how the change in output RPM would affect the drivability of the vehicle.**
	**10. SLIDE 10 EXPLAIN Figure 16-9** joint angle is the difference between the angles of the joint
	**DEMONSTRATION: Show the students how To find driveshaft angle.**
	**HANDS-ON-TASK: Have students practice checking drive shaft angles & use the Internet to research U.S. Patent 2,010,899. Ask them to write a report that includes information on invention and how it affects way drive axles are designed today.**
	11. SLIDE 11 EXPLAIN Figure 16-10 The angle of this rear Cardan U-joint is noticeable.
	**SEARCH INTERNET CURRICULAR ACTIVITY: MATHEMATICS: Have students determine foot-pounds of torque supplied to wheels for a given vehicle. Then have them determine mathematically torque applied to each of 6 balls in fixed CV joint.**
	**CV Joint**

ICONS	Chapter 16 Drive Axle Shafts & CV Joints
	**12. SLIDE 12 EXPLAIN Figure 16-11** A double-Cardan U-joint.
	**DEMONSTRATION: Show the students an example of a double-Cardan U-joint (FIGURE 16-11). Show them relationship between two joints and how the torque is transmitted through center yoke support.**
	**13. SLIDE 13 EXPLAIN Figure 16-12** A constant velocity (CV) joint can operate at high angles without a change in velocity (speed) because the joint design results in equal angles between input and output.
	**DISCUSSION: Have the students discuss the advantage of a constant velocity joint as shown in Figure 16–12**
	**DEMONSTRATION: Show the students examples of an outer CV joint. Show them the main components of the joint. Figure 16–12**
	**14. SLIDE 14 EXPLAIN Figure 16-13** A Rzeppa fixed joint on a front-wheel-drive vehicle. This type of CV joint is commonly used at the wheel side of the drive axle shaft on a front-wheel-drive vehicle. This joint can operate at high angles to compensate for suspension travel and steering angle changes
	**HANDS-ON-TASK Have the students identify the major components of the CV joint assembly, using a diagram similar to Figure 16–13**
	**DEMONSTRATION: Show the students an outer CV joint and demonstrate how it transmits torque equally to the drive wheels at angles up to 40 degrees.**
	**DEMONSTRATION: Show an example of an inner CV joint. Show how the inner (plunge) CV joint can move in and out, unlike the outer (fixed) CV joint.**
	**DISCUSSION: Discuss the difference between inner and outer CV joints. What is the major difference?**

ICONS	Chapter 16 Drive Axle Shafts & CV Joints
	**15. SLIDE 15 EXPLAIN Figure 16-14** protective CV joint boot has been torn away on this vehicle and all of the grease has been thrown outward onto the brake and suspension parts. The driver of this vehicle noticed a "clicking" noise, especially when turning.
	**DEMONSTRATION: Show examples of damaged or torn CV joint boots like the one in FIGURE 16-14**
	**16. SLIDE 16 EXPLAIN Figure 16-15** A tripod fixed joint. This type of joint is found on some Japanese vehicles. If the joint wears out, it is to be replaced with an entire drive axle shaft assembly.
	17. SLIDE 17 EXPLAIN Figure 16-16 The fixed outer joint is required to move in all directions because the wheels must turn for steering as well as move up and down during suspension movement. The inner joint has to be able to not only move up and down but also plunge in and out as the suspension moves up and down.
	**18. SLIDE 18 EXPLAIN Figure 16-17** Unequal-length driveshafts result in unequal drive axle shaft angles to the front drive wheels. This unequal angle side-to- side often results in a steering of vehicle during acceleration called torque steer. By using an intermediate shaft, both drive axles are same angle & torque steer effect is reduced
	**DEMONSTRATION: Show examples of equal length, half shafts & an intermediate shaft.**
 	**DISCUSSION: Ask the students to discuss why the inner CV joint must be able to plunge?**
	**DEMONSTRATION: Show examples of natural rubber, silicone rubber, hard thermoplastic, and urethane CV boots.**
	**HANDS-ON-TASK Have the students identify with labels the different materials CV boots are made from.**
	**19. SLIDE 19 EXPLAIN FIGURE 16–18** typical drive axle shaft with dampener weight.
	20. SLIDE 20 EXPLAIN FIGURE 16-19 tripod joint is also

ICONS	Chapter 16 Drive Axle Shafts & CV Joints
	called a tripot, tripode, or tulip design
	**HANDS-ON-TASK** Have the students identify the major components of the plunge CV joint assembly, using a diagram similar to **Figure 16–19**
	**21. SLIDE 21 EXPLAIN Figure 16-20** A cross-groove plunge joint is used on many German front-wheel-drive vehicles and as both inner and outer joints on the rear of vehicles that use an independent-type rear suspension
	**22. SLIDE 22 EXPLAIN Figure 16-21** A cross-groove plunge joint is used on many German front-wheel-drive vehicles and as both inner and outer joints on the rear of vehicles that use an independent-type rear suspension
	**23. SLIDE 23 EXPLAIN Figure 16-22** Getting the correct boot kit or parts from the parts store is more difficult on many Chrysler front-wheel-drive vehicles because Chrysler has used four different manufacturers for its axle shaft assemblies
	**DISCUSSION:** Ask the students to discuss how the boot around the CV joint can be damaged. (Examples: Road hazards, mechanic's error when working around the boot, and drying out from age)
	**DISCUSSION:** Ask the students to discuss the importance of inspecting the CV boot whenever you have an opportunity to look under the vehicle. Ask them to list several opportunities a technician would have to inspect the CV boot.
	**HANDS-ON-TASK** have the students inspect several CV joint boots on lab vehicles
	**Split CV boot is good to use in an emergency for a temporary repair. You should then replace it & clean CV joint ASAP**
	**DEMONSTRATION:** Show an example of CV joint grease and an example of common chassis grease. Compare viscosity and texture of the two greases.
	**DISCUSSION:** Ask the students to discuss the importance of clean and correct grease in a CV joint. Ask them to discuss how the grease can become contaminated.

ICONS	Chapter 16 Drive Axle Shafts & CV Joints
  	**DISCUSSION:** Ask the students to discuss problems that might occur if the wrong grease is used in a CV joint. After cleaning a CV joint with solvent, the solvent must be removed. Any solvent left behind will contaminate the new grease. **SEARCH INTERNET:** Have the students search the Internet for ways to reduce torque steer. Have students share their findings during the next class.