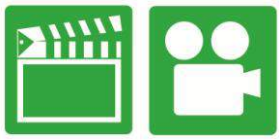
ATE5 Chapter 126 FWD & AWD

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 four-wheel-drive systems. 2. Describe the components of a transfer case. 3. Discuss the purpose and function of an interaxle differential. 4. Describe the procedure to diagnose and service transfer cases and locking hubs.
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 126: ATE5 Chapter Images

ICONS	Chapter 126 FWD & AWD Systems
	1. **SLIDE 1 Chapter 126: FWD & AWD**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/ WEB SITE IS CONSTANTLY UPDATED**
	**Videos**
	**DEMONSTRATION: Show FWD vehicle on the hoist. Point out the two differentials and the transfer case**
	**DEMONSTRATION: Show FWD selector in a vehicle and procedure in its owner's manual for changing from FWD to two-wheel-drive.**
	2. **SLIDE 2 EXPLAIN Figure 126-1** Many light trucks and sport utility vehicles use a transfer case to provide engine torque to all four wheels and to allow a gear reduction for maximum power to get through mud or snow 3. **SLIDE 3 EXPLAIN Figure 126-2** Cutaway of a manually-operated locking hub. 4. **SLIDE 4 EXPLAIN Figure 126-3** Manual locking hubs require that the hubs be rotated to the locked position by hand to allow torque to be applied to the front wheels. Automatic locking hubs enable the driver to shift into four-wheel drive from inside the vehicle.
	**DEMONSTRATION: Show the students an example of a locking hub assembly. Demonstrate the inner workings of the hub: FIGURE 126-2, 3**
	**DISCUSSION: Ask the students to discuss the path the torque follows through the center of the hub, through the locking device, and out to wheel.**
	**HANDS-ON-TASK: Have the students inspect a locking hub assembly. Have them determine which parts are the locking system and which are the drive components. FIGURE 126-2, 3**

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	5. **SLIDE 5 EXPLAIN FIGURE 126-4** If a four-wheel-drive vehicle must be towed, it should be either on (a) a flatbed truck or (b) a dolly. 6. **SLIDE 6 EXPLAIN Figure 126-5** When turning a corner, each wheel takes a slightly different path and rotates at a slightly different speed. Unlike a part-time four-wheel-drive system, which when engaged locks the front and rear axles together, a full-time system uses a center differential that allows for any speed differences between the front and rear axles. It can therefore be activated on any surface—slippery or dry.
	**DISCUSSION: Ask the students to discuss why some vehicles have FWD. Discuss when FWD would be needed**
	**DISCUSSION: Ask the students to discuss the differences between part-time and full-time four-wheel-drive**
	**HANDS-ON-TASK: Have the students' research automotive careers that require the ability to repair and troubleshoot FWD vehicles. Have them DISCUSS in class career opportunities, their advantages & disadvantages, & compensation levels.**
	Active 4WD (View) (Download) Active 4WD Transfer Case (View) (Download) AWD Differentials (View) (Download) Transfer Case, Chain Drive (View) (Download)
	7. **SLIDE 7 EXPLAIN Figure 126-6** viscous coupling is a sealed unit containing many steel discs. One-half of them are splined to the input shaft, with every other disc splined to the output shaft. Surrounding these discs is a thick (viscous) silicone fluid that expands when hot and effectively locks the discs together. 8. **SLIDE 8 EXPLAIN Figure 126-7** typical four-wheel-drive vehicle that uses a longitudinal engine and a transfer case to send engine torque to both the front and rear wheel.
	**DEMONSTRATION: Show the students a viscous coupling. Demonstrate how the coupling locks up as speed increases.**

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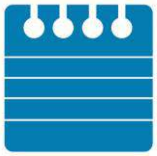
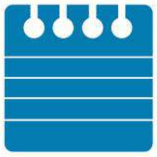
	**DISCUSSION: Ask the students to discuss the operation of a viscous coupling**
	**An example of a dilatant fluid similar to that used in a viscous coupler is Silly Putty. Under low shear force, such as pulling it apart slowly, Silly Putty is somewhat fluid. Pulling it apart fast (high shear force) causes it to become structurally less fluid, and it snaps apart. This is why Silly Putty bounces. Another viscous coupler found on rear-wheel-drive cars is the clutch that holds the fan to the front of the engine. As engine heats up, the fluid becomes stiffer, causing fan to engage.**
	9. **SLIDE 9 EXPLAIN Figure 126-8** center differential is the heart of a typical all-wheel-drive system. AWD systems do not use a low range, and therefore the vehicle may not be able to go off-road like a vehicle equipped with a four-wheel drive with a low range.
	**DEMONSTRATION: Show an AWD vehicle, including the lack of controls in the driver's compartment. With vehicle on a hoist, point out 2 differentials & viscous coupler, if one is present.**
	**DISCUSSION: Ask the students to discuss use of AWD. Have them discuss the advantages and disadvantages associated with AWD**
	**DISCUSSION: Have students discuss front and rear gear ratios of an AWD vehicle. Ask them to discuss why there would be a problem if both gear ratios were exactly same. What if the rear ratio was higher than the front?**
	**DEMONSTRATION: Show example of a drive chain transfer case. Demonstrate change in output as transfer case shifts between modes and ranges**
	10. **SLIDE 10 EXPLAIN Figure 126-9** A typical transfer case is attached to the output of the transmission and directs engine torque to the rear or to the front and rear differentials. 11. **SLIDE 11 EXPLAIN Figure 126-10** exploded view of New Venture 241 transfer case

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	**DISCUSSION:** Ask the students to discuss the torque flow through a chain-type transfer case like the one in **FIGURE 126–10**
	**HANDS-ON-TASK:** Have the students' research operational flaws of chain drive. Ask them to DISCUSS their findings, making sure to include a discussion of torque loss, roller chains, and the use of belts rather than chains.
	12. **SLIDE 12 EXPLAIN Figure 126-11 (a)** When one axle shaft is disconnected, both front wheels can rotate independently, reducing excessive tire wear. 13. **SLIDE 13 EXPLAIN Figure 126-11 (b)** In four-wheel-drive mode, vacuum is applied to the front part and the opposite side is vented to atmospheric pressure retracting the shift motor stem. The shift fork and collar move into engagement with both axle shaft gears. Engine torque from the front differential can now be applied to both front axles. When transfer case is placed in two-wheel drive, vacuum is applied to the other side of the diaphragm and shift collar moves, unlocking front axles.
	**SEARCH INTERNET:** Have students use Internet to research viscous fluids. Ask them to describe to the class how such a fluid becomes stiffer under conditions such as the two ends of a viscous coupler moving at different speeds.
	**DEMONSTRATION:** Show examples of transfer case **shifting options**, including manual floor, vacuum-operated, and electric
	**DISCUSSION:** Ask students to discuss operation and service concerns related to each of the three engagement options: **manual floor, vacuum-operated, and electric**
	**DISCUSSION:** Ask the students to discuss the difference between mode shift and range shift
	**DISCUSSION:** Ask the students to discuss when four-wheel low range would be appropriate

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	**14. SLIDE 14 EXPLAIN FIGURE 126-12** General Motors sport utility vehicle front axle showing the electric axle disconnect actuator. **15. SLIDE 15 EXPLAIN FIGURE 126-13** range shift selector on a Hummer H1 sport utility vehicle**.** **16. SLIDE 16 EXPLAIN Figure 126-14** A typical planetary gear set used in a transfer case. **17. SLIDE 17 EXPLAIN Figure 126-15** Cutaway of a planetary gear set transfer case.
	**DEMONSTRATION: Show the students an example of a planetary gear transfer case. Demonstrate the mode and range shifts and how they affect the output of the transfer case.**
	**DISCUSSION: Have students discuss how gear reduction is achieved with a planetary gear set**
	**18. SLIDE 18 EXPLAIN Figure 126-16** Two-wheel-drive/high-range torque flow in a NV231 transfer case. The sliding range clutch is shifted to the forward position by the range lever and fork, which connects the input gear to the output shaft and rear axle. The mode synchronizer sleeve is moved out of engagement from the drive sprocket to remove torque from the front axle. **19. SLIDE 19 EXPLAIN Figure 126-17** Four-wheel-drive/high-range torque flow in a NV231 transfer case. The range clutch position remains the same as in two-wheel drive/high-range, but the synchronizer sleeve is moved rearward and engages the drive sprocket clutch teeth. This action connects the drive sprocket to the rear output shaft, thereby applying equal torque to both front and rear output shafts. **20. SLIDE 20 EXPLAIN Figure 126-18** Four-wheel-drive/low-range torque flow in a NV231 transfer case. The mode synchronizer assembly remains engaged and the range clutch is moved to the rearward position. The annulus (ring) gear is fixed to the case and the input (sun) gear drives the pinion gears, which walk around the stationary annulus gear and drive the planetary carrier and output shaft at a speed lower than the input gear.

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DEMO	**DEMONSTRATION:** Show the students how the chain drive sprocket is engaged for all-wheel drive and how the planetary set is engaged for low-range drive in the figures for the NV231 transfer case. **FIGURE 126–16, 17**
	Active 4WD Transfer Case (View) (Download) Transfer Case, Chain Drive (View) (Download)
We Support NATEF	**ON-VEHICLE NATEF TASK:** Inspect, adjust, and repair shifting controls. Page 419
DEMO	**DEMONSTRATION:** Show the students an example of an **interaxle differential**. Demonstrate how the differential is similar to a rear differential in that it has pinion gears, a ring gear, and a drive pinion gear.
	21. **SLIDE 21 EXPLAIN Figure 126-19** bevel gear-type interaxle differential. 22. **SLIDE 22 EXPLAIN Figure 126-20** A viscous coupling. Note that the unit is attached to the output shaft between the transfer case (or transaxle) and the rear differential. A typical viscous coupling in a sealed unit is serviced as a complete assembly.
DEMO	**DEMONSTRATION:** When differential is shifted, it locks front axle and sends torque to that axle. Show students that when the front axle is shifted out, it is free-turning with no torque applied. Note that there is no provision for four-wheel low
	HANDS-ON-TASK: Have the students rotate input shaft and observe the torque flow and then shift into all wheel and see how torque flow changes to both shafts
	HANDS-ON-TASK: Have the students use an interaxle differential and determine the gear ratio of the front and rear axles in all-wheel drive. Have them determine the gear ratio of front axle when the differential is in rear-wheel drive

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	**DISCUSSION: Ask the students to discuss the advantages and disadvantages of front axles with Cardan U-joints and CV joints FIGURE 126–21**
	23. **SLIDE 23 EXPLAIN FIGURE 126-21A** standard Cardan U-joint used on the output driveshaft from the transfer case to the front differential assembly. 24. **SLIDE 24 EXPLAIN FIGURE 126-21B** Cardan-type U-joint at the front drive wheels on a Jeep Wrangler.
	**DEMONSTRATION: Show procedure for removing a Cardan U-joint axle shaft. Demonstrate how to check seals and bearings in the axle tubes. Show the students how to replace a Cardan U-joint**
	**HANDS-ON-TASK: Have the students' remove the locking or automotive hub assembly, remove the Cardan U-joint drive axle, and inspect the U-joint and determine if it needs to be replaced. Have them reassemble the axle and hub assembly and check for smooth operation. Grade students on their ability to complete the task, following proper procedures and all applicable safety precautions**
	25. **SLIDE 25 EXPLAIN Figure 126-22** Constant velocity (CV) joints are used on the front axles of many four-wheel-drive vehicles like this Chevrolet Blazer.
	**HANDS-ON-TASK: Have the students research the cost of a replacement transfer case for a vehicle. Ask them to include cost of labor to replace it. Have them role play, presenting their findings to the class the way an automotive technician would report findings to a customer.**
	**SEARCH INTERNET: Have students search Internet to research the available vehicles with true all-wheel-drive capability. Ask them to be prepared DISCUSS the vehicles and indicates whether the all-wheel drive is standard or an option.**
	26. **SLIDE 26 EXPLAIN Figure 126-23** Most transfer cases use an internal oil pump to force the lubricant throughout the unit. Using the correct lubricant is critical to the proper operation of the transfer case.

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	**DEMONSTRATION:** Show student how to drain and refill transfer case. Discuss the importance of using the correct fluid in all transfer cases
 	**DISCUSSION:** Ask the students to discuss why some transfer cases use automatic transmission fluid and some use gear lube
	**HANDS-ON-TASK:** Have the students drain and refill a transfer case
 	**ON-VEHICLE NATEF TASK:** Check transfer case lube level and vents/seals. **Page 423**
	**Transfer case & differential vents on FWD should be located as high as possible. Be certain there tubing has no kinks in it & vents are not routed near hot/moving parts**
	27. **SLIDE 27 EXPLAIN Figure 126-24A** pin and rocker-type chain, which is also called a rocker joint-type chain, is used in transfer cases because of low noise and high efficiency, which improves fuel economy 28. **SLIDE 28 EXPLAIN FIGURE 126-24B** rocker pin-type chain used in a transfer case.
	**DEMONSTRATION:** Show the students how to properly visually inspect a transfer case before **disassemble**. Check for end play and runout of input and output shafts. Check for case cracks and deformities
	**It may be more expensive to repair major problems with a transfer case than to just replace the entire assembly**
	**HANDS-ON-TASK:** Have the students do pre-disassembly inspections on several transfer cases. Have them tag the transfer cases with a list of concerns about each unit
	**DEMONSTRATION:** Show the students how to identify a transfer case before disassembly

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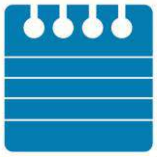
	**ON-VEHICLE NATEF TASK:** Remove and install transfer case. Page 420
	29. **SLIDE 29 EXPLAIN Figure 126-25 (a)** transfer case shift forks attach to the synchronizer sleeve. 30. **SLIDE 30 EXPLAIN Figure 126-25 (b)** sleeve, hub, and inserts are similar in design except larger than those used in a manual transmission/transaxle. 31. **SLIDE 31 EXPLAIN FIGURE 126-26** When reassembling a transfer case (or another automotive component) that includes a snap ring, always be sure that the upper opening is tapered from the top to allow snap-ring pliers room to get a grip on open end.
	**Before disassembling a transfer case for service, make sure parts are available for that particular type**
	**HANDS-ON-TASK:** Have students list the steps in disassembling, inspecting, and reassembling the transfer case they have been assigned. Grade them on the completeness of the list
	**ON-VEHICLE NATEF:** Disassemble and reassemble transfer case. Page 421
	**ON-VEHICLE NATEF TASK:** Diagnose, test, and adjust electrical/electronic transfer case components. Page 424
	32. **SLIDE 32 EXPLAIN Figure 126-27** (a) exploded view of a Dualmatic® manual locking hub. (b) A Warn® manual locking hub
	**HANDS-ON-TASK:** Have students disassemble and reassemble a locking hub front axle. Grade them on their ability to complete the task, following all applicable safety procedures.
	**ON-VEHICLE NATEF TASK:** Inspect front bearings and locking hubs; perform necessary action. Page 422

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	**SEARCH INTERNET:** Have students search the Internet research and report on the NP203 doubler. Have them include the process for building a doubler and the advantages of doubling up a transfer case.
	**ON-VEHICLE NATEF TASK:** Diagnose noise and vibration concerns; determine necessary action.
	**Page 418**
	33. SLIDES 33-53 OPTIONAL 20 SLIDES TO EXPLAIN NV-242 TRANSFER CASE SERVICE
	**Crossword Puzzle (Microsoft Word) (PDF)**
	Word Search Puzzle (Microsoft Word) (PDF)