ATE5 Chapter 122 Manual Transmissions/Transaxles

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 different types of gears and gear ratios. 2. Describe the relationship between torque, speed, and power. 3. Explain the construction and operation of a synchronizer. 4. Describe the torque flow through a five-speed manual transmission. 5. Describe the procedure to diagnose, remove, disassemble, and install manual transmission/ transaxle.
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 122: ATE5 Chapter Images

ICONS	Chapter 122 Trans Fundamentals
	**1. SLIDE 1 CH122: Manual Transmissions/Transaxles**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/ WEB SITE IS CONSTANTLY UPDATED**
	**Videos**
	**2. SLIDE 2 EXPLAIN Figure 122-1** Spur gears have straight-cut teeth. **3. SLIDE 3 EXPLAIN Figure 122-2** teeth of a helical gear are cut at an angle to the gear axis.
	**DEMONSTRATION: Show the students a vehicle with a transmission and one with a transaxle.**
	**DISCUSSION: Ask the students to advantages & disadvantages of the transaxle design compared to transmission design.**
	**4. SLIDE 4 EXPLAIN Figure 122-3** A spur gear has straight-cut teeth. This design is very strong and is used where strength is important. Spur gears are noisy during operation. Helical-cut gears, on the other hand, operate quietly but create a force in line with the axis of the gears due to the angle of the gear teeth.
	**DEMONSTRATION: Show a spur gear. Show examples of where they would find spur gears in non-automotive applications. (Examples: boat winches, gear reduction units on machinery, and analog clocks and watches)**
	**DISCUSSION: Ask the students to discuss the difference between spur and helical gears and other places in vehicle where you may find each.**
	**5. SLIDE 5 EXPLAIN Figure 122-4** A pinion gear meshed with an internal ring gear rotates in the same direction around a parallel axis of rotation. **6. SLIDE 6 EXPLAIN Figure 122-5** When two external

gears mesh, they rotate in opposite directions.

7. **SLIDE 7 EXPLAIN Figure 122-6** Bevel gears are often used to change the direction of rotation and are typically used in differentials.
8. **SLIDE 8 EXPLAIN Figure 122-7** differential uses a hypoid gear set to provide a change in direction of torque and for gear reduction (torque increases) to drive wheels.

DEMONSTRATION: Show the students an example of a hypoid gear in a differential. Point out how the pinion gear is offset from the ring gear.

9. **SLIDE 9 EXPLAIN Figure 122-8** Gear ratio is determined by dividing the number of teeth of the driven (output) gear (24 teeth) by the number of teeth on the driving (input) gear (12 teeth). The ratio illustrated is 2:1.
10. **SLIDE 10 EXPLAIN Figure 122-9** gear combination provides a gear reduction of 3:1.
11. **SLIDE 11 EXPLAIN Figure 122-10** This gear combination provides an overdrive ratio of 0.33:1.

DEMONSTRATION: Show the students how using different size combinations of gears changes rotation speed.

External Gears, 2:1 (View) (Download)
Internal & External Gear (View) (Download)

DISCUSSION: Ask the students to discuss how gear ratios help when pedaling a multi-speed bike

12. **SLIDE 12 EXPLAIN Figure 122-11** Idler gears affect the direction of rotation in a gear train, but not the final drive ratio.

Show ANIMATION: Idler Gear Operation
External Gears With Idler (View) (Download)

DEMONSTRATION: Show the students two gears connected by an idler gear. Explain how idler gear keeps both gears rotating in the same direction.

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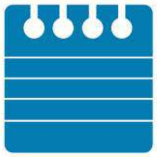	**Good example of an idler gear used in an in-block cam system is a gear called a "bone," which takes place of a timing chain**
	13. **SLIDE 13 EXPLAIN Figure 122-12** Gears apply torque in the same way a wrench applies torque—the force applied multiplied by the distance from the center of the gear equals the torque. 14. **SLIDE 14 EXPLAIN Figure 122-13** lever can be used to multiply torque, but it does so at the expense of distance or speed.
	**DEMONSTRATION: Show the students how a fulcrum and lever can reduce lifting effort. Set a long lever on fulcrum ¼ of way to the load you want to lift. Then move fulcrum to ¼ of distance from the input point. Show students how decreased lift effort increases the length of movement and then opposite happens for other setup.**
	**DISCUSSION: Have students discuss other places on the vehicle where leverage is used to reduce input effort.**
	**HANDS-ON TASK: Have students use several combinations of fulcrums and levers to lift objects so they can experience input force required to lift heavier objects or to move objects longer distance.**
	15. **SLIDE 15 EXPLAIN Figure 122-14** Cross section of a five-speed manual transmission showing the main parts. 16. **SLIDE 16 EXPLAIN Figure 122-15** Cutaway of 6-speed manual transmission showing its internal parts.
	**DEMONSTRATION: Show examples of manual transmissions. Show difference in construction of each. Show the students internal workings of several manual transmissions. Show locations of major parts.**
	**DISCUSSION: Ask students to discuss why the design of manual transmissions varies. Ask them to explain advantage & disadvantage of each design.**
	**DISCUSSION: Ask the students to discuss the terms "gear reduction" and "overdrive." In each combination, something is gained and something is**

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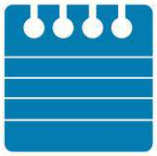
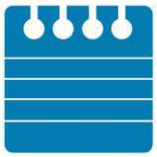
	lost. (For example, in gear reduction, the number of rotations is lost but torque is increased)
	**17. SLIDE 17 EXPLAIN Figure 122-16** Notice that the countershaft and the main shaft both use gears of increasing size that mesh together.
	**DEMONSTRATION: Show countershaft. Show how gears on shaft are fixed and decrease in size from one end to other. Demonstrate that gears on countershaft are fixed to shaft and all turn together whenever power comes into the input shaft. Show the main shaft. Show them that only the input gear is fixed to shaft. Show the students how the gears on the main shaft decrease in size in the opposite direction from the countershaft.**
	**DEMONSTRATION: Show an example of a floor shift rod-and-fork shifting mechanism. Show them how moving the shift lever moves the forks and how detents prevent two gears from being shifted at one time.**
	**HANDS-ON TASK: Have the students move the shift lever and watch the action of the forks. Have them observe use of detents to prevent two forks from moving at one time.**
	**18. SLIDE 18 EXPLAIN Figure 122-17** typical shift mechanism showing shift detents designed to not only give driver a solid feel when shifting but also to prevent 2 gears from being selected at same time. Shifter also prevents shifting into reverse except from neutral position.
	**Worn detents can cause trans lock-up when 2 gears synchronize at same time**
	**Transmission Interlocks & Detents (View) (Download)**
	**19. SLIDE 19 EXPLAIN Figure 122-18** The shifter fork fits into the groove of the synchronizer sleeve. When a shift is made, the sleeve is moved toward the speed gear. The sleeve presses the stop ring (synchronizer ring) against the cone area of the speed gear. The friction

between the stop ring and the speed gear causes the speed of the two to become equal, permitting the sleeve to engage the gear clutch teeth of the speed gear. When this engagement occurs, the shift is complete.

DEMONSTRATION: Show a synchronizer assembly. Show major components of synchronizer and how they fit together. Show the placement of synchronizer in a manual transmission. Show students how synchronizer moves between centered positions to speed gear.



Cutting a 90-degree pie shape out of a synchronizer assembly with a band saw makes it easier to see operation.

DEMONSTRATION: Show how to inspect components of a synchronizer assembly. Show the students how the back taper works to help engage and hold the synchronizer into the speed gear.

Show ANIMATION: Synchronizer Operation

Synchronizer Operation (View) (Download)

20. **SLIDE 20 EXPLAIN Figure 122-19** Typical synchronizer assembly.
21. **SLIDE 21 EXPLAIN Figure 122-20** Synchronizer keys are attached to the clutch hub and push against the synchronizer ring when the sleeve is being moved during a shift. Notice the grooves on the synchronizer ring. These grooves prevent lubricating oil from becoming trapped between the ring and the cone surface of the speed gear. The grooves also help the ring release from the cone surface when a shift is made out of a gear.
22. **SLIDE 22 EXPLAIN Figure 122-21** A shift sequence starts when the shift fork is moved by the driver, (1) applying a force on the sleeve that moves it toward the speed gear. (2) The sleeve and the inserts contact the stop ring (blocking ring). (3) The synchronizer ring (stop ring) engages the cone on the speed gear, causing both assemblies to reach the same speed. (4) The shift is completed when the internal teeth of the sleeve mesh with the gear clutch teeth of the speed gear.

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  	**23. SLIDE 23 EXPLAIN Figure 122-22** Before reassembling the transmission/transaxle, carefully inspect the splines on the synchronizer sleeves for wear. The shape of the splines helps prevent the transmission/transaxle from jumping out of gear during acceleration and deceleration. **24. SLIDE 24 EXPLAIN Figure 122-23** A three-piece synchronizer assembly. This type of synchronizer uses two cones, which helps achieve a smooth shift with less driver effort. Many newer transmissions/transaxles use a paper lining similar to that of the clutches in an automatic transmission. The transmissions/transaxles that have these paper linings must use automatic transmission fluid (ATF) for proper operation and long life. **DISCUSSION: Have the students discuss the effect of worn synchronizer rings in the assembly.** **Transmission Power Flow (View) (Download)** **25. SLIDE 25 EXPLAIN Figure 122-24** In neutral, the input shaft and the countershaft are rotating if the clutch is engaged (clutch pedal up), but no torque is being transmitted through the transmission. **26. SLIDE 26 EXPLAIN Figure 122-25** first gear, 1–2 synchronizer sleeve is moved rearward, locking the first speed gear to the output shaft. Torque is transmitted from the input shaft to countershaft and then to output shaft. **27. SLIDE 27 EXPLAIN Figure 122-26** In second gear, the 1–2 synchronizer sleeve is moved forward, which locks the second speed gear to the output shaft. **28. SLIDE 28 EXPLAIN Figure 122-27** To achieve third gear, the shaft linkage first centers the 1–2 synchronizer sleeve and then moves the 3–4 synchronizer sleeve rearward, locking third speed gear to the output shaft. **29. SLIDE 29 EXPLAIN Figure 122-28** In fourth gear, the 3–4 synchronizer sleeve is moved forward, which locks the fourth speed gear to the output shaft. **30. SLIDE 30 EXPLAIN Figure 122-29** To achieve fifth gear, the shift linkage first centers the 3–4 synchronizer sleeve and then moves the fifth synchronizer sleeve toward the fifth speed gear, locking it to the output shaft.

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	31. **SLIDE 31 EXPLAIN Figure 122-30** Torque flows through the transmission in reverse gear. Note that the idler gear drives the 1–2 synchronizer sleeve gear, which is splined to the output shaft. 32. **SLIDE 32 EXPLAIN Figure 122-31** Cutaway of T56 6-SPD transmission showing all its internal parts.
	**6 Speed Transaxle Operation (View) (Download)**
	**DEMONSTRATION: Show students how power flows through a 5-speed transmission, using Figures 122-24 to 122-30. Show how neutral is achieved with centering of all synchronizers.**
	**DEMONSTRATION: Show the students how reverse is achieved with the centering of all synchronizers.**
	**DISCUSSION: Ask the students to discuss what the effect would be on shift quality as the gears and synchronizers begin to wear.**
	33. **SLIDE 33 EXPLAIN Figure 122-32** Notice that this five-speed transaxle from a Dodge/Plymouth Neon uses synchronizers on both the input and output shafts. 34. **SLIDE 34 EXPLAIN Figure 122-33** Cutaway of a typical manual transaxle showing all of its internal parts including the final drive assembly.
	**DEMONSTRATION: Show the students an example of a manual transaxle. Show the students the similarities between a transaxle and a rear-wheel-drive manual transmission.**
	**Transaxle, Power Flow (View) (Download)**
	**DISCUSSION: discuss advantages & disadvantages of 2 types of transmissions. Ask them what similarities they see & what differences.**
	**ON-VEHICLE NATEF TASK: Describe the operational characteristics of an electronically controlled manual transmission/transaxle. P398**

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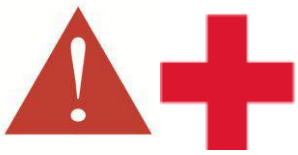
	**SEARCH INTERNET: use Internet to research how helical and hypoid gears are manufactured. Ask them to write a report that describes at least two different manufacturing processes.**
	35. **SLIDE 35 EXPLAIN Figure 122-34** When the transmission/transaxle is removed from the vehicle, the engine must be supported. In this case, the engine oil pan is supported with a block of wood to spread the load across the entire oil pan to prevent damage. The block of wood is placed on top of a tall safety stand that allows room for the service technician to work while standing.
	**DEMONSTRATION: Show how to support the engine during transmission removal. Show them how to support engine from below and from above.**
	**DISCUSSION: discuss importance of supporting engine properly. Ask them to discuss damage that can happen to engine if it is not supported properly. Ask students to discuss safety factors involved in properly supporting engine.**
	36. **SLIDE 36 EXPLAIN Figure 122-35** A transaxle being removed from underneath a vehicle and being supported by a transmission jack. 37. **SLIDE 37 EXPLAIN Figure 122-36** Typical cable-operated shift linkage used on a FWD transaxle.
	**SAFETY: With cover off of transmission and someone turning output or input shaft, be careful of students getting their fingers pinched between gears.**
	**HANDS-ON TASK: Have students move synchronizers into place to see how the gears are engaged. Have the students place correct synchronizer into place to achieve reverse.**
	**ON-VEHICLE NATEF TASK: Inspect powertrain mounts. Page 389**
	38. **SLIDE 38 EXPLAIN Figure 122-37** Drain the fluid into a suitable container and dispose of the old fluid according to local, state, and federal regulations

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	**ON-VEHICLE NATEF TASK: Diagnose fluid loss, level, and condition; determine necessary action. Page 382**
	**ON-VEHICLE NATEF TASK: Drain and refill manual transmission/transaxle and final drive unit. Page 383**
	**DEMONSTRATION: ON-VEHICLE NATEF TASK: Remove and reinstall transmission/transaxle. Page 384**
	
	**SEARCH INTERNET: Have the students use the Internet to research Have the students use the Internet to research M22 GM Muncie transmission known as the Rock Crusher. Ask them to summarize their findings in a report, making sure they discuss the gear ratio and construction characteristics of this muscle-car transmission**
	**DEMONSTRATION: Show proper procedure for disassembling the transmission and inspecting parts for wear.**
	39. **SLIDE 39 EXPLAIN Figure 122-38** Borg-Warner T5 5-speed transmission shown with shifter cover removed. 40. **SLIDE 40 EXPLAIN Figure 122-39** cost to replace these gears may exceed the cost of a replacement transmission. 41. **SLIDE 41 EXPLAIN Figure 122-40** It often requires 2 people to assemble a transaxle because shaft with the shifter forks needs to be placed into the case as an assembly, as on this unit.
	42. **SLIDE 42 EXPLAIN Figure 122-41 (a)** During the disassembly of any manual transmission/transaxle, carefully check for the location of the snap rings. Often they are hidden. Consult the factory service manual or unit repair manual for information and procedures for the unit being serviced. 43. **SLIDE 43 EXPLAIN Figure 122-41 (b)** Using snap-ring pliers to remove a snap ring. Many snap rings have

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	an "up" side. Be sure to reinstall any snap rings in the correct direction.
	**DEMONSTRATION: Show the importance of inspection before disassemble. Explain that at times damage as simple as a bad gear can outweigh the cost of a new transmission by time you consider labor for rebuilding. Show students the proper way to remove snap rings. Explain that there is always a correct tool for job.**
	44. **SLIDE 44 EXPLAIN Figure 122-41 (c)** After the snap ring is removed, some components can be simply lifted off the main shaft, while other gears may require the use of a press.
	45. **SLIDE 45 EXPLAIN Figure 122-42a** Many gears require that a hydraulic press be used to separate the gear(s) from the shaft. After double-checking that all snap ring retainers have been removed and after checking in the service manual to see which gear needs to be pressed off, carefully position the "bearing splitter" as far inward as possible to avoid damaging the teeth during the pressing operation.
	46. **SLIDE 46 EXPLAIN Figure 122-42b** Use caution when pressing parts onto the main shaft.
	**ON-VEHICLE NATEF TASK: Disassemble and reassemble transmission OR transaxle components. Page 385**
	**ON-VEHICLE NATEF TASK: Inspect transmission/transaxle case and related parts; determine necessary action. Page 386**
	**ON-VEHICLE NATEF TASK: Diagnose transaxle final drive assembly; determine necessary action. Remove, inspect, measure, adjust, and reinstall final drive pinion Page 395**
	**HOMEWORK: SEARCH INTERNET: Have students use Internet to research synchronizers and how gears are selected. Ask them to report their findings to the class in a presentation.**
	**ON-VEHICLE NATEF TASK: Diagnose noise, hard shifting concerns; determine necessary action Page 387**

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	**ON-VEHICLE NATEF TASK: Inspect, adjust, and reinstall shift linkage. Page 388**
	**DISCUSSION: Have students discuss importance of using proper fluid for each transmission they are working on. Have them discuss why different fluids are recommended for different transmissions.**
	47. **SLIDE 47 EXPLAIN Figure 122-43** Some manual transmissions/transaxles require synchromesh transmission fluid. 48. **SLIDE 48 EXPLAIN Figure 122-44** Some manual transmissions/transaxles require synchromesh transmission fluid
	**ON-VEHICLE NATEF TASK: Inspect lubrication devices; perform necessary action. Page 396**
	**ON-VEHICLE NATEF TASK: Inspect and test manual transmission/transaxle sensors and switch Page 397**
	**DISCUSSION: Ask the students to discuss different wear points and how they would affect transmission performance.**
	49. **SLIDES 49-64 EXPLAIN NV-1500 MANUAL TRANSMISSION**
	**ON-VEHICLE NATEF TASK: Inspect and replace manual transmission gaskets and seals. Page 390**
	**ON-VEHICLE NATEF TASK: Remove and replace transaxle final drive. Page 391**
	**ON-VEHICLE NATEF TASK: Inspect and adjust shift cover and fork. Page 392**

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	**ON-VEHICLE NATEF TASK:** Measure endplay on transmission/transaxle; perform necessary action. **Page 393**
	**ON-VEHICLE NATEF TASK:** Inspect and reinstall synchronizer assembly. **Page 394**
	**DEMONSTRATION:** Show the students how to use a press to remove a bearing from the shaft. Show them how to check bearing for wear and to determine if the bearing is reusable.
	65. SLIDES 65-82 EXPLAIN NV-350 TRANSAXLE SERVICE
	**SEARCH INTERNET:** Have the students use Internet to research the manufacturers of manual transmissions. Ask them to report to the class on three different manufacturers and the advantages or disadvantages of each manufacturer's product. In their reports, have them compare prices of the transmissions.
	Crossword Puzzle (Microsoft Word) (PDF) Word Search Puzzle (Microsoft Word) (PDF)