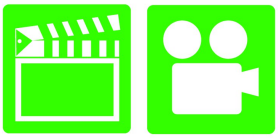
Automotive Maintenance and Light Repair, 1ST Edition

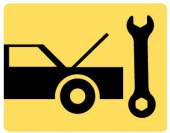
Chapter 64 Manual Transmission/Transaxles

Opening Your Class

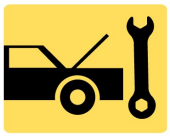
KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers **Automotive Maintenance and Light Repair.** It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure 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 the chapter learning objectives to the students. ⁀ Prepare for the ASE Manual Drive Train and Axles (A3) certification test content area "B" (Transmission Diagnosis and Repair) and content area "C" (Transaxle Diagnosis and Repair). ⁀ Explain how to calculate gear ratios. ⁀ Name the parts of a typical manually shifted transmission/transaxle. ⁀ Describe how the synchronizer assembly allows for smooth, clash-free shifting. ⁀ Describe the different types of lubricants that may be used in a manual transmission/transaxle. ⁀ Diagnose a difficult-to-shift manual transmission/transaxle. ⁀ Describe the service and overhaul procedures for manual transmission and transaxles.
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.

ICONS	Ch64 Manual Transmission/Transaxles
	**1. SLIDE 1 CH64 Manual Transmission/Transaxles** **2. SLIDES 2-3 EXPLAIN** OBJECTIVES
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE REGULARLY UPDATED**
	**4. SLIDES 4-5 EXPLAIN Need for a Transmission**
	**6. SLIDES 6-7 EXPLAIN** Gear Types **8. SLIDE 8 EXPLAIN Figure 64-1** Spur gears have straight-cut teeth. **9. SLIDE 9 EXPLAIN Figure 64-2** teeth of a helical gear are cut at an angle to the gear axis.
	**DEMONSTRATION: SHOW VEHICLE WITH A TRANSMISSION AND ONE WITH A TRANSAXLE.**
	**DISCUSSION: DISCUSSADVANTAGES & DISADVANTAGES OF THE TRANSAXLE DESIGN COMPARED TO TRANSMISSION DESIGN.**
	**10. SLIDE 10 EXPLAIN Figure 64-3** 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 SPUR GEAR & WHERE THEY WOULD FIND SPUR GEARS IN NON-AUTOMOTIVE APPLICATIONS. (EG: BOAT WINCHES, GEAR REDUCTION UNITS ON MACHINERY, & ANALOG CLOCKS AND WATCHES)**
	**DISCUSSION: DISCUSS THE DIFFERENCE BETWEEN SPUR AND HELICAL GEARS AND OTHER PLACES IN VEHICLE WHERE YOU MAY FIND EACH.**

ICONS	Ch64 Manual Transmission/Transaxles
	11. **SLIDE 11 EXPLAIN Figure 64-4** A pinion gear meshed with an internal ring gear rotates in the same direction around a parallel axis of rotation. 12. **SLIDE 12 EXPLAIN Figure 64-5** When two external gears mesh, they rotate in opposite directions. 13. **SLIDE 13 EXPLAIN** Gear Types 14. **SLIDE 14 EXPLAIN Figure 64-6** Bevel gears are often used to change the direction of rotation and are typically used in differentials. 15. **SLIDES 15-16 EXPLAIN** Gear Types 17. **SLIDE 17 EXPLAIN Figure 64-7** 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.**
	18. **SLIDES 18-20 EXPLAIN** Gear Ratios 21. **SLIDE 21 EXPLAIN Figure 64-8** 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. 22. **SLIDES 22-23 EXPLAIN** Gear Ratios 24. **SLIDE 24 EXPLAIN Figure 64-9** gear combination provides a gear reduction of 3:1. 25. **SLIDE 25 EXPLAIN** Gear Ratios 26. **SLIDE 26 EXPLAIN Figure 64-10** This gear combination provides an overdrive ratio of 0.33:1. 27. **SLIDE 27 EXPLAIN** Gear Ratios
	**DEMONSTRATION: SHOW THE STUDENTS HOW USING DIFFERENT SIZE COMBINATIONS OF GEARS CHANGES ROTATION SPEED.**
	**DISCUSSION: DISCUSS HOW GEAR RATIOS HELP WHEN PEDALING A MULTI-SPEED BIKE**
	28. **SLIDE 28 EXPLAIN Figure 64-11** Idler gears affect the direction of rotation in a gear train, but not the final drive ratio.

ICONS	Ch64 Manual Transmission/Transaxles
	**IDLER GEAR OPERATION** **WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A8_ANIMATION/CHAPTER95_FIG_95_10/INDEX.HTM
	**DEMONSTRATION: SHOW 2 GEARS CONNECTED BY AN IDLER GEAR. EXPLAIN HOW IDLER GEAR KEEPS BOTH GEARS ROTATING IN THE SAME DIRECTION.**
	**GOOD EXAMPLE OF AN IDLER GEAR USED IN IN-BLOCK CAM SYSTEM IS A GEAR CALLED A "BONE," WHICH TAKES PLACE OF A TIMING CHAIN**
	29. **SLIDE 29 EXPLAIN** Torque, Speed, and Power 30. **SLIDE 30 EXPLAIN Figure 64-12** 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. 31. **SLIDES 31-32 EXPLAIN** Torque, Speed, and Power 33. **SLIDE 33 EXPLAIN Figure 64-13** lever can be used to multiply torque, but it does so at the expense of distance or speed. 34. **SLIDES 34-35 EXPLAIN** Torque, Speed, and Power
	**DEMONSTRATION: SHOW 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: DISCUSS OTHER PLACES ON THE VEHICLE WHERE LEVERAGE IS USED TO REDUCE INPUT EFFORT.**
	**HANDS-ON TASK: 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.**

ICONS	Ch64 Manual Transmission/Transaxles
	**INPUT SHAFT OPERATION** **WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYLABS/AKAMAI/TEMPLATE/VIDEO640X480.PHP?TITLE=INPUT%20SHAFT%20OPERATION&CLIP=PANDC/CHET/2012/AUTOMOTIVE/AUTO_PARTS_SPECIALIST/EXP19.MOV&CAPTION=CHET/CHET_MYLABS/AKAMAI/2012/AUTOMOTIVE/AUTO_PARTS_SPECIALIST/XML/EXP19.XML
	**36. SLIDES 36-40 EXPLAIN** Transmission Construction **41. SLIDE 41 EXPLAIN Figure 64-14** Cross section of a five-speed manual transmission showing the main parts. **42. SLIDE 42 EXPLAIN Figure 64-15** Cutaway of 6-speed manual transmission showing its internal parts.
	**DEMONSTRATION: SHOW MANUAL TRANSMISSIONS. SHOW DIFFERENCE IN CONSTRUCTION OF EACH. SHOW INTERNAL WORKINGS OF MANUAL TRANSMISSIONS. SHOW LOCATIONS OF MAJOR PARTS.**
	**DISCUSSION: DISCUSS WHY DESIGN OF MANUAL TRANSMISSIONS VARIES. ASK THEM TO EXPLAIN ADVANTAGE & DISADVANTAGE OF EACH DESIGN.**
	**43. SLIDES 43-45 EXPLAIN** Torque Flow Through a Manual Transmission
	**DISCUSSION: DISCUSS TERMS "GEAR REDUCTION" & "OVERDRIVE." IN EACH COMBINATION, SOMETHING IS GAINED AND SOMETHING IS LOST (EG, GEAR REDUCTION, # OF ROTATIONS IS LOST BUT TORQUE IS INCREASED)**
	**46. SLIDE 46 EXPLAIN** Speed Gears **47. SLIDE 47 EXPLAIN Figure 64-16** 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**

ICONS	Ch64 Manual Transmission/Transaxles
	DIRECTION FROM THE COUNTERSHAFT.
	**DEMONSTRATION: SHOW 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 STUDENTS MOVE THE SHIFT LEVER AND WATCH ACTION OF THE FORKS. HAVE THEM OBSERVE USE OF DETENTS TO PREVENT 2 FORKS FROM MOVING AT ONE TIME.**
	**48. SLIDES 48-49 EXPLAIN** Synchronizer Parts and Operation **50. SLIDE 50 EXPLAIN Figure 64-17** typical shift mechanism showing shift detents designed to not only give driver 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**
	**51. SLIDES 51-55 EXPLAIN** Synchronizer Parts and Operation **56. SLIDE 56 EXPLAIN Figure 64-18** 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.**

ICONS	Ch64 Manual Transmission/Transaxles
	CUTTING A 90-DEGREE PIE SHAPE OUT OF SYNCHRONIZER ASSEMBLY WITH A BAND SAW MAKES IT EASIER TO SEE OPERATION.
	57. SLIDES 57-64 EXPLAIN Synchronizer Parts and Operation
DEMO	**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.**
	SYNCHRONIZER OPERATION
	WWW.MYAUTOMOTIVELAB.COM
	HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A8_ANIMATION/CHAPTER95_FIG_95_20/INDEX.HTM
	65. SLIDE 65 EXPLAIN Figure 64-19 Typical synchronizer assembly.
	66. SLIDE 66 EXPLAIN Figure 64-20 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.
	67. SLIDE 67 EXPLAIN Figure 64-21 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.
	68. SLIDE 68 EXPLAIN Figure 64-22 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.
	69. SLIDE 69 EXPLAIN Figure 64-23 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: DISCUSS THE EFFECT OF WORN SYNCHRONIZER RINGS IN THE ASSEMBLY.

70. SLIDES 70-75 EXPLAIN Five-Speed Transmission Torque Flow

76. SLIDE 76 EXPLAIN Figure 64-24 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.

77. SLIDE 77 EXPLAIN Figure 64-25 In first gear, the 1–2 synchronizer sleeve is moved rearward, locking the first speed gear to the output shaft. Torque is transmitted from the input shaft to the countershaft and then to the output shaft.

78. SLIDE 78 EXPLAIN Figure 64-26 In second gear, the 1–2 synchronizer sleeve is moved forward, which locks the second speed gear to the output shaft.

79. SLIDES 79-81 EXPLAIN Five-Speed Transmission Torque Flow

82. SLIDE 82 EXPLAIN Figure 64-27 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.

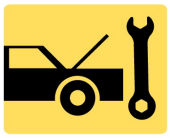
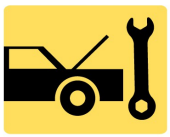
83. SLIDE 83 EXPLAIN Figure 64-28 In fourth gear, the 3–4 synchronizer sleeve is moved forward, which locks the fourth speed gear to the output shaft.

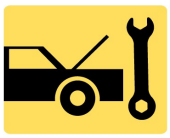
84. SLIDE 84 EXPLAIN Figure 64-29 To achieve fifth gear, the shift linkage first centers the 3–4 synchronizer sleeve and then moves the fifth synchronizer sleeve toward the fifth speed gear, locking it to the output shaft.

85. SLIDES 85-87 EXPLAIN Five-Speed Transmission Torque Flow

88. SLIDE 88 EXPLAIN Figure 64-30 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.

ICONS	Ch64 Manual Transmission/Transaxles
	89. **SLIDE 89 EXPLAIN Figure 64-31** Cutaway of T56 6-SPD transmission showing all its internal parts.
DEMO	**DEMONSTRATION: SHOW HOW POWER FLOWS THROUGH A 5-SPEED TRANSMISSION. SHOW HOW NEUTRAL IS ACHIEVED WITH CENTERING OF ALL SYNCHRONIZERS.**
DEMO	**DEMONSTRATION: SHOW HOW REVERSE IS ACHIEVED WITH THE CENTERING OF ALL SYNCHRONIZERS.**
QUESTION	**DISCUSSION: DISCUSS WHAT THE EFFECT WOULD BE ON SHIFT QUALITY AS THE GEARS AND SYNCHRONIZERS BEGIN TO WEAR.**
	90. **SLIDES 90-91 EXPLAIN** MT Construction 92. **SLIDE 92 EXPLAIN Figure 64-32** Notice that this five-speed transaxle from a Dodge/Plymouth Neon uses synchronizers on both the input and output shafts. 93. **SLIDE 93 EXPLAIN Figure 6-33** Cutaway of a typical manual transaxle showing all of its internal parts including the final drive assembly.
DEMO	**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.**
QUESTION	**DISCUSSION: ASK STUDENTS TO DISCUSS ADVANTAGES & DISADVANTAGES OF THE TWO TYPES OF TRANSMISSIONS. ASK THEM WHAT SIMILARITIES THEY SEE AND WHAT DIFFERENCES.**
We Support NATEF	**NATEF MLR TASK A3C1 DESCRIBE OPERATIONAL CHARACTERISTICS OF ELECTRONICALLY CONTROLLED MANUAL TRANSMISSION/TRANSAXLE**
	SEARCH INTERNET: HAVE THE STUDENTS 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.

ICONS	Ch64 Manual Transmission/Transaxles
	94. SLIDES 94-98 EXPLAIN Transmission/Transaxle Removal 99. SLIDES 99-101 EXPLAIN Transmission/Transaxle Disassembly
	**DEMONSTRATION:** SHOW STUDENTS HOW TO SUPPORT THE ENGINE DURING TRANSMISSION REMOVAL. SHOW THEM HOW TO SUPPORT ENGINE FROM BELOW AND FROM ABOVE.
	**DISCUSSION:** HAVE STUDENTS 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.
	**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.
	**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
	**DISCUSSION:** DISCUSS IMPORTANCE OF USING PROPER FLUID FOR EACH TRANSMISSION THEY ARE WORKING ON. HAVE THEM DISCUSS WHY DIFFERENT FLUIDS ARE RECOMMENDED FOR DIFFERENT TRANSMISSIONS.

ICONS	Ch64 Manual Transmission/Transaxles
 	**102. SLIDES 102-108 EXPLAIN** Gear Lubrication **109. SLIDE 109 EXPLAIN Figure 64-34** Some manual transmissions/transaxles require synchromesh transmission fluid. **SEARCH INTERNET: HAVE THE STUDENTS USE INTERNET TO RESEARCH THE MANUFACTURERS OF MANUAL TRANSMISSIONS. ASK THEM TO REPORT TO THE CLASS ON 3 DIFFERENT MANUFACTURERS AND THE ADVANTAGES OR DISADVANTAGES OF EACH MANUFACTURER'S PRODUCT. IN THEIR REPORTS, HAVE THEM COMPARE PRICES OF THE TRANSMISSIONS.**