Introduction to Automotive Service
Chapter 38 Manual Transmissions/Transaxles
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class serves as an introduction to the world of automotive service. 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. 1. 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). 2. List the parts that are included in the clutch system. 3. Describe how the clutch works. 4. Explain how to calculate gear ratios. 5. Name the parts of a typical manually shifted transmission/transaxle. 6. Explain the purpose and function of a drive shaft. 7. Describe the operation of CV joints 8. Determine the rear axle ratio. 9. Describe the difference between 4WD & AWD.
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	Chapter 38 Manual Transmissions/Transaxles
	**1. SLIDE 1 CH122: Manual Transmissions/Transaxles** **2. SLIDE 2 EXPLAIN** Purpose and Function of a Clutch
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS UPDATED REGULARLY**
	**VIDEOS Clutch (53 Links)** **Drive Axle (41 Links)** **Four Wheel Drive (26 LInks)** **http://www.jameshalderman.com/**
	**3. SLIDE 3 EXPLAIN FIGURE 38-1** clutch assembly attached to the engine crankshaft at the rear of the engine.
	**DISCUSSION: Ask the students to discuss the experiences they may have had with clutches**
	**4. SLIDE 4 EXPLAIN** Parts and operation **5. SLIDE 5 EXPLAIN FIGURE 38-2** (a) When the clutch is in the released position (clutch pedal depressed), the clutch fork is applying a force to the throwout (release) bearing, which pushes on the diaphragm spring, releasing the pressure on the friction disc **6. SLIDE 6 EXPLAIN FIGURE 38-2** (b) When the clutch is in the engaged position (clutch pedal up), the diaphragm spring exerts force on the clutch disc, holding it between the flywheel and the pressure plate
	**DISCUSSION: Show the students the leverage advantages used in clutch applications, such as the length of the clutch fork pushing on the throwout bearing in Figure 38–2. Another example would be the levers used in a lever and-rod linkage**
	**DEMONSTRATION: Show examples of a clutch disc, throw-out bearing and pressure plate.**

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	**Show ANIMATION: Clutch Operation www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A8_Animation/Chapter94_Fig_94_2/index.htm
	**Show ANIMATION: Clutch Operation http://www.jameshalderman.com/**
	**DEMONSTRATION: Show examples of a pilot bearing and a bushing.**
 	**DISCUSSION: Ask the students to discuss the difference between the pilot bearing and the bushing. Which would be the better style to use and why?**
	**Show VIDEO: 3 MINUTES Clutch System Components www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_mylabs/akamai/template/video640x480.php?title=Clutch%20System%20Components&clip=pandc/chet/2012/automotive/Auto_Parts_Specialist/Exp18.mov&caption=chet/chet_mylabs/akamai/2012/automotive/Auto_Parts_Specialist/xml/Exp18.xml
	**DEMONSTRATION: Show the students examples of pressure plates and how the lever style and diaphragm style work to disengage the clutch plate.**
 	**DISCUSSION: Ask the students to discuss why manufacturers use 2 types of pressure plates. What are advantages and disadvantages of each?**
	7. **SLIDE 7 EXPLAIN FIGURE 38-3** hydraulic clutch linkage uses a master cylinder and a slave cylinder.
	**ANIMATION: Cable Clutch Operation http://www.jameshalderman.com/**
	8. **SLIDE 8 EXPLAIN FIGURE 38-4** typical clutch master cylinder and reservoir mounted on the bulkhead on the driver's side of the vehicle. DOT 3 brake fluid is used in the hydraulic system to operate the slave cylinder located on the bell housing
	**ANIMATION: Clutch Hydraulic Operation http://www.jameshalderman.com/**

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	**9. SLIDE 9 EXPLAIN FIGURE 38-5** clutch pedal linkage moves the clutch fork, which then applies a force against the release bearing, which then releases the clamping force the pressure plate is exerting on the clutch disc **10. SLIDE 10 EXPLAIN FIGURE 38-6** typical clutch friction disc that uses coil spring torsional dampers that absorb the initial shock of engagement and help dampen engine firing in pulses being transmitted into and through the transmission/transaxle
	**DEMONSTRATION: Show students torsion dampening springs in a clutch disc. Demonstrate how these springs dampen the twisting motion of the clutch disc as the clutch is engaged.**
	**11. SLIDE 11 EXPLAIN** Flywheels
	12. SLIDE 12 EXPLAIN FIGURE 38-7 flywheel has a friction surface for the clutch and has gear teeth that are used by the starter motor to rotate the engine for starting
	**DEMONSTRATION: Show the students examples of flywheels with pilot bearings and some without.**
	**SAFETY Flywheels can be very heavy, and caution should be used when lifting. Flywheels also present a finger pinching hazard. Remind the students to follow appropriate safety precautions.**
	**DEMONSTRATION: Show two rotating objects of considerably different weights. An example would be a bicycle tire compared to a car tire. Demonstrate difference in inertia between two.**
	**SEARCH INTERNET: Have students research automotive careers that require the ability to repair, replace, and troubleshoot clutches. Ask the students to prepare to present at next class the following: career opportunities, their advantages and disadvantages, and their compensation levels.**

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	**Show VIDEO: 2.5 MINUTES Clutch Diagnosis** **www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_mylabs/akamai/template/video640x480.php?title=Diagnosis%20Clutch%20Problems&clip=pandc/chet/2012/automotive/Manual_Transmision/Diagnosing_Clutch_Problems.mov&caption=chet/chet_mylabs/akamai/2012/automotive/Manual_Transmision/xml/Diagnosing_Clutch_Problems.xml
	**13. SLIDES 13-14 EXPLAIN Manual Transmissions**
	**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.**
	**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.**
	**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.**
	**15. SLIDE 15 EXPLAIN Figure 38-8** 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.
	**ANIMATION: External Gears, 2:1** **http://www.jameshalderman.com/**
	**DEMONSTRATION: Show the students how using different size combinations of gears changes rotation speed**

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	**DISCUSSION:** Ask the students to discuss how gear ratios help when pedaling a multi-speed bike
	**Show ANIMATION: 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 the students two gears connected by an idler gear. Explain how idler gear keeps both gears rotating in the same direction
	**Show VIDEO: 1 MINUTE 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
	**16. SLIDE 16 EXPLAIN FIGURE 38-9** A manual transmission on a restored muscle car showing the bell housing, transmission, extension housing, and shifter **17. SLIDE 17 EXPLAIN Figure 38-10** Cross section of a five-speed manual transmission showing the main parts
	**DEMONSTRATION:** Show examples of manual transmissions. Show difference in construction of each. Show 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 lost. (For example, in gear reduction, the number of rotations is lost but torque is increased)

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	**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.**
	**ANIMATION: Transmission Power Flow** **http://www.jameshalderman.com/**
	**5 Speed Transmission, 1st Gear** **http://www.jameshalderman.com/**
	**ANIMATION: Transmission 2nd Gear** **http://www.jameshalderman.com/**
	**ANIMATION: Transmission 3rd Gear** **http://www.jameshalderman.com/**
	**ANIMATION: Transmission 4th Gear** **http://www.jameshalderman.com/**
	**ANIMATION: Transmission 5th Gear** **http://www.jameshalderman.com/**
	**ANIMATION: Transmission Reverse** **http://www.jameshalderman.com/**
	**ANIMATION: Transaxle, Power Flow** **http://www.jameshalderman.com/**
	**18. SLIDE 18 EXPLAIN Figure 38-11** typical shift mechanism showing shift detents designed to not only give driver a solid feel when shifting but also to prevent 2 gears being selected at same time. Shifter also prevents

shifting into reverse except from neutral position.

DEMONSTRATION: Show an example of a floor shift rod-&-fork shifting mechanism. Show them how moving shift lever moves forks & how detents prevent 2 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.

Worn detents can cause trans lock-up when 2 gears synchronize at same time

19. **SLIDE 19** EXPLAIN **Figure 38-12** 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.

ANIMATION: Synchronizer Operation
http://www.jameshalderman.com/

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.

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	**Show ANIMATION: Synchronizer Operation** **www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A8_Animation/Chapter95_Fig_95_20/index.htm
	**DISCUSSION: Have the students discuss the effect of worn synchronizer rings in the assembly.**
	**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.**
	**20. SLIDE 20 EXPLAIN FIGURE 38-13** partially disassembled manual transaxle showing the final drive assembly and some of the bearings and gears
	**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.**
	**DISCUSSION: Ask students to discuss advantages & disadvantages of the two types of transmissions. Ask them what similarities they see and what differences.**
	**ON-VEHICLE NATEF TASK (A3-C-17)** **Describe the operational characteristics of an electronically controlled manual transmission/transaxle (P-3) Page 398**
	**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.**
	**DEMONSTRATION: Show students how to support the engine during transmission removal. Show them how to support engine from below and from above.**

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	**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.
	**ON-VEHICLE NATEF TASK : (A3-A-5)** Diagnose fluid loss, level, and condition; determine necessary action. (P-1)
	**ON-VEHICLE NATEF TASK (A3-A-6)** Drain and refill manual transmission/transaxle and final drive unit. (P-1)
	**SEARCH INTERNET:** Have students use Internet to research M22 GM Muncie transmission known as Rock Crusher. Ask them to summarize their findings in a report, making sure they discuss gear ratio and construction characteristics of this muscle-car transmission
	**HOMEWORK:** Have students use Internet to research synchronizers and how gears are selected. Ask them to report their findings to the class in a presentation.
	**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.
	21. **SLIDE 21** EXPLAIN **FIGURE 38-14** Some manual transmissions/transaxles require synchromesh transmission fluid.
	**Show VIDEO: 1 MINUTE Measuring Main Shaft End Play www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_mylabs/akamai/template/video640x480.php?title=Measuring%20and%20Adjusting%20Main%20shaft%20End%20Play&clip=pandc/chet/2012/automotive/Drivetrain/A3T3.mov&caption=chet/chet_mylabs/akamai/2012/automotive/Drivetrain/xml/A3T3.xml
	**ON-VEHICLE NATEF TASK (A3-C-10)** Inspect and adjust shift cover and fork (P-2) Page 392
	**SEARCH INTERNET:** Have students' research manufacturers of manual transmissions. Ask them to report to the class on three different manufacturers & advantages or disadvantages of

each manufacturer's product. In their reports, have them compare prices of transmissions.

22. **SLIDE 22** EXPLAIN Drive Shafts

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.

DEMONSTRATION: Show driveshaft made of steel and another one made of aluminum. Show them parts of driveshaft, including tube, slip yoke, end yoke, & balance weights.

ANIMATION: RWD Driveshaft Operation
http://www.jameshalderman.com/

23. **SLIDE 23** EXPLAIN **FIGURE 38-15** Typical rear-wheel-drive power train arrangement. The engine is mounted longitudinal (lengthwise)

24. **SLIDE 24** EXPLAIN **FIGURE 38-16** A simple universal joint (U-joint)

ANIMATION: Universal Joint Operation
http://www.jameshalderman.com/

25. **SLIDE 25** EXPLAIN **FIGURE 38-17** Cardan U-joint used on the drive shaft on a rear-wheel-drive vehicle

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.

26. **SLIDE 26** EXPLAIN **FIGURE 38-18** 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

DEMONSTRATION: Show procedure for removing large axle nut on the end of the drive axle. Demonstrate how to use an impact wrench

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	and a large breaker bar
	27. SLIDE 27 EXPLAIN FIGURE 38-19 drive axle shaft (also called a half shaft) on a front-wheel-drive vehicle showing the inner and outer CV joints. The rubber boots that cover the joints and hold in the grease should be inspected for tears or other faults due to road debris
	**Show VIDEO: 1 MINUTE Axle Driveshaft Operation www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_mylabs/akamai/template/video640x480.php?title=Drive%20Axles%20and%20CV%20Joints&clip=pandc/chet/2012/automotive/Auto_Parts_Specialist/Exp22.mov&caption=chet/chet_mylabs/akamai/2012/automotive/Auto_Parts_Specialist/xml/Exp22.xml
	**ANIMATION: CV Joint http://www.jameshalderman.com/**
	**Show ANIMATION: Outer CV Joint www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A8_Animation/Chapter96_Fig_96_13/index.htm
	**DEMONSTRATION: Show the various boot-attaching methods. Demonstrate tools used to tighten the clamps on boots.**
	**DEMONSTRATION: Show the students how to remove an outer CV joint from the drive axle shaft.**
	**DEMONSTRATION: Show how to properly disassemble CV Joint. Demonstrate packing joint and resealing the boot with appropriate clamps.**
	**HANDS-ON-TASK: Have the students mark and remove the boot from the CV joint. Have them remove and disassemble CV joint, clean and inspect the CV joint, and reassemble the CV joint and install the boot. Grade them on the completeness and accuracy of their inspection and reassembly.**
	**28. SLIDE 28 EXPLAIN** Drive Axles and Differentials
	**Show ANIMATION: Differential Components www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A8_Animation/Chapter98_Fig_98_2/index.htm

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	**ANIMATION: Differential Action** **http://www.jameshalderman.com/**
	**DEMONSTRATION: Show an example of a complete differential asm. Demonstrate how turning pinion transfers rotation of axle shafts 90 degrees from rotation of pinion.**
	**VIDEO Differential Operation** **http://www.jameshalderman.com/**
	**29. SLIDE 29 EXPLAIN FIGURE 38-20** The differential assembly changes the direction of engine torque and increases the torque to drive wheels **30. SLIDE 30 EXPLAIN FIGURE 38-21** difference between the travel distance of the drive wheels is controlled by the differential **31. SLIDE 31 EXPLAIN FIGURE 38-22** When the vehicle turns a corner, the inner wheel slows and the outer wheel increases in speed to compensate. This difference in rotational speed causes the pinion gears to "walk" around the slower side gear
	**32. SLIDE 32 EXPLAIN FIGURE 38.23** (a) A two-wheel-drive vehicle equipped with a standard differential. (b) A two-wheel-drive vehicle equipped with a limited-slip differential
	**Adjust Carrier, Threaded Adjusters** **http://www.jameshalderman.com/**
	**DISCUSSION: Ask the students to discuss reason for using a hypoid gear set as compared to a standard beveled gear arrangement** **FIGURE 125-4**
	**DISCUSSION: Ask the students to discuss the design of ring and pinion that qualifies it as a hypoid gear assembly. FIGURE 125-4**

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	**33. SLIDE 33** EXPLAIN Drive Axles and Differentials
	**Show ANIMATION: Differential Exploded View www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A8_Animation/Chapter98_Fig_98_6/index.htm
	**34. SLIDE 34** EXPLAIN Four-Wheel Drive
	35. SLIDE 35 EXPLAIN **FIGURE 38-24** typical transfer case is attached to output of transmission and directs engine torque to rear or to front & rear differentials
	**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**
	**36. SLIDES 36-38** EXPLAIN Four-Wheel Drive
	39. SLIDE 39 EXPLAIN **FIGURE 38-25** controls for transfer case on Chevrolet four-wheel-drive pickup truck
	**ANIMATION: Transfer Case, Chain Drive** **http://www.jameshalderman.com/**
	**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?**

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	**DEMONSTRATION: Show example of a drive chain transfer case. Demonstrate change in output as transfer case shifts between modes and ranges**
	**ANIMATION: Power Transfer Unit** http://www.jameshalderman.com/
	**40. SLIDE 40 EXPLAIN FIGURE 38-26** identification tag on the housing of a transfer case. This identification information is often needed to be sure that the correct parts or fluids are purchased. **41. SLIDE 41 EXPLAIN FIGURE 38-27** Some transfer cases require the use of special fluids. Always check service information for the exact fluid needed
	**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.**
	**Homework: complete Ch38 crossword puzzle: http://www.jameshalderman.com/links/book_intro/cw/crossword_ch_38.pdf**