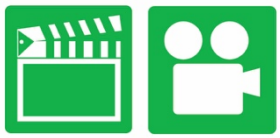
Hybrids & Alternative Fuel Vehicles 5/E

Chapter 11 Hybrid Vehicle Transmissions and Transaxles

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **Hybrid and Alternative Fueled Vehicles**. 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. 1. Describe the function of a hybrid electric vehicle (HEV) transmission. 2. Understand the relationship required between the ICE and electric motor(s). 3. Describe how the idle stop function is related to the needs of the automatic transmission operation. 4. Discuss modifications made to automatic transmissions installed in hybrid electric vehicles. 5. Explain the operation of continuously variable transmissions (CVTs).
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 Hybrids 4th Edition
Chapter Images found on Jim's web site @
www.jameshalderman.com
LINK CHP 11: Chapter Images

ICONS	Ch11 Hybrid Vehicle Trans & Transaxles
	**1. SLIDE 1 Hybrid Vehicle Transmissions and Transaxles** **2. SLIDE 2 EXPLAIN FIGURE 11.1** A vehicle transmission must adjust engine speed and torque to allow the vehicle to operate efficiently over a wide speed range **Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED**
 	**3. SLIDE 3 EXPLAIN FIGURE 11.2** Rear-wheel-drive (RWD) vehicles use transmissions to send torque to the rear differential and final drive. Front-wheel-drive (FWD) vehicles use a transaxle, which incorporates the differential and final drive into the transaxle case. **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**
 	**4. SLIDE 4 EXPLAIN FIGURE 11.3** Graph showing engine torque vs. horsepower output for a typical internal combustion engine. ICEs produce maximum torque at high RPM, whereas electric motors produce maximum torque at low RPM **DISCUSS FREQUENTLY ASKED QUESTIONS**
 	**5. SLIDE 5 EXPLAIN FIGURE 11.4** When output speed decreases in a transmission, output torque will increase
	**6. SLIDE 6 EXPLAIN FIGURE 11.5** Components of a differential assembly. The drive shafts of a FWD vehicle are connected to the side gears. **7. SLIDE 7 EXPLAIN FIGURE 11.6** Manual transaxle and clutch assembly from a Honda Civic Hybrid. The flywheel is attached to the engine crankshaft through the IMA rotor. **8. SLIDE 8 EXPLAIN FIGURE 11.7** A gear reduction with a 3:1 gear ratio. This means that the drive gear will turn three times for each revolution of the driven gear.

ICONS	Ch11 Hybrid Vehicle Trans & Transaxles
	**9. SLIDE 9 EXPLAIN FIGURE 10.8** A transaxle final drive uses helical gears to reduce speed and increase torque. The differential assembly is attached to the final drive ring gear. **10. SLIDE 10 EXPLAIN FIGURE 10.9** Lowering the splash shield to gain access to the manual transaxle fill and drain plugs. **11. SLIDE 11 EXPLAIN FIGURE 11.10** Remove oil fill plug, making sure that gasket is intact and is reinstalled with the plug after service. The oil should be level with the bottom of the fill hole. **12. SLIDE 19 EXPLAIN FIGURE 11.11** OEM products are the best guarantee of using the correct fluids for a vehicle. **13. SLIDE 22 EXPLAIN FIGURE 11.12** The torque converter attaches to the ICE crankshaft through a flexplate. **14. SLIDE 23 EXPLAIN FIGURE 11.13** Torque multiplication occurs when the fluid leaving the turbine strikes the front of the stator vanes and is redirected back to the impeller. Once the turbine speed reaches 90% of the impeller speed, the torque converter enters the coupling phase **15. SLIDE 15 EXPLAIN FIGURE 11.14** The torque converter clutch (TCC) is applied and released by reversing the flow of fluid through the torque converter housing. **16. SLIDE 16 EXPLAIN FIGURE 11.15** Planetary gearset showing the input attached to the sun gear and the output attached to planet carrier. The ring gear would be held to make this a functional gearset **17. SLIDE 26 EXPLAIN FIGURE 11.16** one-way clutch will freewheel in one direction, but lock up if rotated in the opposite direction. **18. SLIDE 18 EXPLAIN FIGURE 11.17** Multiple-disc clutches are applied by exerting hydraulic pressure on the piston. Piston seal rings are used to prevent leakage and maintain transmission fluid pressure. **19. SLIDE 19 EXPLAIN FIGURE 11.18** Cross-sectional view of torque converter and oil pump drive. **20. SLIDE 20 EXPLAIN FIGURE 11.19** Control strategy for one type of electronically controlled automatic

ICONS	Ch11 Hybrid Vehicle Trans & Transaxles
	transmission. **21. SLIDE 21 EXPLAIN FIGURE 11.20** Hydraulic circuit diagram for a GM 4L60E Model M33 transmission. Note the inclusion of an electric secondary fluid pump in the top right of the diagram. **22. SLIDE 22 EXPLAIN FIGURE 11.21** Integrated starter-generator (ISG) assembly adapted to a production 4L60E transmission. Note that the torque converter diameter is smaller to fit inside the rotor assembly. **23. SLIDE 23 EXPLAIN FIGURE 11.22** Electric secondary fluid pump from 4L60E transmission in a GM hybrid pickup
	**DISCUSS FREQUENTLY ASKED QUESTION**
	**24. SLIDE 24 EXPLAIN FIGURE 11.23** The two-mode transmission has orange high-voltage cable entering the unit to carry electric energy from the high-voltage battery pack to propel the vehicle and also to charge the battery during deceleration **25. SLIDE 25 EXPLAIN FIGURE 11.24** Using two planetary gearsets, ICE can be maintained in most efficient speed of 2,000 RPM under most conditions. **26. SLIDE 26 EXPLAIN FIGURE 11.25 (a)** Disassembly of the 2ML70 transmission requires the use of a lift or engine hoist to remove the motor assembly. **27. SLIDE 27 EXPLAIN FIGURE 11.25 (b)** The motor assembly after being removed for the transmission
	**28. SLIDE 28 EXPLAIN FIGURE 11.26** Cutaway view of Honda Accord Hybrid automatic transmission. **29. SLIDE 29 EXPLAIN FIGURE 11.27** Honda Accord Hybrid power train, including 3.0-liter V6, IMA assembly, and 5-speed automatic transmission. **30. SLIDE 30 EXPLAIN FIGURE 11.28** Honda Accord Hybrid auxiliary transmission fluid pump. This pump only operates when the ICE enters idle stop mode. **31. SLIDE 31 EXPLAIN FIGURE 11.29** Torque converter clutch (TCC) lockup in a Honda Accord Hybrid transmission. Clutch piston is attached to the turbine, so applying the clutch locks the turbine to the torque converter cover.

ICONS	Ch11 Hybrid Vehicle Trans & Transaxles
	**32. SLIDE 32 EXPLAIN FIGURE 11.30** The TCC is released by reversing the flow of fluid in the housing. Fluid pressure on the front side of the clutch piston causes it to move to the right, causing the turbine to be released from the torque converter housing **33. SLIDE 33 EXPLAIN FIGURE 11.31** Control schematic for a Honda Accord Hybrid automatic transmission. Note that all sensor inputs are shown to the left of the PCM, while the output signals and actuators are shown on the right. **34. SLIDE 34 EXPLAIN FIGURE 11.32** Honda Accord Hybrid will alert the driver of a transmission malfunction by flashing the "D" indicator on the instrument panel. **35. SLIDE 35 EXPLAIN FIGURE 11.33** Interpreting a blinking "D" indicator to retrieve transmission DTCs from a Honda Accord Hybrid
	**36. SLIDE 36 EXPLAIN FIGURE 10.34** The Toyota Hybrid System uses two electric motor/generators (MG1 and MG2) and an ICE all connected together by a power-split device which is a simple planetary gearset. **37. SLIDE 37 EXPLAIN FIGURE 11.35** power-split device from the Toyota Hybrid System. Note that the vehicle will only move when MG2 (and the ring gear) is turning. **38. SLIDE 38 EXPLAIN FIGURE 11.36** planetary gearset used in the Toyota Hybrid System (THS) has 2.6 times the number of teeth in its ring gear as it has in its sun gear. This means that the ICE (attached to the planet carrier) will send 72% of its torque to the ring gear (drive wheels), and 28% of its torque to the sun gear (MG1).
	**39. SLIDE 39 EXPLAIN FIGURE 11.37** Vehicle is stopped, ICE shut off along with both motor/generators. **40. SLIDE 40 EXPLAIN FIGURE 11.38** Under light acceleration, power is sent to MG2 to move the vehicle. **41. SLIDE 41 EXPLAIN FIGURE 11.39** Light acceleration—the engine is stopped (0 RPM), MG2 is turning forward (+), and MG1 is turning backward (–). **42. SLIDE 42 EXPLAIN FIGURE 11.40** To start ICE, MG1 (sun) acts as motor and turns CW, causing the planet carrier (attached to the ICE) to also turn CW
	**DISCUSSION: REVIEW IDLE STOP MODE WITH THE STUDENTS AND HIGHLIGHT THE DIFFERENCE BETWEEN A CONVENTIONAL STARTER &**

ICONS	Ch11 Hybrid Vehicle Trans & Transaxles
  	**VOLTAGE MOTOR GENERATOR.** **43. SLIDE 43 EXPLAIN FIGURE 11.41** Normal driving—the ICE is now running and some of its torque is used to drive MG1. Electricity generated by MG1 is used to power MG2 or recharge the HV battery. **44. SLIDE 44 EXPLAIN FIGURE 11.42** Normal driving—the engine is running, MG2 is turning forward +), and MG1 is turning backward (–) **DISCUSS FREQUENTLY ASKED QUESTION** **45. SLIDE 45 EXPLAIN FIGURE 11.43** Full-throttle acceleration and high-speed cruise—with greater demand for acceleration, power from MG1 is combined with power from the HV battery to generate higher output from MG2. It is also possible to configure MG2 as a generator and send its power to MG1 (which then acts as a motor). **46. SLIDE 46 EXPLAIN FIGURE 11.44** Full-throttle acceleration and high-speed cruise—this graph shows MG1 acting as a motor using power from MG2. This increases the speed of the ICE, allowing it to produce higher output. **47. SLIDE 47 EXPLAIN FIGURE 11.45** Deceleration & braking MG2 configured as generator, recharges battery. **48. SLIDE 48 EXPLAIN FIGURE 11.46** During normal energy flow, MG1 acts as a generator and supplies energy to power MG2. **49. SLIDE 49 EXPLAIN FIGURE 11.47** Under certain circumstances, the hybrid system is most efficient when MG2 acts as a generator and sends its power to MG1 **50. SLIDE 50 EXPLAIN FIGURE 11.48** Reverse—MG2 alone is used to move the car in reverse. This is accomplished by reversing the direction of MG2. **51. SLIDE 51 EXPLAIN FIGURE 11.49** Excessive heat created in the electric motors must be controlled and proper maintenance of the cooling system is important for long life to help avoid overheating motor winding as shown. **52. SLIDE 52 EXPLAIN FIGURE 11.50** Cutaway view of the Ford Escape Hybrid transaxle.

ICONS	Ch11 Hybrid Vehicle Trans & Transaxles
	53. SLIDE 53 EXPLAIN FIGURE 11.51 Ford Escape Hybrid transaxle operates very similar to the one used in the Toyota Hybrid System, but is constructed very differently. **54. SLIDE 54 EXPLAIN FIGURE 11.52** A Ford eCVT transaxle assembly showing the electrical connectors on the top of the assembly. **EXPLAIN TECH TIP**
	**55. SLIDE 55 EXPLAIN FIGURE 11.53 (a)** The vehicle speed increases, the drive pulley will have progressively higher pressure applied to it, while the driven pulley application pressure is lowered. **56. SLIDE 56 EXPLAIN FIGURE 11.53 (b)** This results in a higher speed ratio, allowing the engine to operate at a lower RPM.
	**EXPLAIN TECH TIP**
	**57. SLIDE 57 EXPLAIN FIGURE 10.54** Honda CVT drive belt construction. **58. SLIDE 58 EXPLAIN FIGURE 10.55** Honda CVT is connected to ICE through a drive plate and flywheel **59. SLIDE 59 EXPLAIN FIGURE 10.56** Honda CVT power flow in Park (P) or Neutral (N). **60. SLIDE 60 EXPLAIN FIGURE 10.57** Honda CVT power flow in Drive (D) or Low (L). **61. SLIDE 61 EXPLAIN FIGURE 10.58** Location of the Honda CVT start clutch. **62. SLIDE 62 EXPLAIN FIGURE 11.59** Honda CVT power flow in Reverse (R). **63. SLIDE 63 EXPLAIN FIGURE 11.60** The parking pawl mechanism on a Honda CVT **64. SLIDE 64 EXPLAIN FIGURE 11.61** Honda CVT transmission control module (TCM), with input (sensor) information on the left and outputs shown on the right
	**65. SLIDE 65 EXPLAIN FIGURE 11.62** Honda CVT has a dipstick for checking fluid level in the transmission case. The oil level should be maintained between the low (cold) and the high (hot) marks on the dipstick. **66. SLIDE 66 EXPLAIN FIGURE 11.63** Honda Accord V-6 hybrid electric vehicles used a Honda non-planetary

ICONS	Ch11 Hybrid Vehicle Trans & Transaxles
 	gear type automatic transaxle equipped with a small electric pump motor to maintain hydraulic fluid pressure during idle stop operation **DISCUSSION: WHAT ARE COMMON VOLTAGE RATINGS FOR MILD, MEDIUM, AND FULL HYBRID VEHICLES? REMIND STUDENTS OF SAFETY PRECAUTIONS REQUIRED FOR WORKING ON HYBRID ELECTRIC VEHICLES** **DISCUSSION: HAVE STUDENTS DISCUSS EFFICIENCIES OF ELECTRIC MOTORS AND INTERNAL COMBUSTION ENGINES. WHICH IS MORE EFFICIENT OVERALL—ELECTRIC MOTOR OR ICE?**