

# Automatic Transmissions and Transaxles, 7e

## Chapter 10 Hybrid Electric Vehicle Transmissions and Transaxles

### Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers Automatic Transmissions and Transaxles 7th Edition. It correlates material to task lists specified by <a href="#">ASE and ASE Education (NATEF)</a> .
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. <ol style="list-style-type: none"><li>1. Prepare for ASE Automatic Transmissions (A2) certification test content area "A" (General Transmission and Transaxle Diagnosis).</li><li>2. Identify the types of hybrid vehicles.</li><li>3. Identify the levels of hybrids.</li><li>4. Explain how an automatic transmission can be converted for use in hybrid electric vehicles.</li><li>5. Identify the components of a two-mode hybrid transmission system and explain its operation.</li><li>6. Discuss the operation of different hybrid vehicle transmissions.</li></ol>
Establish the Mood or Climate	Provide a <i>WELCOME</i> , 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 automatic Transmissions & Transaxle 6<sup>th</sup> Edition Chapter Images found on Jim's web site @ [www.jameshalderman.com](http://www.jameshalderman.com)**  
**DOWNLOAD CHP 10: Chapter Images**

## ICONS



## Ch10 HEV Transmissions and Transaxles

### 1. SLIDE 1 Hybrid Electric Vehicle Transmissions and Transaxles

Check for **ADDITIONAL VIDEOS & ANIMATIONS**  
@ <http://www.jameshalderman.com/>  
**WEB SITE IS CONSTANTLY UPDATED**

#### Videos

At the beginning of this class, you can download  
the crossword puzzle & Word Search from  
[http://www.jameshalderman.com/books\\_a2.html](http://www.jameshalderman.com/books_a2.html)  
to familiarize your class with the terms in this  
chapter & then discuss them

**DOWNLOAD Crossword Puzzle**

**DOWNLOAD Word Search Puzzle**










**Hybrid Auto Transmission (View) (Download)**

**DISCUSSION: HAVE STUDENTS COMPARE &  
CONTRAST COMPONENTS OF SERIES AND  
PARALLEL HYBRID VEHICLES. ASK STUDENTS TO  
IDENTIFY THE PROS AND CONS OF COMPONENTS.**

2. **SLIDE 2 EXPLAIN FIGURE 10-1** The power flow in a  
typical series-hybrid vehicle.
3. **SLIDE 3 EXPLAIN FIGURE 10-2** The power flow in a  
typical parallel-hybrid vehicle.
4. **SLIDE 4 EXPLAIN FIGURE 10-3** A series-parallel  
hybrid design allows the vehicle to operate in electric  
motor mode only or in combination with the internal  
combustion engine.

**SERIES HYBRID (VIEW) (DOWNLOAD)**

**PARALLEL HYBRID (VIEW) (DOWNLOAD)**

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	<p><b>DISCUSSION:</b> WHAT ARE COMMON VOLTAGE RATINGS FOR MILD, MEDIUM, AND FULL HYBRID VEHICLES? REMIND STUDENTS OF SAFETY PRECAUTIONS REQUIRED FOR WORKING ON HYBRID ELECTRIC VEHICLES</p>
	<p><b>DISCUSSION:</b> HAVE STUDENTS TALK ABOUT BELT ALTERNATOR STARTER SYSTEMS. WHAT ARE THE ADVANTAGES OF BAS SYSTEMS?</p>
	<p><b>DISCUSSION:</b> IDENTIFY OTHER FUELS THAT CAN REPLACE DIESEL FUEL. HOW WILL THESE ALTERNATE FUELS HELP REDUCE FUEL COSTS?</p>
	<p><b>DEMONSTRATION:</b> WHILE A HYBRID ENGINE IS IN IDLE STOP MODE, CONNECT A FIVE-GAS ANALYZER. HAVE STUDENTS TAKE NOTE OF THE CO2 READING TO CONFIRM ZERO OR LOW CO2 LEVELS IN IDLE STOP MODE. NEXT, CONNECT A FIVE-GAS ANALYZER TO AN ICE AND COMPARE CO2 READINGS AT IDLE. DISCUSS RESULTS.</p> <p><a href="#">Hybrid Auto Transmission (View) (Download)</a></p>
	
	<p>5. <b>SLIDE 5 EXPLAIN FIGURE 10-4</b> The rear electric motor on a Lexus RX 400h SUV.</p>
	<p>6. <b>SLIDE 6 EXPLAIN FIGURE 10-5</b> Honda Accord Hybrid auxiliary transmission fluid pump. This pump operates only when the ICE enters idle stop (stop-start) mode.</p>
	<p>7. <b>SLIDE 7 EXPLAIN FIGURE 10-6</b> 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.</p>
	<p>8. <b>SLIDE 8 EXPLAIN FIGURE 10-7</b> Electric secondary fluid pump from a 4L60E transmission in a GM hybrid pickup.</p>
	<p>9. <b>SLIDE 9 EXPLAIN FIGURE 10-8</b> 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.</p>

## ICONS



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### [Power Flow, Two-Mode Hybrid Transmission](#) [\(View\)](#) [\(Download\)](#)

10. **SLIDE 10 EXPLAIN FIGURE 10–9** Using three planetary gear sets, the ICE can be maintained in the most efficient speed of about 2000 RPM under most operating conditions. The ICE powers only the the front ring gear in any mode and all three planet sets are locked together (#3 being the output set) when the rear clutch activates Hi-Mode. In low mode, the rear ring gear is grounded for deep reduction. The mode is determined by the two rear clutches.
11. **SLIDE 11 EXPLAIN FIGURE 10–10a** Disassembly of the 2ML70 transmission requires the use of a lift or engine hoist to remove the motor assembly. **b** The motor assembly after being removed for the transmission.
12. **SLIDE 12 EXPLAIN FIGURE 10–11** Cutaway view of Honda Accord Hybrid automatic transmission.
13. **SLIDE 13 EXPLAIN FIGURE 10–12** Honda Accord Hybrid power train, including 3.0-liter V6, IMA assembly, and 5-speed automatic transmission.
14. **SLIDE 14 EXPLAIN FIGURE 10–13** 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.
15. **SLIDE 15 EXPLAIN FIGURE 10–14** The Honda Accord Hybrid will alert the driver of a transmission malfunction by flashing the “D” indicator on the instrument panel.
16. **SLIDE 16 EXPLAIN FIGURE 10–15** 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 gear set.
17. **SLIDE 17 EXPLAIN FIGURE 10–16** power-split device from the Toyota Hybrid System. Note that vehicle will move only when MG2 (and ring gear) is turning.
18. **SLIDE 18 EXPLAIN FIGURE 10–17** The planetary gear set 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

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wheels), and 28% of its torque to the sun gear (MG1).










19. **SLIDE 19 EXPLAIN FIGURE 10–18** When the vehicle is stopped, the ICE is shut off along with both motor/generators.
20. **SLIDE 20 EXPLAIN FIGURE 10–19** Under light acceleration, power is sent to MG2 to move the vehicle.
21. **SLIDE 21 EXPLAIN FIGURE 10–20** Light acceleration—the engine is stopped (0 RPM), MG2 is turning forward (+), and MG1 is turning backward (–).

**DISCUSSION: DISCUSS EFFICIENCIES OF ELECTRIC MOTORS & INTERNAL COMBUSTION ENGINES (ICE). WHICH IS MORE EFFICIENT OVERALL—ELECTRIC MOTOR OR ICE?**

22. **SLIDE 22 EXPLAIN FIGURE 10–21** To start the ICE, MG1 (sun) acts as a motor and turns clockwise (CW), causing the planet carrier (attached to the ICE) to also turn CW.
23. **SLIDE 23 EXPLAIN FIGURE 10–22** 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.
24. **SLIDE 24 EXPLAIN FIGURE 10–23** Normal driving—the engine is running, MG2 is turning forward (+), and MG1 is turning backward (–).
25. **SLIDE 25 EXPLAIN FIGURE 10–24** 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).
26. **SLIDE 26 EXPLAIN FIGURE 10–25** 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.
27. **SLIDE 27 EXPLAIN FIGURE 10–26** Deceleration and braking—MG2 is configured as a generator and recharges the HV battery.
28. **SLIDE 28 EXPLAIN FIGURE 10–27** Reverse—MG2 alone is used to move the car in reverse. This is accomplished by reversing the direction of MG2.



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	<p><b>DISCUSSION: REVIEW IDLE STOP MODE WITH THE STUDENTS AND HIGHLIGHT THE DIFFERENCE BETWEEN A CONVENTIONAL STARTER &amp; VOLTAGE MOTOR GENERATOR</b></p>
	<p>29. <b>SLIDE 29 EXPLAIN FIGURE 10–28</b> 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.</p>
	<p>30. <b>SLIDE 30 EXPLAIN FIGURE 10–29</b> Cutaway view of Ford Escape Hybrid transaxle.</p> <p>31. <b>SLIDE 31 EXPLAIN FIGURE 10–30</b> Ford Escape Hybrid transaxle operates very similar to the one used in the Toyota Hybrid System, but is constructed very differently.</p> <p>32. <b>SLIDE 32 EXPLAIN FIGURE 10–31</b> Ford eCVT transaxle assembly showing the electrical connectors on the top of the assembly.</p>
	<p><b>EXPLAIN TECH TIP: Traction Motors Move the Vehicle</b></p>
	<p>33. <b>SLIDE 33 EXPLAIN FIGURE 10–32</b> The Honda CVT is connected directly to the ICE through a drive plate and flywheel mechanism.</p> <p>34. <b>SLIDE 34 EXPLAIN FIGURE 10–33</b> The Honda Accord V-6 hybrid electric vehicle use a Honda non-planetary gear type automatic transaxle equipped with a small electric pump motor to maintain hydraulic fluid pressure during idle stop operation.</p>
	<p><b>WHEN SERVICING A HYBRID VEHICLE TRANSMISSION, BE CAREFUL OF ANY ORANGE-COLORED ELECTRICAL WIRE. ORANGE INDICATES PRESENCE OF HIGH-VOLTAGE CURRENT.</b></p>
	<p><b>DEMONSTRATION: DEMO DE-POWERING PROCEDURE ON A HYBRID ELECTRIC VEHICLE</b></p> <p>35. <b>SLIDE 35 EXPLAIN FIGURE 10–34</b> The primary motor/generator is used to propel the vehicle and the secondary motor/generator is used to start the engine and charge the high-voltage battery.</p>

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     <p>QUESTION</p>    	<p><b>EXPLAIN FREQUENTLY ASKED QUESTION:</b>  <b>How Does a Hybrid Work Without a Transmission?</b></p> <p><b>ON-VEHICLE NATEF TASK</b> IDENTIFY LOCATION OF HYBRID VEHICLE HIGH-VOLTAGE CIRCUIT DISCONNECT (SERVICE PLUG) LOCATION AND SAFETY PRECAUTIONS.</p> <p><b>DISCUSSION:</b> HAVE STUDENTS TALK ABOUT WHEN HIGH VOLTAGE SYSTEM NEEDS TO BE DEPOWERED &amp; WHEN IT DOESN'T. WHEN SERVICING A SYSTEM THAT MAY CONTAIN HIGH VOLTAGE, HOW CAN YOU BE SURE OF WHETHER OR NOT IT NEEDS TO BE DE-POWERED?</p> <p>36. SLIDE 36 <b>EXPLAIN</b> FIGURE 10–35 Some scan tool data may or may not be helpful unless there are codes or sub-codes that can lead to the source of a problem. For example, on this Lexus hybrid system, the screen capture shows that high voltage battery modules do not have an difference between them which eliminates the high voltage battery pack from being a concern.</p> <p><b>DEMONSTRATION: DEMO CHECKING SCAN DATA ON AN HEV</b></p> <p><b>HANDS-ON TASK: CHECK SCAN DATA ON AN HEV</b></p> <p><b>HANDS-ON TASK: SUPERVISE STUDENTS AS THEY DE-POWER VEHICLE.</b></p>