Automotive Technology 6th Edition
Chapter 54 CHARGING SYSTEM
Opening Your Class

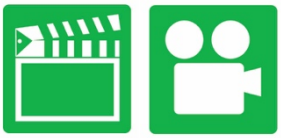
KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 6th text provides complete coverage of automotive components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and ASEEducation (NATEF) and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Case Studies, Videos, Animations, and ASEEducation (NATEF) Task Sheets.
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 why an alternator generates an AC and changes it to DC. 2. Describe an alternator's construction, including overrunning pulleys. 3. Describe components and operation of an alternator. 4. Discuss how an alternator works. 5. List the factors determining an alternator's output voltage and current. 6. Explain how the voltage and heat produced by an alternator are regulated. 7. Discuss computer-controlled alternators. 8. This chapter will help prepare for the ASE Electrical/Electronic Systems (A6) certification test content area "C" (Starting System Diagnosis and Repair).
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: Lesson plan is based on 6th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

DOWNLOAD Chapter 54 Chapter Images: From

http://www.jameshalderman.com/automotive_principles.html

NOTE: You can use Chapter Images or possibly Power Point files:

ICONS	CH54 Charging Operation
         	**1. TITLE SLIDE 1 CHARGING SYSTEM** **Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **http://www.jameshalderman.com/automotive_principles.html** **DOWNLOAD** **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF** **Videos** 2. **SLIDE 2 EXPLAIN Figure 54-1** typical alternator on a Chevrolet V-8 engine. 3. **SLIDE 3 EXPLAIN Figure 54-2** end frame toward the drive belt is called the drive-end housing and the rear section is called the slip-ring-end housing. **DISCUSSION: Have students talk about function of generator, or motor, used in hybrid vehicles. How can an alternator also function as a motor?** **HANDS-ON TASK: Have the students locate the sticker or stamp that shows the alternator amperage rating on several different alternators.** 4. **SLIDE 4 EXPLAIN Figure 54-3** OAP on a Corvette 5. **SLIDE 5 EXPLAIN Figure 54-4** exploded view of an overrunning alternator pulley showing all of internal parts. **DISCUSSION: Discuss the pros and cons of using an OAP or OAD pulley. Why isn't an OAP or OAD being used on every vehicle?** **EXPLAIN TECH TIP: *Alternator Horsepower and Engine Operation:* Many technicians are asked how much power certain accessories require. 100-ampere alternator requires about 2 horsepower from engine. One horsepower is equal to 746 watts. Watts are calculated by multiplying amperes X volts. Power in watts = 100 A X 14.5 V = 1,450 W**

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	1 hp = 746 W, So, 1,450 watts is 2 horsepower. Allowing about 20% for mechanical and electrical losses adds another 0.4 horsepower. Therefore, when someone asks how much power it takes to produce 100 amperes from an alternator, the answer is 2.4 horsepower. Many alternators delay electrical load to prevent engine from stumbling when a heavy electrical load is applied. The voltage regulator or vehicle computer is capable of gradually increasing the output of the alternator over a period of several minutes. Even though 2 horsepower does not sound like much, a sudden demand for 2 horsepower from an idling engine can cause the engine to run rough or stall. The difference in part numbers of various alternators is often an indication of the time interval over which the load is applied. Therefore, using wrong replacement alternator could cause engine to stall!
	6. **SLIDE 6 EXPLAIN FIGURE 54–5** An overrunning alternator damper (OAD) is not a simple one-way clutch or a solid pulley, but instead is engineered to dampen noises and vibrations in the front accessory drive belt system.
	**DISCUSS FREQUENTLY ASKED QUESTION: *Can I Install an OAP or an OAD to My Alternator?* Usually, no. An alternator needs to be equipped with the proper shaft to allow the installation of an OAP or OAD. This also means that a conventional pulley often cannot be used to replace a defective overrunning alternator pulley or dampener. Check service information for the exact procedure to follow.**
	7. **SLIDE 7 EXPLAIN Figure 54-6** A cutaway of an alternator, showing the rotor and cooling fan that is used to force air through the unit to remove the heat created when it is charging the battery and supplying electrical power for the vehicle 8. **SLIDE 8 EXPLAIN Figure 54-7** Rotor assembly of a typical alternator. Current through the slip rings causes the "fingers" of rotor to become alternating north and south

magnetic poles. As rotor revolves, these magnetic lines of force induce a current in the stator windings.

9. **SLIDE 9 EXPLAIN Figure 54-8** An exploded view of a typical alternator showing all of its internal parts including the stator windings.
10. **SLIDE 10 EXPLAIN Figure 54-9** A rectifier usually includes six diodes in one assembly and is used to rectify AC voltage from the stator windings into DC voltage suitable for use by the battery and electrical devices in the vehicle.

DEMONSTRATION: Show the students examples of rotor and stator windings. Have them help you identify each component and explain its purpose.

DISCUSSION: Discuss how diodes function as a valve. What is the difference between an NPN and a PNP?

11. **SLIDE 11 EXPLAIN Figure 54-10** Magnetic lines of force cutting across a conductor induce a voltage and current in the conductor.
12. **SLIDE 49 EXPLAIN Figure 54-11** A sine wave (shaped like the letter S on its side) voltage curve is created by one revolution of a winding as it rotates in a magnetic field.
13. **SLIDE 13 EXPLAIN Figure 54-12** When 3 windings (A, B, and C) are present in stator, the resulting current generation is represented by three sine waves. Voltages are 120 degrees out of phase. The connection of individual phases produces 3-phase alternating voltage.

Charging System (View) (Download)
WYE Stator Winding & Diodes (View) (Download)

14. **SLIDE 14 EXPLAIN Figure 54-13** Wye-connected stator winding.
15. **SLIDE 15 EXPLAIN Figure 54-14** As magnetic field, created in rotor, cuts across windings of stator, a current is induced. Notice that current path includes passing through one positive (+) diode on way to battery and one negative (−) diode as a complete circuit is completed through rectifier and stator.
16. **SLIDE 16 EXPLAIN Figure 54-15** Delta-connected stator winding.

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	**DISCUSSION:** **Draw a pattern of three phase voltage. Show students what happens to the graph when diodes are used to rectify the current.**
	HANDS-ON TASK: **Have the students draw a schematic of a wye connected stator. Grade them on their ability to create an appropriate schematic with accurate information.**
	**Students complete ASEEDUCATION Task Sheet: Research applicable vehicle and service information, such as electrical/electronic system operation, vehicle service history, service precautions, and technical service bulletins (P-1)**
	
	**DISCUSSION: Have the students discuss the difference between delta connected stators and Wye connected stators. What are advantages of each type? Which type has a higher output?**
	**DISCUSSION: Have the students talk about the three main factors that affect the output of an alternator. Why it is important to check the output of an alternator at off-idle engine speed?**
	17. **SLIDE 17 EXPLAIN Figure 54-16** A stator assembly with six, rather than the normal three, windings
	18. **SLIDE 18 EXPLAIN Figure 54-17** Typical voltage regulator range.
	19. **SLIDE 19 EXPLAIN Figure 54-18** A typical electronic voltage regulator with the cover removed showing the circuits inside.
	20. **SLIDE 20 EXPLAIN Figure 54-19** GM SI-style alternator with an integral voltage regulator. Voltage present at terminal 2 is used to reverse bias Zener diode (D2) that controls TR2. The positive brush is fed by ignition current (terminal I) plus current from diode trio.
	**DISCUSSION: Have the students discuss why voltage regulators are a necessary part of the charging system. How is the field current controlled? Have the students talk about battery condition and charging voltage. Why can it be said that the battery is the true voltage regulator?**
	21. **SLIDE 21 EXPLAIN Figure 54-20** coolant-cooled alternator showing hose connections where coolant from the engine flows through the rear frame of the alternator.

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	**DEMONSTRATION: Show the students an example of an internal alternator fan and an external alternator fan. Explain the operation of each. Figure 54-20**
	**22. SLIDE 22 EXPLAIN Figure 54-21** Hall-effect current sensor attached to positive battery cable is used as part of EPM system. **23. SLIDE 23 EXPLAIN Figure 54-22** amount of time current is flowing through field (rotor) determines alternator output.
	**DISCUSS CHART 54-1 output voltage is controlled by varying duty cycle as controlled by PCM.**
	**EXPLAIN TECH TIP: The Voltage Display Can Be a Customer Concern: A customer may complain that the voltmeter reading on dash fluctuates up and down. This may be normal as computer-controlled charging system commands various modes of operation based on the operating conditions. Follow OEM recommended procedures to verify proper operation.**
 	**DISCUSSION: Discuss the EPM system used on GM vehicles. What are the 6 different modes of operation?**
	**DEMONSTRATION: Show how to perform a quick check on a charging system by checking the static and dynamic voltages with a DMM. Also, demonstrate how to check the supplied voltage at the alternator connector. Engine OFF, should be 12.6 volts. Engine Running at 1500 RPM about 14.5 volts.**