A5 BRAKES 7th Edition

Chapter 20 Regenerative Brakes

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **Automotive Brakes.** 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. Explain the principles involved in regenerative braking. 2. State the types of regenerative braking systems. 3. Discuss the parts and components involved in regenerating braking. 4. Explain how the regeneration system works.
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 A5 BRAKES 7th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 20: Chapter Images

ICONS	Ch20 Regenerative Brakes
	**1. SLIDE 1 REGENERATIVE BRAKES**
	**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 the links below to familiarize your class with the terms in this chapter & then discuss them**
	**Word Search Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF)**
	**REGENERATIVE BRAKING (VIEW) (DOWNLOAD)**
	**DEMONSTRATION SHOW STUDENTS COMPONENTS OF HEV REGENERATIVE BRAKES SYSTEM.**
	2. **SLIDE 2 EXPLAIN FIGURE 20–1** Honda Insight hybrid constructed mostly of aluminum to save weight. 3. **SLIDE 3 EXPLAIN FIGURE 20–2** A Toyota Prius hybrid electric vehicle weighs more and therefore has greater kinetic energy than a smaller, lighter vehicle. 4. **SLIDE 4 EXPLAIN FIGURE 20–3** The electronic brake control unit (EBU) is shown on left (passenger side) and the brake hydraulic unit is shown on the right (driver's side) on this Ford Escape system.

5. **SLIDE 5 EXPLAIN FIGURE 20–4** A typical brake curve showing the speed on the left and the percentage of regenerative braking along the bottom. Notice that base brakes are being used more when vehicle speed is low.
6. **SLIDE 6 EXPLAIN FIGURE 20–5** frequency (“f”) applied to windings of AC synchronous motor can be varied to create either forward torque (“T”) or regenerative braking. If frequency is changed from point 1 to point 2 as shown on chart, torque is changed from motoring (powering the vehicle) to generating and this change can be made almost instantly by the controller.
7. **SLIDE 7 EXPLAIN FIGURE 20–6** The Toyota Prius regenerative braking system component showing the master cylinder and pressure switches.

DISCUSSION: DISCUSS NEED FOR SAFETY PRECAUTIONS WHEN WORKING AROUND & WITH HYBRID ELECTRIC VEHICLES. BOTH HYBRID ELECTRIC VEHICLES & ALL-ELECTRIC VEHICLES USE HIGH-VOLTAGE CIRCUITS THAT CANNOT BE TOUCHED WITHOUT PROTECTION.

8. **SLIDE 8 EXPLAIN FIGURE 20–7** The Ford Escape regenerative braking system, showing all of the components. Notice the brake pedal position sensor is an input to the ECU, which controls both the brake and traction control systems.
9. **SLIDE 9 EXPLAIN FIGURE 20–8** “B” position on the shift display on this Lexus RX 400h means braking. This shifter position can be selected when descending long hills or grades. The regenerative braking system will be used to help keep the vehicle from increasing in speed down the hill without the use of the base brakes

10. **SLIDE 10 EXPLAIN FIGURE 20–9** ABS ECU on a Toyota Prius uses brake switch and pressure sensor inputs to control the regenerative braking system. Circuit includes a voltage signal from sensor, regulated 5V supply to it, input from the brake light switch (12V when the brakes are on), and ground (labeled earth) connection
11. **SLIDE 11 EXPLAIN FIGURE 20–10** This graph compares the figures: at the far left, a throttle lift typically giving about 0.1 g deceleration; second from the left, a minimum regenerative braking of about 0.1 g; second from the right, a moderate regenerative braking is about 0.2 g; and on the far right, a hard emergency stop

resulting in braking of (at least) 0.8 g, which uses both the regenerative braking system, as well as the base hydraulic brake system.

12. **SLIDE 12 EXPLAIN FIGURE 20–11** This Honda valve train photo shows the small spring used to absorb the motion of the rocker arm when the cam is switched to a lobe that has zero lift. This action causes the valves to remain closed, thereby reducing engine braking, which increases the amount of energy that can be captured by the regenerative braking system when the vehicle is slowing. The powertrain control module controls this valve action in response to inputs from the throttle position (TP) sensor and vehicle speed information
13. **SLIDE 13 EXPLAIN FIGURE 20–12** master cylinder from a Toyota Highlander hybrid electric vehicle.
14. **SLIDE 14 EXPLAIN FIGURE 20–13** When working on the brakes on a Ford Escape or Mercury Mariner hybrid vehicle, disconnect black electrical connector on the ABS hydraulic control unit located on passenger side under the hood

HANDS-ON TASK SHEET: COMPLETE TASK SHEET ON REGENERATIVE BRAKING SYSTEM IDENTIFICATION