A5 BRAKES 6th Edition

Chapter 17 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.

ICONS	Ch17 Regenerative Brakes
	**1. SLIDE 1 REGENERATIVE BRAKES** **2. SLIDE 2 EXPLAIN OBJECTIVES**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED**
	**3. SLIDE 3 EXPLAIN** Principles of Regenerative Braking: Reclaiming Energy in a Hybrid **4. SLIDE 4 EXPLAIN** Principles of Regenerative Braking: Reclaiming Energy in a Hybrid **5. SLIDE 5 EXPLAIN** Principles of Regenerative Braking: Transferring Torque Back to the Motor **6. SLIDE 6 EXPLAIN** Principles of Regenerative Braking: Transferring Torque Back to the Motor **7. SLIDE 7 EXPLAIN** Principles of Regenerative Braking: Transferring Torque Back to the Motor **8. SLIDE 8 EXPLAIN** Principles of Regenerative Braking: Transferring Torque Back to the Motor **9. SLIDE 9 EXPLAIN** Principles of Regenerative Braking: Principles Involved
	**DEMONSTRATION SHOW STUDENTS COMPONENTS OF HEV REGENERATIVE BRAKES SYSTEM.**
	**10. SLIDE 10 EXPLAIN FIGURE 17–1** Honda Insight hybrid constructed mostly of aluminum to save weight. **11. SLIDE 11 EXPLAIN FIGURE 17–2** A Toyota Prius hybrid electric vehicle weighs more and therefore has greater kinetic energy than a smaller, lighter vehicle. **12. SLIDE 12 EXPLAIN FIGURE 17–3** 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.

13. **SLIDE 13 EXPLAIN FIGURE 17–4** 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.
14. **SLIDE 14 EXPLAIN FIGURE 17–5** 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.
15. **SLIDES 15-18 EXPLAIN** Regenerative Braking Systems: Dash Display
19. **SLIDES 19-20 EXPLAIN** Regenerative Brake Components
21. **SLIDE 21 EXPLAIN FIGURE 17–6** 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.

22. **SLIDE 22 EXPLAIN FIGURE 17–7** 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.
23. **SLIDE 23 EXPLAIN FIGURE 17–8** “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
24. **SLIDES 24-26 EXPLAIN** How the Regeneration System Works

27. **SLIDE 27 EXPLAIN FIGURE 17–9** 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

28. **SLIDES 28-29 EXPLAIN** How the Regeneration System Works

30. **SLIDE 30 EXPLAIN FIGURE 17–10** 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.

31. **SLIDE 31 EXPLAIN FIGURE 17–11** 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

32. **SLIDE 32 EXPLAIN FIGURE 17–12** master cylinder from a Toyota Highlander hybrid electric vehicle.

33. **SLIDE 33 EXPLAIN FIGURE 17–13** 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 (A5-G-10)

34. SLIDES 34-36 EXPLAIN Summary