Automotive Technology 6th Edition

Chapter 41 Series, Parallel, & Series-Parallel Circuits

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 the chapter learning objectives to the students as listed: 1. Discuss series circuits and apply Ohm's laws to series circuits. 2. Explain Kirchhoff's voltage law. 3. Explain series circuits laws and discuss series circuit examples. 4. Explain Kirchhoff's current law and parallel circuit laws and discuss the methods of determining the total resistance in a parallel circuit. 5. Discuss series parallel circuits and solve examples of series-parallel circuits.
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 the 6th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

DOWNLOAD Chapter 41 Chapter Images: From

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

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

ICONS	CH41 Series, Parallel, & Series-Parallel Circuits
	**1 SLIDE 1 Series, Parallel, & Series-Parallel Circuits** **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 FIGURE 40.1 All complete circuits must have a power source, a power path, protection (fuse), an electrical load (light bulb in this case), and a return path back to the power source.** **DEMONSTRATION: SET-UP circuit in Figure 41-1 on an electrical trainer or circuit board & show students how to test the circuit.**
	**EXPLAIN TECH TIP: Farsighted Quality of Electricity. Electricity almost seems to act as if it "knows" what resistances are ahead on the long trip through a circuit. If the trip through the circuit has many high-resistance components, very few electrons (amperes) choose to attempt to make trip. If a circuit has little or no resistance (e.g., a short circuit), as many electrons (amperes) as possible attempt to flow through the complete circuit. If the flow exceeds the capacity of the fuse or the circuit breaker, the circuit is opened and all current flow stops** 3. **SLIDE 3 EXPLAIN Figure 41-2** series circuit with 2 bulbs. 4. **SLIDE 4 EXPLAIN Figure 41-3** As current flows through a circuit, voltage drops in proportion to amount of

resistance in circuit. Most, if not all, of resistance should occur across load such as bulb in this circuit. All of other components and wiring should produce little, if any, voltage drop. If a wire or connection did cause a voltage drop, less voltage would be available to light bulb & bulb would be dimmer than normal.

5. **SLIDE 5 EXPLAIN Figure 41-4** In a series circuit voltage is dropped or lowered by each resistance in the circuit. Higher resistance, greater drop in voltage.

Math Formula, Series Circuit Resistance (View) (Download)

Series Circuit, Open Circuit (View) (Download)

Kirchhoff's Voltage Law: 2nd LAW: Voltage around (Source Voltage) any closed circuit is equal to the sum (total) of the voltage drops across the resistances

DISCUSSION: Have students discuss Kirchhoff's second voltage law. How does Kirchhoff's law relate to Ohm's law?

EXPLAIN TECH TIP:

6. **SLIDE 6 EXPLAIN Figure 41-5** Voltmeter reads differences of voltage between test leads. Voltage read across a resistance is the voltage drop that occurs when current flows through a resistance. A voltage drop is also called an "IR" drop because it is calculated by multiplying the current (I) through the resistance (electrical load) by the value of the resistance (R).
7. **SLIDE 7 EXPLAIN Figure 41-6** In this series circuit with a 2-ohm resistor and a 4-ohm resistor, current (2 amperes) is same throughout even though voltage drops across each resistor.

DISCUSS FREQUENTLY ASKED QUESTION: Why Check the Voltage Drop Instead of Measuring Resistance? Imagine a wire with all strands cut except for one. An ohmmeter can be used to check the resistance of this wire and the resistance would be low, indicating that the wire was okay. But this one small strand cannot properly carry current (amperes)

in the circuit. A voltage drop test is a better test to determine the resistance in components for two reasons:

- An ohmmeter can only test a wire or component that has been disconnected from the circuit and is not carrying current. The resistance can, and does, change when current flows.
- A voltage drop test is a dynamic test because, as the current flows through a component, the conductor increases in temperature, which in turn increases resistance. This means that a voltage drop test is testing the circuit during normal operation and is therefore the most accurate way of determining circuit conditions.

A voltage drop test is also easier to perform because resistance does not have to be known, only that the unwanted loss of voltage in a circuit should be less than 3% or less than about 0.14 volts for any 12-volt circuit.

8. SLIDE 8 EXPLAIN **Figure 41-7** Example 1.
9. SLIDE 9 EXPLAIN **Figure 41-8** Example 2.
10. SLIDE 10 EXPLAIN **Figure 41-9** Example 3.
11. SLIDE 11 EXPLAIN **Figure 41-10** Example 4.

Complete SERIES CIRCUIT Worksheets 1, 2, & 3
Task Sheet on Electrical Circuits Pages 121-123

TASK: Have students perform EXPERIMENTS on SERIES CIRCUITS: Construct a circuit similar to one in Figure 41–4. Show students how to check voltage drop at each lamp. Ask them to add up voltage drops & compare them to source voltage.
TASK: Have students perform EXPERIMENTS on SERIES CIRCUITS Construct a circuit similar to one in Figure 41–8, Figure 41–9, & Figure 41–10. Why does current remain constant, even though there

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are different resistances?

HOMEWORK: SEARCH INTERNET:: Research 2 or more applications of series circuits. Ask them to draw conclusions about settings in which series circuits are used & why another type of circuit is not used.

12. **SLIDE 12 EXPLAIN Figure 41-11** amount of current flowing into junction point A equals the total amount of current flowing out of the junction.

Kirchhoff's Current Law: 1st LAW: Current flowing into any junction of circuit equal to current flowing out of junction

DEMONSTRATION: Build PARALLEL CIRCUIT in Figure 41-11. Show students what happens when 1 bulb is removed. Ask them to compare this circuit with series circuit. Construct series & parallel circuit, each with 3 identical bulbs. Measure total resistance in each circuit. ASK: How do parallel circuits compare to series circuits?

Parallel Circuit, Open (View) (Download)

Parallel Circuits, Volts (View) (Download)

Parallel Circuit (View) (Download)

13. **SLIDE 13 EXPLAIN Figure 41-12** current in a parallel circuit splits (divides) according to the resistance in each branch.
14. **SLIDE 14 EXPLAIN Figure 41-13** In a typical parallel circuit, each resistance has power and ground and each leg operates independently of other legs of circuit.

DEMO Build Figure 41-13: Show students how to solve for total circuit current using method one on page 39. Change values and have students solve for current flow

15. **SLIDE 15 EXPLAIN Figure 41-14** Schematic showing 2 resistors in parallel connected to 12-volt battery.

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DEMONSTRATE Building PARALLEL circuits, using Figures: 41-13, 41-14, & 41-15

Build Figure 41-14: Calculate resistance of 41-14 using Method 2 on page 39. Change values & have students solve for resistance.

16. **SLIDE 16 EXPLAIN Figure 41-15** A parallel circuit with three resistors connected to a 12-volt battery.

Build Figure 41-15: Calculate resistance of 41-15 using Method 3 on page 39. Change values & have students solve for resistance.

17. **SLIDE 17 EXPLAIN Figure 41-16** Using an electronic calculator to determine total resistance of parallel circuit.

DEMONSTRATION: Show students how to solve problem in Figure 41–16 using calculator. Have students work with you as you solve problem

HANDS-ON TASK: Students work in TEAMS & use calculator to solve parallel circuit problems using Figure 41-16

18. **SLIDE 18 EXPLAIN Figure 41-17** Another example of how to use an electronic calculator to determine the total resistance of a parallel circuit. The answer is 13.45 ohms. Notice that the effective resistance of this circuit is less than the resistance of the lowest branch (20 ohms).

19. **SLIDE 19 EXPLAIN Figure 41-18** A parallel circuit containing four 12-ohm resistors. When a circuit has more than one resistor of equal value, the total resistance can be determined by simply dividing the value of the resistance (12 ohms in this example) by the number of equal-value resistors (4 in this example) to get 3 ohms.

DISCUSSION: Ask students to talk about methods for solving parallel circuit problems. Which method is easiest to use?

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	20. SLIDE 20 EXPLAIN Figure 41-19 Example 1. **21. SLIDE 21 EXPLAIN Figure 41-20** Example 2. **22. SLIDE 22 EXPLAIN Figure 41-21** Example 3. **23. SLIDE 23 EXPLAIN Figure 41-22** Example 4. **TASK: BUILD the PARALLEL Circuits in Figures 41-19, 41-20, 41-21, & 41-22. Determine what they are to solve for.** **DISCUSSION: Ask students to talk about voltage in parallel circuits. Is voltage always 12 volts? Explain that the voltage in automotive applications of parallel circuits usually is 12 volts, but that the same rules would apply if voltage were 20, 30, or 50 volts or more.** **Complete PARALLEL CIRCUIT Worksheets 1, 2, & 3 Task Sheet on Electrical Circuits Pages 124-126 of worktext** **HOMEWORK: Change values for Figures 41–16 and 41–17 and have the students solve for resistance. Grade students on their understanding of circuits and methods for solving the problems, as well as accurate calculations.** **24. SLIDE 24 EXPLAIN Figure 41-23** series-parallel circuit. **25. SLIDE 25 EXPLAIN Figure 41-24** complete headlight circuit with all bulbs and switches is a series-parallel circuit. **DISCUSSION: Ask students to discuss the use of series-parallel circuits in automotive wiring systems. What are series connections and what are the parallel connections for headlight switch?** **DEMONSTRATION: BUILD SERIES-PARALLEL CIRCUITS on Project Board in Figures 41-26 and 41-27 & Show students how to solve the problems** **26. SLIDE 26 EXPLAIN Figure 41-25** Solving series-parallel circuit problem. **27. SLIDE 27 EXPLAIN Figure 41-26** Example 1.

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	28. SLIDE 28 EXPLAIN Figure 41-27 Example 2. **29. SLIDE 29 EXPLAIN Figure 41-28** Example 3. **30. SLIDE 30 EXPLAIN Figure 41-29** Example 4. **TRAINER TASK: BUILD SERIES-PARALLEL CIRCUITS in Figures 41-28 & 41-29** **LAB TIME 4: Complete SERIES-PARALLEL CIRCUIT Worksheets 1, 2, & 3 Task Sheet on Electrical Circuits** **HOMEWORK: SEARCH INTERNET Have students use Internet to research wiring diagrams. Ask them to download at least 2 wiring diagrams to compare.**