Automotive Electrical & Engine Performance 8/E

Chapter 5 Series, Parallel, & Series Parallel Circuits

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Electrical & Engine Performance 8th edition provides complete coverage of automotive areas pertaining vehicle electrical systems and engine performance. 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, and Animations that are listed in this Lesson Plan. This Lesson Plan also references ASEEducation (NATEF) Task Sheets available from Jim's web site.
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. Identify a series circuit. 2. Identify a parallel circuit. 3. Identify a series-parallel circuit. 4. Calculate the total resistance in a parallel circuit. 5. State Kirchhoff's voltage law. 6. Calculate voltage drops in a series circuit. 7. Explain series and parallel circuit laws. 8. State Kirchhoff's current law. 9. Identify where faults in a series-parallel circuit can be detected or determined. **Prepare for ASE Electrical/Electronic Systems (A6) certification test content area "A" (General Electrical/ Electronic System Diagnosis).**
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 Automotive Electrical & Engine Performance 8th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

DOWNLOAD Chapter 05 Chapter Images: From

http://www.jameshalderman.com/books_a8.html#anchor2

ICONS	Ch05 ELECTRICAL CIRCUITS
	**1. SLIDE 1 CH5 SERIES, PARALLEL, & SERIES-PARALLEL CIRCUITS**
	**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 Jim's web site to familiarize your class with terms in this chapter & then discuss them, see below:** **HTTP://WWW.JAMESHALDERMAN.COM/BOOKS_A8.HTML#ANCHOR2** **DOWNLOAD** **CROSSWORD PUZZLE (MICROSOFT WORD) (PDF)** **WORD SEARCH PUZZLE (MICROSOFT WORD) (PDF**
	
	**2. SLIDE 2 EXPLAIN Figure 5-1** Series circuit with 3 bulbs. All current flows through all resistances (bulbs). Total resistance of circuit is sum of total resistance of bulbs, & bulbs will light dimly because of increased resistance & reduction of current flow (amperes) through circuit.
	**DISCUSSION: DISCUSS SERIES CIRCUITS. WHERE, AND FOR WHAT PURPOSE, ARE SERIES CIRCUITS USED? REVIEW OHM'S LAW FOR USE IN UNDERSTANDING SERIES CIRCUITS. *WHY IS TOTAL RESISTANCE SUM OF ALL RESISTANCES?***
KIRCHHOFF'S VOLTAGE LAW	
	**DEMONSTRATION: SET-UP CIRCUIT IN FIGURE 5-1 & SHOW STUDENTS HOW TO USE**
	**3. SLIDE 3 EXPLAIN Figure 5-2** series circuit with 2 bulbs.
	**EXPLAIN TECH TIP: *Farsighted Quality of Electricity.* Electricity almost seems to act as if it "knows" what resistances are ahead on the long**

ICONS	Ch05 ELECTRICAL CIRCUITS
	**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** 4. **SLIDE 4 EXPLAIN Figure 5-3** 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 circuit. All of other components & 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 and bulb would be dimmer than normal. 5. **SLIDE 5 EXPLAIN Figure 5-4** In a series circuit voltage is dropped or lowered by each resistance in the circuit. Higher resistance, greater drop in voltage. 6. **SLIDE 6 EXPLAIN Figure 5-5** 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). **KIRCHHOFF'S VOLTAGE LAW: 2ND LAW:** **VOLTAGE AROUND 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?** **DISCUSS FREQUENTLY ASKED QUESTION: *WHY CHECK 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,**
  	

ICONS	Ch05 ELECTRICAL CIRCUITS
	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.**
	**7. SLIDE 7 EXPLAIN Figure 5-6** 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.
	**COMPLETE SERIES CIRCUIT WORKSHEETS 1, 2, & 3 TASK SHEET ON ELECTRICAL CIRCUITS**
	**Math Formula, Series Circuit Resistance (View) (Download)** **Series Circuit, Open Circuit (View) (Download)**

ICONS	Ch05 ELECTRICAL CIRCUITS
	**TASK: HAVE STUDENTS PERFORM EXPERIMENTS ON SERIES CIRCUITS: CONSTRUCT A CIRCUIT SIMILAR TO ONE IN FIGURE 5–4. 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 5–8, FIGURE 5–9, & FIGURE 5–10. WHY DOES CURRENT REMAIN CONSTANT, EVEN THOUGH THERE 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.**
	8. **SLIDE 8 EXPLAIN Figure 5-7** Example 1. 9. **SLIDE 9 EXPLAIN Figure 5-8** Example 2. 10. **SLIDE 10 EXPLAIN Figure 5-9** Example 3. 11. **SLIDE 11 EXPLAIN Figure 5-10** Example 4. 12. **SLIDE 12 EXPLAIN Figure 5-11** 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 5-11. SHOW 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)**

ICONS	Ch05 ELECTRICAL CIRCUITS
	**13. SLIDE 13 EXPLAIN Figure 5-12** current in a parallel circuit splits (divides) according to resistance in each branch
	**EXPLAIN TECH TIP: *Path of Least Resistance*** **There is an old saying that *electricity will always take path of least resistance*. This is true, especially if there is a fault, such as in secondary (high-voltage) section of ignition system. If there is a path to ground that is lower than path to spark plug, high-voltage spark will take path of least resistance. In a parallel circuit where there is more than one path for current to flow, most of current will flow through branch with lower resistance. This does not mean that all of current will flow through lowest resistance, because other path does provide a path to ground, and amount of current flow through other branches is determined by resistance and applied voltage according to Ohm's law. *Therefore, only place where electricity takes path of least resistance is in a* Series Circuit where there are no other paths for current to flow.**
	**14. SLIDE 14 EXPLAIN Figure 5-13** In a typical parallel circuit, each resistance has power and ground and each leg operates independently of other legs of circuit
	**DEMO BUILD FIGURE 5-13: SHOW HOW TO SOLVE FOR TOTAL CIRCUIT CURRENT. CHANGE VALUES AND HAVE STUDENTS SOLVE FOR CURRENT FLOW**
	**15. SLIDE 15 EXPLAIN Figure 5-14** Schematic showing 2 resistors in parallel connected to 12-volt battery.
	**DEMONSTRATE BUILDING PARALLEL CIRCUITS, USING FIGURES: 5-13, 5-14, & 5-15**

ICONS	Ch05 ELECTRICAL CIRCUITS
	**BUILD FIGURE 5-14: CALCULATE RESISTANCE OF FIGURE 5-14 USING. CHANGE VALUES & HAVE STUDENTS SOLVE FOR RESISTANCE.**
	**16. SLIDE 16 EXPLAIN Figure 5-15** parallel circuit with three resistors connected to a 12-volt battery.
	**BUILD FIGURE 5-15: CALCULATE RESISTANCE OF FIGURE 5-15. CHANGE VALUES & HAVE STUDENTS SOLVE FOR RESISTANCE.**
	**17. SLIDE 17 EXPLAIN Figure 5-16** Using an electronic calculator to determine total resistance of parallel circuit.
	**DEMONSTRATION: SHOW STUDENTS HOW TO SOLVE PROBLEM IN FIGURE 5–16 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 5-16**
	**18. SLIDE 18 EXPLAIN Figure 5-17** 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 5-18** 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?**
	**20. SLIDE 20 EXPLAIN Figure 5-19** Example 1. **21. SLIDE 21 EXPLAIN Figure 5-20** Example 2. **22. SLIDE 22 EXPLAIN Figure 5-21** Example 3.

ICONS	Ch05 ELECTRICAL CIRCUITS
       	23. **SLIDE 23 EXPLAIN Figure 5-22** Example 4. **TASK: BUILD PARALLEL CIRCUITS IN FIGURES 5-19, 5-20, 5-21, & 5-22. 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** **HOMEWORK:: CHANGE VALUES FOR FIGURES 5–16 & 5–17 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 5-23** series-parallel circuit. 25. **SLIDE 25 EXPLAIN Figure 5-24** complete headlight circuit with all bulbs & switches is series-parallel circuit. **DISCUSSION: DISCUSS 3 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 5-26 AND 5-27 & SHOW STUDENTS HOW TO SOLVE THE PROBLEMS** 26. **SLIDE 26 EXPLAIN Figure 5-25** Solving series-parallel circuit problem. 27. **SLIDE 27 EXPLAIN Figure 5-26 Example 1.** 28. **SLIDE 28 EXPLAIN Figure 5-27 Example 2.**

ICONS	Ch05 ELECTRICAL CIRCUITS
  	29. SLIDE 29 EXPLAIN Figure 5-28 Example 3. 30. SLIDE 30 EXPLAIN Figure 5-29 Example 4. **TRAINER TASK: BUILD SERIES-PARALLEL CIRCUITS IN FIGURES 5-28 & 5-29** **COMPLETE SERIES-PARALLEL CIRCUIT WORKSHEETS 1, 2, & 3 TASK SHEET** **HOMEWORK: SEARCH INTERNET HAVE STUDENTS USE INTERNET TO RESEARCH WIRING DIAGRAMS. ASK THEM TO DOWNLOAD AT LEAST 2 WIRING DIAGRAMS TO COMPARE AND CONTRAST**