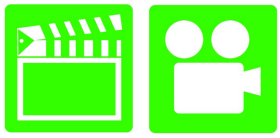
Advanced Automotive Electricity & Electronics

Chapter 3 Series, Parallel, & Series Parallel Circuits

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **Advanced Automotive Electricity and Electronics Systems.** 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. Diagnose electrical/electronic integrity for series, parallel, and series-parallel circuits using Ohm's law. 2. Explain Kirchhoff's voltage law. 3. Calculate voltage drops in a series circuit. 4. State Kirchhoff's current law. 5. Explain parallel circuit laws. 6. Calculate voltage drops in a parallel circuit. 7. Identify a series-parallel circuit. 8. Identify where faults in a series-parallel circuit can be detected. 9. Calculate current flow and voltage drops in a series-parallel circuit. **This chapter will help you prepare for the 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.

ICONS	Ch03 ELECTRICAL CIRCUITS
	**1. SLIDE 1 CH3 SERIES, PARALLEL, & SERIES-PARALLEL CIRCUITS**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED**
	**2. SLIDE 2 EXPLAIN** SERIES CIRCUITS **3. SLIDE 3 EXPLAIN** NOTE **4. SLIDE 4 EXPLAIN Ohm's Law and Series Circuits** **5. SLIDE 5 EXPLAIN Figure 3-1** 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.
 QUESTION ***KIRCHHOFF'S VOLTAGE LAW***	**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?***
	**DEMONSTRATION: SET-UP CIRCUIT IN FIGURE 41-1 & SHOW STUDENTS HOW TO USE**
	**6. SLIDE 6 EXPLAIN Figure 41-2** series circuit with 2 bulbs.
	**7. SLIDE 7 EXPLAIN TECH TIP**
	**8. SLIDE 8 EXPLAIN *KIRCHHOFF'S VOLTAGE LAW*** **9. SLIDE 9 EXPLAIN Figure 3-3** 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.

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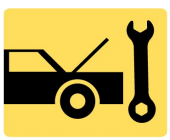
	**10. SLIDE 10 EXPLAIN Figure 3-4** In a series circuit voltage is dropped or lowered by each resistance in the circuit. Higher resistance, greater drop in voltage. **11. SLIDE 11 EXPLAIN FREQUENTLY ASKED QUESTION**
	**12. SLIDE 12 EXPLAIN Figure 3-5** Voltmeter reads differences of voltage between test 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). **13. SLIDE 13 EXPLAIN Kirchhoff's Voltage Law**
 	**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?**
	**14. SLIDE 14 EXPLAIN NOTE**
	**15. SLIDE 15 EXPLAIN: SERIES CIRCUIT LAWS** **16. SLIDE 16 EXPLAIN Figure 3-6 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.** **17. SLIDE 17 EXPLAIN Figure 3-7** Example 1. **18. SLIDE 18 EXPLAIN Figure 3-8** Example 2. **19. SLIDE 19 EXPLAIN Figure 3-9** Example 3. **20. SLIDE 20 EXPLAIN Figure 3-10** Example 4.
	**COMPLETE SERIES CIRCUIT WORKSHEETS 1, 2, & 3 TASK SHEET ON ELECTRICAL CIRCUITS**

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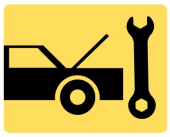
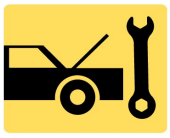
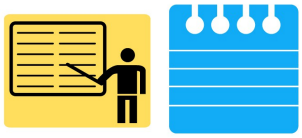
	TASK: HAVE STUDENTS PERFORM EXPERIMENTS ON SERIES CIRCUITS: CONSTRUCT A CIRCUIT SIMILAR TO ONE IN FIGURE 3–4. SHOW STUDENTS HOW TO CHECK VOLTAGE DROP AT EACH LAMP. ASK THEM TO ADD UP VOLTAGE DROPS & COMPARE THEM TO SOURCE VOLTAGE.
	TASK: HAVE STUDENTS PERFORM EXPERIMENTS ON SERIES CIRCUITS CONSTRUCT A CIRCUIT SIMILAR TO ONE IN FIGURE 3–8, FIGURE 3–9, & FIGURE 3–10. 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.
 Kirchhoff's Current Law: 1st LAW: Current flowing into any junction of circuit equal to current flowing out of junction	21. SLIDE 21 EXPLAIN PARALLEL CIRCUITS 22. SLIDE 22 EXPLAIN: *KIRCHHOFF'S CURRENT LAW* 23. SLIDE 23 EXPLAIN **Figure 3-11** amount of current flowing into junction point A equals the total amount of current flowing out of the junction
 	DEMONSTRATION: BUILD PARALLEL CIRCUIT IN FIGURE 3-11. 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?
	24. SLIDE 24 EXPLAIN: PARALLEL CIRCUIT LAWS 25. SLIDE 25 EXPLAIN NOTE 26. SLIDE 26 EXPLAIN **Figure 3-12** current in a parallel circuit splits (divides) according to resistance in each branch
	27. SLIDE 27 EXPLAIN TECH TIP

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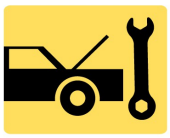
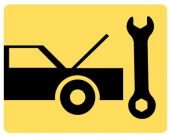
	**28. SLIDE 28: EXPLAIN DETERMINING TOTAL RESISTANCE IN PARALLEL CIRCUIT** **29. SLIDE 29 EXPLAIN NOTE** **30. SLIDES 30-31 EXPLAIN DETERMINING TOTAL RESISTANCE IN PARALLEL CIRCUIT** **32. SLIDE 32 EXPLAIN Figure 3-13** In a typical parallel circuit, each resistance has power and ground and each leg operates independently of other legs of circuit
	**DEMO BUILD FIGURE 3-13: SHOW STUDENTS HOW TO SOLVE FOR TOTAL CIRCUIT CURRENT USING METHOD ONE ON PAGE 39. CHANGE VALUES AND HAVE STUDENTS SOLVE FOR CURRENT FLOW**
	**33. SLIDE 33 EXPLAIN Figure 3-14** Schematic showing 2 resistors in parallel connected to 12-volt battery. **34. SLIDE 34 EXPLAIN NOTE**
	**DEMONSTRATE BUILDING PARALLEL CIRCUITS, USING FIGURES: 3-13, 3-14, & 3-15**
	**BUILD FIGURE 3-14: CALCULATE RESISTANCE OF FIGURE 3-14 USING. CHANGE VALUES & HAVE STUDENTS SOLVE FOR RESISTANCE.**
	**35. SLIDE 35 EXPLAIN Figure 3-15** parallel circuit with three resistors connected to a 12-volt battery.
	**BUILD FIGURE 41-15: CALCULATE RESISTANCE OF FIGURE 3-15. CHANGE VALUES & HAVE STUDENTS SOLVE FOR RESISTANCE.**
	**36. SLIDE 36 EXPLAIN Figure 3-16** Using an electronic calculator to determine total resistance of parallel circuit.
	**DEMONSTRATION: SHOW STUDENTS HOW TO SOLVE PROBLEM IN FIGURE 3–16 USING CALCULATOR. HAVE STUDENTS WORK WITH YOU AS YOU SOLVE PROBLEM**

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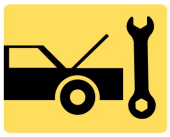
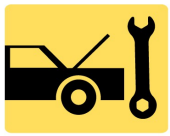
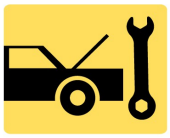
	**HANDS-ON TASK: STUDENTS WORK IN TEAMS & USE CALCULATOR TO SOLVE PARALLEL CIRCUIT PROBLEMS USING FIGURE 3-16**
	**37. SLIDE 37 EXPLAIN Figure 3-17** Another example of how to use an electronic calculator to determine the total resistance of a parallel circuit. The answer is 13.45 ohms. Notice that the effective resistance of this circuit is less than the resistance of the lowest branch (20 ohms). **38. SLIDE 38 EXPLAIN Determining Total Resistance in Parallel Circuit** **39. SLIDE 39 EXPLAIN NOTE** **40. SLIDE 40 EXPLAIN Figure 3-18** 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. **41. SLIDE 41 EXPLAIN NOTE**
	**DISCUSSION: ASK STUDENTS TO TALK ABOUT METHODS FOR SOLVING PARALLEL CIRCUIT PROBLEMS. WHICH METHOD IS EASIEST TO USE?**
 	**42. SLIDE 42 EXPLAIN PARALLEL CIRCUIT EXAMPLES** **43. SLIDE 43 EXPLAIN Figure 3-19** Example 1. **44. SLIDE 44 EXPLAIN Figure 3-20** Example 2. **45. SLIDE 45 EXPLAIN Figure 3-21** Example 3. **46. SLIDE 46 EXPLAIN Figure 3-22** Example 4.
	**TASK: BUILD THE PARALLEL CIRCUITS IN FIGURES 3-19, 3-20, 3-21, & 3-22. 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.**

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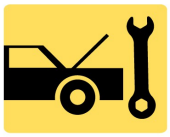
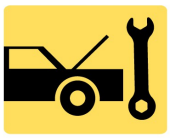
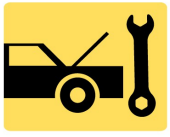
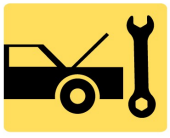
	COMPLETE PARALLEL CIRCUIT WORKSHEETS 1, 2, & 3 TASK SHEET ON ELECTRICAL CIRCUITS
	HOMEWORK: (2 HOURS OUTSIDE WORK): CHANGE VALUES FOR FIGURES 3–16 & 3–17 AND HAVE THE STUDENTS SOLVE FOR RESISTANCE. GRADE STUDENTS ON THEIR UNDERSTANDING OF CIRCUITS AND METHODS FOR SOLVING THE PROBLEMS, AS WELL AS ACCURATE CALCULATIONS.
	47. **SLIDE 47 EXPLAIN SERIES-PARALLEL CIRCUITS** 48. **SLIDE 48 EXPLAIN Figure 3-23** series-parallel circuit. 49. **SLIDE 49 EXPLAIN Figure 3-24** 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 3-26 AND 3-27 & SHOW STUDENTS HOW TO SOLVE THE PROBLEMS**
	50. **SLIDE 50 EXPLAIN: SOLVING SERIES-PARALLEL CIRCUIT PROBLEMS** 51. **SLIDE 51 EXPLAIN Figure 3-25** Solving series-parallel circuit problem. 52. **SLIDE 52 EXPLAIN Figure 3-26 Example 1.** 53. **SLIDE 53 EXPLAIN Figure 3-27 Example 2.** 54. **SLIDE 54 EXPLAIN Figure 3-28 Example 3.** 55. **SLIDE 55 EXPLAIN Figure 3-29 Example 4.**
	TRAINER TASK: BUILD SERIES-PARALLEL CIRCUITS IN FIGURES 3-28 & 3-29
	COMPLETE SERIES-PARALLEL CIRCUIT WORKSHEETS 1, 2, & 3 TASK SHEET

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	**HOMEWORK: SEARCH INTERNET** HAVE STUDENTS USE INTERNET TO RESEARCH WIRING DIAGRAMS. ASK THEM TO DOWNLOAD AT LEAST 2 WIRING DIAGRAMS TO COMPARE AND CONTRAST