Student's Name: Date:

Introduction to Circuit Analysis Laboratory

Lab Experiment 9

Power Dissipation in a Resistivity Circuit

Introduction to Power

Power is familiar to us since we see the power value in electric circuit and devices like light bulbs, hair dryer, power adapter, heater, etc. The higher the watt rating of a device, the more energy it can get out of it per unit time. For example, the greater the power rating of the heater, the more heat energy it can produce per second. In general, the rate at which electric energy is handled is called **power**. The symbol for power is **P** and its unit is **Watts "W".**

Power is related to energy, which is the capacity to do work or the rate to transfer energy, in an interval of time:

$$P = \frac{W}{t}$$

Since our interest is in electrical power, if ***W*** and ***t*** is substitute from the current and voltage formula, respectively:

$$t = \frac{\boldsymbol{Q}}{\boldsymbol{I}}$$

$$W = \boldsymbol{QV}$$

$$P = \frac{\boldsymbol{QV}}{\frac{\boldsymbol{Q}}{\boldsymbol{I}}} = \boldsymbol{V}\boldsymbol{I}$$

To express the power in terms of electrical quantities, the three basic relationships for power in electrical quantities are:

$$P = VI$$

$$P = I^2 R$$

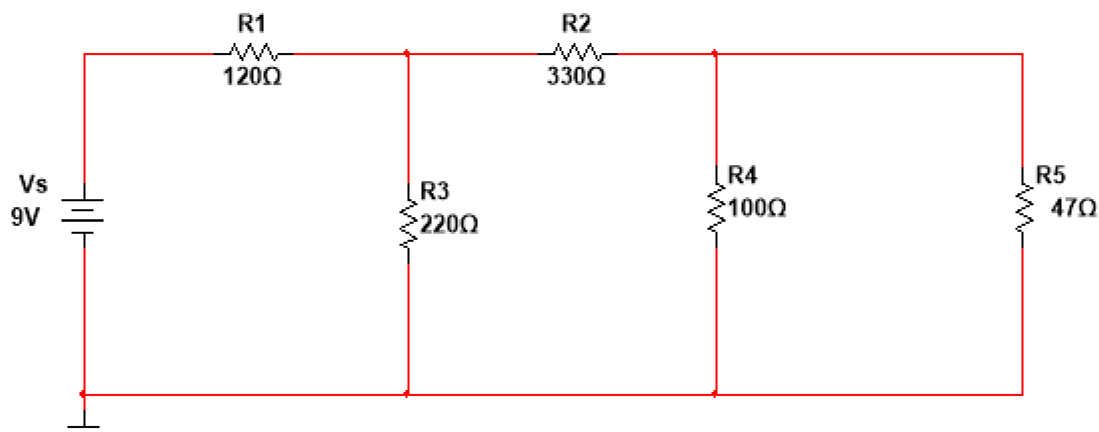
$$P = \frac{V^2}{R}$$

Formula 9.1 – Power Formula

Lab Experimental Procedure

Part 1: Resistance Measurements

Circuit 9.1 shows a series-parallel resistivity circuit built of five resistors.



Circuit 9.1 Voltages & Currents in Series-Parallel Circuit

1. Obtain resistors 47 Ω, 100 Ω ,120 Ω, 220 Ω, and 330 Ω from your components' kit
2. Measure the resistance of each resistor individually and record the measurement in Table 9.1 (Table 9.1 is in page 4)
3. Using wiring practices, assemble the Circuit 9.1 on your protoboard without the power source.

4. Before connecting the power source to Circuit 9.1, measure the total resistance as seen by the source terminals and record the measurement in Table 9.1. Check Figure 9.1 for reference.

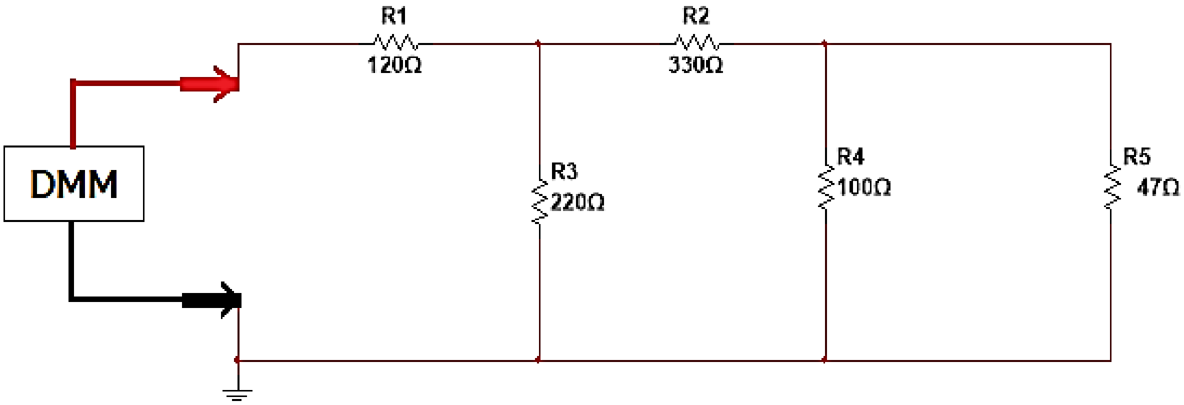


Figure 9.1 – Measuring total resistance using a DMM

5. Calculate the total resistance and record the answer in Table 9.1

Show calculation for total resistance here

6. Calculate the percent of difference between the measured and the given resistance of each resistor.

$$\%\ of\ difference = \left(\frac{Resistance_{Actual(calculated)} - Resistance_{Measured}}{Resistance_{Actual(calculated)}}\right) \times 100\ \%$$

7. Record calculation in Table 9.1

Part 2: Current Measurements and Calculations

8. Connect 9 V from the power supply or 9 V battery to the + and – node of the protoboard.
9. Prepare the circuit and the DMM to measure the current through each resistor.
10. Measure and record the current through each resistor in Table 9.2.
11. Calculate the current through each resistor in Circuit 9.1 and record the calculated value in Table 9.2.
12. Find the percent of difference between the measured and calculated current through each resistor. Record result in Table 9.2

Component	Measured Current (Include unit)	Calculated Current (Include unit)	% of difference
$I_{R1(120\ \Omega)}$			
$I_{R2(220\ \Omega)}$			
$I_{R3(470\ \Omega)}$			
I_S = Current Source			

Table 9.2 – Measured and calculated current of Circuit 9.1

Part 3: Voltage Measurements and Calculations

13. Prepare the circuit and the DMM to measure the voltage across each resistor.
14. Measure and record the voltage across each resistor in Table 9.3
15. Calculate the voltage across each resistor using Ohm's law or Voltage Divider Rule. Record the calculated voltage in Table 9.3.

Component	Measured Voltage (Include unit)	Calculated Voltage (Include unit)	% of difference
$V_{R1(120\ \Omega)}$			
$V_{R2(220\ \Omega)}$			
$V_{R3(470\ \Omega)}$			
V_S = Voltage Source			

Table 9.3 – Measured and calculated voltage of Circuit 9.1

16. Find the percent of difference between the measured and calculated voltage through each resistor. Record result in Table 9.2
17. Disassemble the circuit, put your components in your lab kit, and turn OFF all lab equipment.

Part 4: Power Dissipation Calculations Using Three Different Power Formula

For this part of lab, you will need to calculate the measured and calculated power using three different power formula:

$$P = VI$$

$$P = I^2 R$$

$$P = \frac{V^2}{R}$$

Formula 9.1 – Power Formula

18. Using the *Measured Current* from Table 9.2 and the *Measured Voltage* from Table 9.3, calculate the power dissipation for each resistor using the **first** power formula from Formula 9.1 ➔ P = VI
19. Record calculation of *Measured Power* in Table 9.4
20. Using the *Calculated Current* from Table 9.2 and the *Calculated Voltage* from Table 9.3, calculate the power dissipation for each resistor using the first power formula from Formula 1 ➔ P = VI
21. Record calculation of *Calculated Power* in Table 9.4
22. Find the *Percent of Difference* between the Measured and Calculated Power and record result in Table 9.4

Component	Measured Power (Include unit)	Calculated Power P = VI	% of difference
$P_{R1(120\ \Omega)}$			
$P_{R2(220\ \Omega)}$			
$P_{R3(470\ \Omega)}$			
P_S = Power Source			

Table 9.4 – Measured and calculated power dissipation in Circuit 9.1 using P = VI

23. Using the *Measured Current* from Table 9.2, calculate the power dissipation for each resistor using the **second** power formula from Formula 1 ➔ $P = I^2R$
24. Record calculation of *Measured Power* in Table 9.5
25. Using the *Calculated Current* from Table 9.2, calculate the power dissipation for each resistor using the **second** power formula from Formula 1 ➔ $P = I^2R$
26. Record calculation of *Calculated Power* in Table 9.5
27. Find the *Percent of Difference* between the Measured and Calculated Power and record result in Table 9.5

Component	Measured Power (Include unit)	Calculated Power $P = I^2 R$	% of difference
$P_{R1(120\ \Omega)}$			
$P_{R2(220\ \Omega)}$			
$P_{R3(470\ \Omega)}$			
P_S = Power Source			

Table 9.5 – Measured and calculated power dissipation in Circuit 9.1 using $P = I^2R$

28. Using the *Measured Voltage* from Table 9.3, calculate the power dissipation for each resistor using the **third** power formula from Formula 1 ➔ $P = \frac{V^2}{R}$
29. Record calculation of *Measured Power* in Table 9.6
30. Using *Calculated Voltage* from Table 9.3, calculate the power dissipation for each resistor using the **third** power formula from Formula 1 ➔ $P = \frac{V^2}{R}$
31. Record calculation of *Calculated Power* in Table 9.6
32. Find the *Percent of Difference* between the Measured and Calculated Power and record result in Table 9.6

Component	Measured Power (Include unit)	Calculated Power $P = \frac{V^2}{R}$	% of difference
$P_{R1(120\ \Omega)}$			
$P_{R2(220\ \Omega)}$			
$P_{R3(470\ \Omega)}$			
P_S = Power Source			

Table 9.6 – Measured and calculated power dissipation in Circuit 9.1 using $P = \frac{V^2}{R}$

Questions

1. Explain the possible reason why the powers to the components using the three different formulas are slightly different. (Compare result from table 9.4, table 9.5, and table 9.6)
2. For circuit 9.1, if the power rating for R1, R2, and R3 is ¼ Watts, what would happen with the power dissipation at each resistor if the voltage source is increased to 18 V? Explain and justify your answer.
3. From table 9.4, 9.5, and 9.6, the highest percent of difference between the measured and the calculated power is by using which of the three power formula? Explain your answer.

Student's Signature: _____________ Lab Instructor' Signature: ______________ Date: _______

-------------------------------------- LAB EXPERIMENT ENDS HERE --------------------------------------