UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE
Department of Electrical and Computer Engineering

EXPERIMENT 1 – MAXIMUM POWER TRANSFER

OBJECTIVES
In this experiment the student will investigate the circuit requirements for the transfer of maximum power from the power source to the load in DC circuits with only real impedances.

MATERIALS/EQUIPMENT NEEDED
DC Voltage Source (capable of 10 Vdc)
Resistors: 100Ω, 1kΩ, 10kΩ, 100kΩ
Decade Resistor Box
Multimeter

INTRODUCTION
The circuit shown in Figure 1-1 uses an ideal voltage source in series with a sourcing resistance to approximate a practical voltage source in which the terminal voltage drops with increasing load current. In a resistive circuit like this, the resistive load receives maximum power when the load resistance is equal to the source resistance (R_L=R_S). The maximum power can be calculated using the expression

$$p_{\max} = \frac{V_s^2}{4R_s}$$

The laboratory experiment will verify, for several sourcing resistors, that maximum power transfer is achieved when the load resistance is selected as established above.

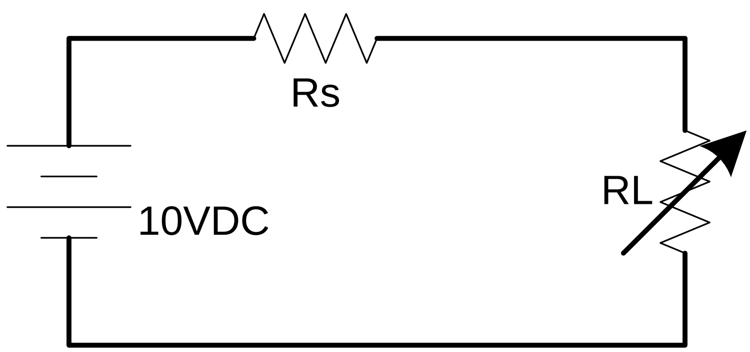

Figure 1-1 Lab circuit setup

PRELAB

1. For the circuit shown in Figure 1-1, determine the theoretical value of the load voltage and load power for a 100Ω source resistance and load resistances in Table 1-1.
2. For the circuit shown in Figure 1-1, determine the theoretical value of the load voltage and load power for a 1kΩ source resistance and load resistances in Table 1-2.
3. For the circuit shown in Figure 1-1, determine the theoretical value of the load voltage and load power for a 10kΩ source resistance and load resistances in Table 1-3.
4. For the circuit shown in Figure 1-1, determine the theoretical value of the load voltage and load power for a 100kΩ source resistance and load resistances in Table 1-4.

PROCEDURE

1. Construct the circuit shown in Figure 1-1 using a variable voltage source, a fixed resistor for the sourcing resistance and a decade box for the load resistance.
2. Be careful that your voltage source is set to a value that will not cause the power ratings of the selected sourcing resistor or the decade box to be exceeded.
3. Additionally, the selected decade box must cover the range of values presented in Tables 1-1 to 1-4 so the plot of power vs. load resistance will show a clear maximum.
4. To determine load power, measure the load voltage and calculate the load power. Complete these measurements and calculations for sourcing resistances of 100Ω, 1kΩ, 10kΩ, and 100kΩ. Record your results in the tables.

DATA/OBSERVATIONS

Table 1-1: Values for 100 Ω Source Resistance and Variable Load Resistance

R_S	R_L	Theoretical		Measurements	
		V_L	$P_L = (V_L)^2/R_L$	V_L	$P_L = (V_L)^2/R_L$
100 Ω	10				
	50				
	75				
	90				
	95				
	100				
	105				
	110				
	125				
	500				
	1K				
	5K				
	10K				
	50K				
	75K				
	100K				

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Table 1-2: Values for 1K Ω Source Resistance and Variable Load Resistance

R_S	R_L	Theoretical		Measured	
		V_L	$P_L = (V_L)^2/R_L$	V_L	$P_L = (V_L)^2/R_L$
1K Ω	10				
	50				
	100				
	500				
	900				
	950				
	975				
	1K				
	1.25K				
	1.5K				
	1.75K				
	5K				
	10K				
	50K				
	75K				
	100K				

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Table 1-3: Values for 10K Ω Source Resistance and Variable Load Resistance

R_S	R_L	Theoretical		Measured	
		V_L	$P_L = (V_L)^2/R_L$	V_L	$P_L = (V_L)^2/R_L$
10K Ω	10				
	50				
	100				
	500				
	1K				
	5K				
	7K				
	9K				
	9.5K				
	9.75K				
	10K				
	10.25K				
	10.5K				
	11K				
	12K				
	25K				
	50K				
	75K				
	100K				

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Table 1-4: Values for 100K Ω Source Resistance and Variable Load Resistance

R_S	R_L	Theoretical		Measurement	
		V_L	$P_L = (V_L)^2/R_L$	V_L	$P_L = (V_L)^2/R_L$
100K Ω	10				
	50				
	100				
	500				
	1K				
	5K				
	10K				
	50K				
	75K				
	90K				
	95K				
	97K				
	99K				
	100K				
	101K				
	103K				
	105K				
	110K				

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POST-LAB

Post-Lab questions must be answered in each experiment's laboratory report.

1. Create Table 1-5 in Excel or similar software for import into your write-up. Use the values from the Pre-Lab to calculate theoretical maximum power.

$$\%\ \text{error} = \frac{meas - theo}{theo} \times 100$$

Table 1-5: Maximum Power Transfer for Source Resistors

Source Resistance R_S	Load Resistance R_L	Measured Load Voltage V_L	Maximum Power (Measured) $P_L = (V_L)^2/R_L$	Maximum Power (Theoretical) $P = (V_S)^2/4R_S$	Percent Error
100 Ω					
1000 Ω					
10K Ω					
100K Ω					

2. For each of the four sourcing resistors, create a plot of output power vs. load resistance. Format axis to show bell curve.
3. Explain how resistor tolerances can cause errors in the experimentally determined maximum power.

Be sure to include all items from the post-lab exercise above in your written lab report.