Class: First Stage
Subject: Electrical Tech. Laborotory
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Maximum Power Transfer

Objective

The objective of this exercise is to determine the conditions under which a load will produce maximum power. Further, the variance of load power and system efficiency will be examined graphically.

Theory Overview

In order to achieve the maximum load power in a DC circuit, the load resistance must equal the driving resistance, that is, the internal resistance of the source. Any load resistance value above or below this will produce a smaller load power. System efficiency (η) is 50% at the maximum power case. This is because the load and the internal resistance form a basic series loop, and as they have the same value, they must exhibit equal currents and voltages, and hence equal powers. As the load increases in resistance beyond the maximizing value the load voltage will rise, however, the load current will drop by a greater amount yielding a lower load power. Although this is not the maximum load power, this will represent a larger percentage of total power produced, and thus a greater efficiency (the ratio of load power to total power).

Equipment

(1) Adjustable DC power supply model:________________srn:__________________

(1) Digital multimeter model:________________srn:__________________

(1) Resistance decade box

(1) 3.3 kΩ __________________

Schematics

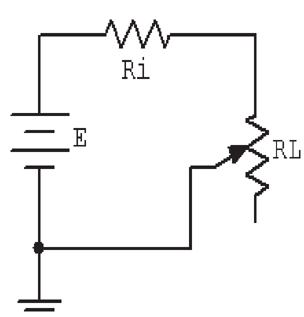

Figure 12.1

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Procedure

1. Consider the simple the series circuit of Figure 12.1 using E = 10 volts and Ri = 3.3 k. Ri forms a simple voltage divider with RL. The power in the load is VL^2/RL and the total circuit power is E^2/(Ri+RL). The larger the value of RL, the greater the load voltage, however, this does not mean that very large values of RL will produce maximum load power due to the division by RL. That is, at some point VL^2 will grow more slowly than RL itself. This crossover point should occur when RL is equal to Ri. Further, note that as RL increases, total circuit power decreases due to increasing total resistance. This should lead to an increase in efficiency. An alternate way of looking at the efficiency question is to note that as RL increases, circuit current decreases. As power is directly proportional to the square of current, as RL increases the power in Ri must decrease leaving a larger percentage of total power going to RL.

2. Using RL = 30, compute the expected values for load voltage, load power, total power and efficiency, and record them in Table 12.1. Repeat for the remaining RL values in the Table. For the middle entry labeled Actual, insert the measured value of the 3.3 k used for Ri.

3. Build the circuit of Figure 12.1 using E = 10 volts and Ri = 3.3 k. Use the decade box for RL and set it to 30 ohms. Measure the load voltage and record it in Table 12.2. Calculate the load power, total power and efficiency, and record these values in Table 12.2. Repeat for the remaining resistor values in the table.

4. Create two plots of the load power versus the load resistance value using the data from the two tables, one for theoretical, one for experimental. For best results make sure that the horizontal axis (RL) uses a log scaling instead of linear.

5. Create two plots of the efficiency versus the load resistance value using the data from the two tables, one for theoretical, one for experimental. For best results make sure that the horizontal axis (RL) uses a log scaling instead of linear.

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Data Tables

R_L	V_L	P_L	P_T	η
30				
150				
500				
1 k				
2.5 k				
Actual=				
4 k				
10 k				
25 k				
70 k				
300 k				

Table 12.1

R_L	V_L	P_L	P_T	η
30				
150				
500				
1 k				
2.5 k				
Actual=				
4 k				
10 k				
25 k				
70 k				
300 k				

Table 12.2

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Questions

1. At what point does maximum load power occur?

2. At what point does maximum total power occur?

3. At what point does maximum efficiency occur?

4. Is it safe to assume that generation of maximum load power is always a desired goal? Why/why not?