ECET 102/CPET101
Lab 8
Maximum Power Transfer Lab

By Prof. Paul I. Lin

Required Devices & Equipment:

Resistors: 2kΩ x 2, 1kΩ x 1
Potentiometer 5kΩ x 2
Bread board x 1 with wires, wire strippers and cutters
Variable Power Supply x 1
Digital Multimeter (DMM) x 1

Objectives:

1. Learn to use the Maximum Power Transfer theorem in circuit analysis.
2. Learn to construct a circuit and measure maximum power transfer to the load.
3. Learn to use a computer simulation to verify the Maximum Power Transfer.

Introduction:

The maximum power transfer theorem states that for an electrical circuit with a finite internal source resistance, Rs, the maximum power transfer from source to the load occurs when the load resistance, RL, equals the Rs, or RL = Rs.

Consider the example circuit shown in Figure 1, where Rs = 100Ω, and RL is a variable resistor between 0 to 200Ω. The current passing through the circuit is I = E/(Rs + RL), and the power dissipation at the RL is P = I^2*RL.

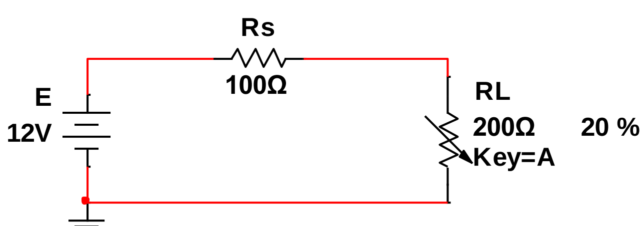

Figure 1. An example circuit

The following Matlab program can be used to calculate the output power, with RL changed from 0, 10, 20, …200 ohms, and compute the corresponding I and P for each RL step changes. Figure 2 shows the maximum power at RL occurs when RL = 100 ohms.

```
% maxpower.m
Rs = 100;
RL = 0:10:200;
E = 12;
I = E./(Rs + RL);
V_RL = I.*RL;
P = (I.^2).*RL;
subplot(2,1,1),plot(RL, V_RL), grid on, xlabel('RL - Ohms'), ylabel('V_RL -
Volt');
subplot(2,1,2), plot(RL, P), grid on, xlabel('RL - Ohms'), ylabel('P -
Watts');
```

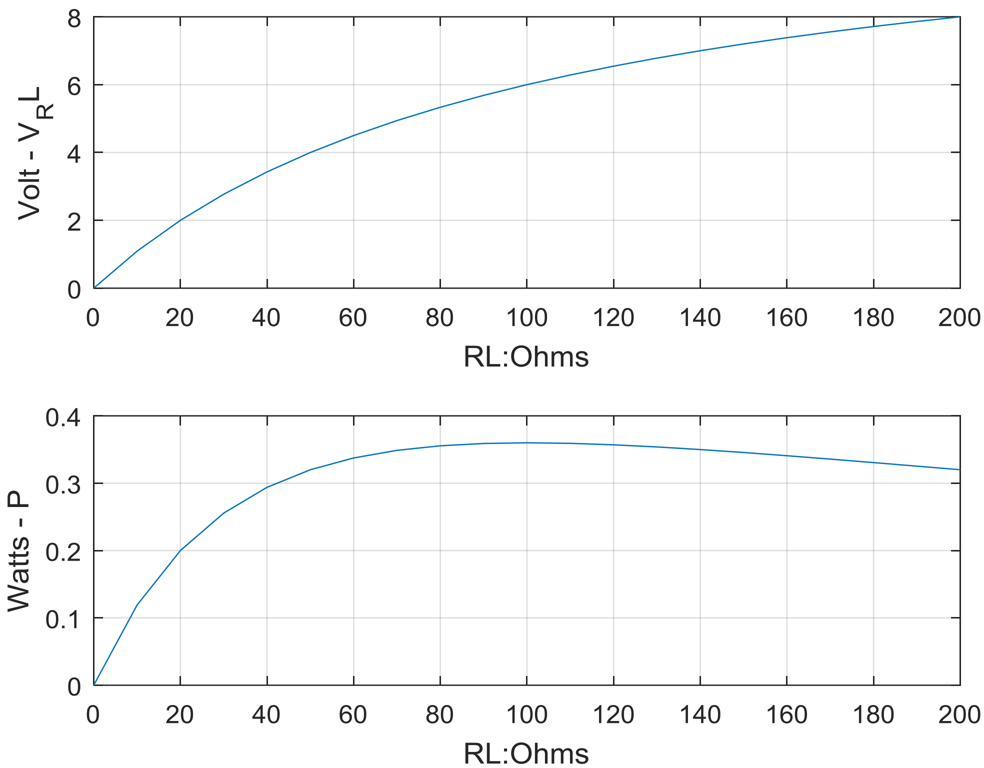

Figure 2. RL vs Vab and RL-P plots

Procedure: Consider the circuit shown in Figure 3 for the Lab 8. We will apply the following three methods for maximum power transfer calculation and verification:

- Using Thevenin's equivalent circuit and maximum power transfer circuit transfer theorem to compute the load resistance RL for a maximum power transfer.
- Using one of the following computer tools to compute and a plot with the maximum power vs. RL:
    - Excel spread sheet, or
    - Matlab program, or
    - Multisim program, configuring a DC Sweep analysis
- Set up a lab circuit to measure the condition for the maximum power transfer.

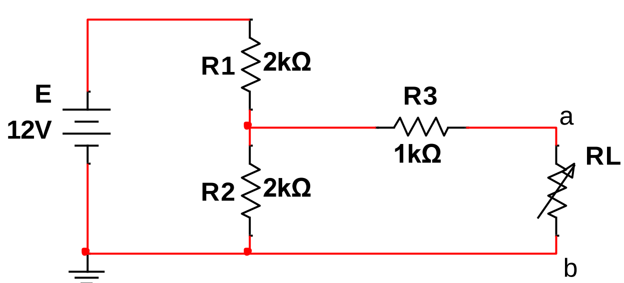

Figure 3. The Circuit for Lab 8

Part 1. Calculations

For the circuit shown in Figure 3, perform the following calculations:

(a) Find the Thevenin equivalent circuit related to the load resistor, RL, namely Eth and Rth.

(b) What the value of RL should be for a maximum transfer of power.

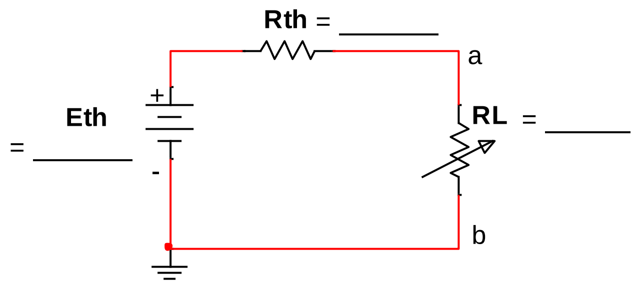

Figure 4. Thevenin equivalent circuit

Part 2. Measurement

a) Construct the circuit shown in Figure 5 for measurement.

(1) Set the value of Eth as the calculated value from Part1 on the power supply, and measure the current through and the voltage across R.

(2) Set the value of Rth on one of the 5 kΩ potentiometer.

(3) Set the value of RL on another 5 kΩ potentiometer.

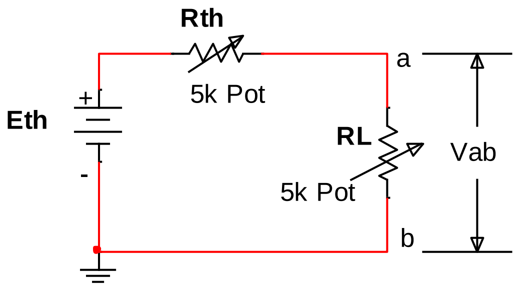

Figure 5. Setup for the measurement

(4) Vary the value of the RL potentiometer above and below the calculated value for maximum power transfer.

(5) Read and record the voltage across R for each of the values that are chosen.

(6) For each value of RL used, remove and read the RL value with an Ohmmeter.

(7) Plot the data read, with RL values on the X-axis and voltage across RL or Vab on the Y axis.

(8) What value of "RL" produces the highest voltage drop across RL?

Part 3. **Computer Analysis**

(a) Construct the circuit shown in Figure 5 in a computer program, such as, Multisim.
(b) Vary the value of RL and plot RL vs. Vab, where Vab is the voltage across the load resistor, RL.

Part 4. Compare the three methods of calculation, computer analysis and measurement. In particular, compare the RL vs. Vab curves that are obtained with the computer analysis and with the measurement results. Note any differences in the results.