Optimizing Power Transfer to a Load Using Matlab

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- ***Problem Description***

The aim of this task is to calculate the maximum power transferred from a fixed supply, to a load.
To put this requirement into perspective, *given a fixed supply, i.e. an electrical outlet, what is the maximum load you can connect to it in order to obtain the maximum power transfer from the supply to the load.*

As shown in the Figure below, the supply can be represented by two components, a voltage source, denoted by V_S, and a supply resistance, denoted by R_S. The load being applied can be simplified to its equivalent total resistance, R_L. By continually varying this load, and calculating the corresponding power at each value, the load that results in maximum power can be obtained.

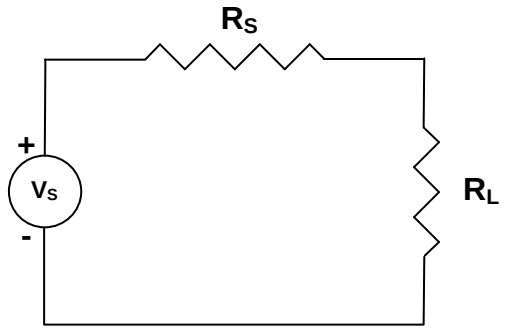

Figure 1: Circuit under test.

In order to be able to solve this sort of problem the following equation can be used:

$$\text{Power} = \left(\frac{Vs}{Rs+R_L} \right)^2 * R_L$$

Using MATLAB, carry out the following:

1) Given a supply, with V_S = 6V and R_S = 330Ω, vary the load resistance, R_L, between 50Ω and 500Ω in increments of 5Ω, and plot Power P vs R_L. From this graph, extract the value of R_L which gives maximum power.
   (HINT: we do not want max(P), we want the RL that causes the max(P).
   NOTE: you cannot use the graph to determine the value of RL, you must use matlab commands to find it)
2) Again plot Power P vs R_L, but this time use supply values: V_S = 6V, R_S = 500Ω. Vary R_L, in increments of 10Ω, between 300Ω and 700Ω. Extract the value of the load resistance, R_L, such that maximum power is obtained.
   (HINT: we do not want max(P), we want the RL that causes the max(P).
   NOTE: you cannot use the graph to determine the value of RL, you must use matlab commands to find it)
3) From your results, what is the relationship, if any, between the supply resistance, and the load resistance, in order to obtain maximum power?

- ***Deriving the Equation:***

The two main equations that are used are Ohms Law, and the power equation:

Ohms Law: $V = IR$
Power Equation: $P = IV = I^2R$.

where V = Voltage
I = Current
R = Resistance

First we must calculate the current running through the circuit of ***Figure 1***. Therefore, using Ohms Law, and the rule of resistances in series, we get:

$$I = \left(\frac{Vs}{Rs+R_L} \right)$$

Substituting this into our power equation, we get:

$$P = \left(\frac{Vs}{Rs+R_L} \right)^2 * R$$

The R at the end of this equation represents the resistance of the load that we are connecting to our circuit, i.e. R_L. By substituting into the above equation accordingly:

$$P = \left(\frac{Vs}{Rs+R_L} \right)^2 * R_L$$