Max Power Transfer

A Practical Exercise

Name: ____________________  Section: ____________

I. Purpose.
1. Review the concept of Thévenin’s Theorem for determining the Thévenin equivalent circuit of a DC series/parallel circuit from the standpoint of a two terminal load.
2. Introduce the concept of the maximum power transfer theorem.

II. Equipment.

- Keysight 34450A Digital Multimeter (DMM)
- Agilent E3620A Dual DC Power Supply
- 220, 560, 1500 Ohm resistors. Decade Box (variable resistor)

III. Pre-lab Calculations

**Step One:** Calculate $E_{\text{Thévenin}} (E_{th})$

- For the DC series/parallel circuit in Figure 1, calculate the open-circuit voltage (which is $E_{th}$) across terminals “a” and “b”. [Remember, this calculation is done with $R_{\text{load}}$ removed.]

![Figure 1](image)

$E_{th} = __________$

**Step Two:** Calculate $R_{\text{Thévenin}} (R_{th})$.

- For the DC series/parallel circuit in Figure 1, calculate the Thévenin equivalent resistance, $R_{th}$, as seen at terminals “a” and “b”.

$R_{th} = __________$
Max Power Transfer Theorem

**Step Three:** Sketch the Thévenin circuit and use it for current and power calculations

☐ Sketch the Thévenin Equivalent circuit in the space provided below. This will be Figure 2.

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**Figure 2**

☐ Use your Thévenin Equivalent circuit to calculate the DC current $I_{load}$ supplied to the load when the load resistance is equal to 300, $R_{th}$, and 900 ohms.

\[
I_{load \ (300\Omega)} = \underline{\quad} \\
I_{load \ (R-th)} = \underline{\quad} \\
I_{load \ (900\Omega)} = \underline{\quad}
\]

**Step Four:** Instructor or lab assistant verification that pre-lab calculations are complete.

________________________________________________________
Max Power Transfer Theorem

IV. Lab Procedure. Time Required: 35 minutes. Check-off each step as you complete it.

**Step One:** Construct the original DC series/parallel circuit of Figure 1.

☐ Measure the values of each resistor and record in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>220-Ω</th>
<th>560-Ω</th>
<th>1500-Ω</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured Values</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1

☐ Using a QUAD board construct the DC series/parallel circuit of Figure 1. Use the Variable Resistor as your load.

**Step Two:** Measure actual Thévenin equivalent Voltage and Resistance.

☐ Remove the variable load resistor from your circuit.

☐ Measure the voltage with a DMM across the open terminals a and b. \(V_{th} = \)___________

☐ “Turn Off” the power supply by disconnecting it from the circuit and shorting across where the power supply was connected with a blue wire.

☐ Measure the Thévenin Resistance with a DMM across the open terminals a and b.

\(R_{th} = \)___________

How closely does this value of \(R_{th}\) compare to the value calculated in the pre-lab calculations?

Exact__________ Very close__________ Very Different__________

☐ Restore your circuit by removing the blue wire, reconnecting the power supply and installing the variable load resistor.

☐ Use a DMM to accurately set the 15 V output of the Power Supply.

**Step Three:** Measure DC current.

☐ Use the DMM to measure the current through the load resistor for each of the three values of load resistance (300, \(R_{th}\), 900 Ω). Use the \(R_{th}\) value that you measured above in Step Two.

\(I_{load (300\Omega)} = \)___________

\(I_{load (R-th)} = \)___________

\(I_{load (900\Omega)} = \)___________

**NOTE:** Verify the accuracy of each setting of the variable resistor with a DMM.
Max Power Transfer Theorem

How closely does these values of $I_{\text{load}}$ compare to the values calculated in the pre-lab calculations?

<table>
<thead>
<tr>
<th>Exact</th>
<th>Very close</th>
<th>Very Different</th>
</tr>
</thead>
</table>

**Step Four:** Analysis of results.

☐ Use the measured DC current value and $R_{\text{load}}$ to calculate the power dissipated by each value of $R_{\text{load}}$. Show work below.

\[
P_{\text{load}}(300\Omega) = \_\_\_\_
\]

\[
P_{\text{load}}(R_{\text{th}}) = \_\_\_\_
\]

\[
P_{\text{load}}(900\Omega) = \_\_\_\_
\]

☐ Plot the power dissipated by the load vs. load resistance below:

![Graph showing power dissipated vs. load resistance]

How do these results confirm the Maximum Power Transfer Theorem? _______________________
_______________________________________________________________________________
_______________________________________________________________________________

Why was it necessary to determine the Thévenin Equivalent Resistance to confirm these results?
_______________________________________________________________________________
_______________________________________________________________________________

4 of 4