**LAB 6: The Thévenin Equivalent Circuit**

Name:

**Objective:**

To characterize a multiple resistive network by its Thévenin’s equivalent circuit.

**Learning Outcomes:**

Ability to obtain and analyze the Thevenin equivalent circuit.

**Instrument/Component:**

Proteus Simulation Software

Resistors: 50Ω, 300 560820Ω, 2.2KΩ

Variable Resistor: 0-10k0-50k0-100k

**Theory:**

***Thévenin’s Theorem:*** It is a process by which a complex circuit is reduced to an equivalent series circuit consisting of a single voltage source (VTH), a series resistance (RTH) and a load resistance (RL). After creating the Thévenin Equivalent Circuit, the load voltage VL or the load current IL may be easily determined.

One of the main uses of Thévenin’s theorem is the replacement of a large part of a circuit, often a complicated and uninteresting part, by a very simple equivalent. The new simpler circuit enables us to make rapid calculations of the voltage, current, and power which the original circuit is able to deliver to a load. It also helps us to choose the best value of this load resistance for *maximum* power transfer.

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**Figure 6.1**

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**Figure 6.2 Thevenin equivalent circuit of Figure 6.1**

***Maximum Power Transfer Theorem*** states that an independent voltage source in series with a resistance RS or an independent current source in parallel with a resistance RS, delivers a maximum power to that load resistance RL for which RL = RS.

In terms of a Thévenin Equivalent Circuit, maximum power is delivered to the load resistance RL when RL is equal to the Thévenin equivalent resistance RTH of the circuit.



**Figure 6.3 Maximum Power Transfer**

**Task 1: Verifying the Thévenin’s theorem**

1. Construct the circuit of Figure 6.1 using the following component values:

R1 = 300 

R2 = 560 

R3 = 560 

R4 = 300 

R5 = 820 

RL = 1.2 K

VS = 10 V

1. Measure the voltage VL across the load resistance.

Answer:

1. Find VTH: Remove the load resistance RL and measure the open circuit voltage, Voc across the terminals. This is equal to VTH.

Answer:

1. Find RTH: Remove the source voltage VS and replace it with a short circuit.

Answer:

1. Measure the resistance looking into the opening where RL was with an ohmmeter (DMM). This gives RTH.
2. Obtaining VTH and RTH, construct the circuit of Figure 6.2. Set the value of RTH using a variable resistor.
3. Measure the VL for this circuit and compare it to the VL obtained from circuit of Figure 6.1. This verifies the Thévenin theorem.

Answer:

1. Repeat steps 1(b) to 1(f) for RL = 3.3 K
2. Verifying the Maximum Power Transfer theorem:

Answer:

1. Construct the circuit as in Figure 6.3 using the following values:

VS = 10 V

R1 = R2 = 560 

R3 = 820 

RL = Variable Resistor (0-10k)

1. Connect the DMM across RL for measuring the load voltage. To find the value of RL for which maximum power is transferred, vary the resistances between 600 to 1200 and note down VL for each case.

Answer:

1. The value of RL at which VL is maximum, gives the load resistance for maximum power transfer.

Answer:

**Task 2: Thevenin Theorem**

**PreLab:**

1. The circuit in Figure 6.4 (a) can be converted to (b) using Thevenin theorem.

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| --- | --- |
|  |  |

1. (b)

**Figure 6.4**

1. Determine *VTH* and *RTH* given that *R*1 = 50 Ω, *R*2 = 2.2 kΩ, *R*3 = 4.7 kΩ and *Vin* = 5V.

Answer:

1. Construct the circuit shown in **Figure 6.4(a).** Use 50kΩ Variable Resistor for RL.
2. Record and plot *IO* versus the voltage at node *VO* relative to ground for six different values of *RL* including the cases when *RL* is open-circuited and *RL*is short circuited.

Answer:

|  |  |  |
| --- | --- | --- |
| ***RL*** | ***VO*** | ***IO*** |
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|  |  |  |
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|  |  |  |
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1. From the plot, derive an equation relating *IO* and *VO*. From the equation, infer and obtain the Thévenin parameters.
2. Compare the measured values with the calculated values from the prelab. Explain the differences between the values, if any.

Answer:

1. Construct the circuit in Figure 6.4(b) and measure *IO* and *VO* for this network using the same load resistors as in step (2).

Answer:

|  |  |  |
| --- | --- | --- |
| ***RL*** | ***VO*** | ***IO*** |
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1. What is the significance of step (5)? What does this experiment tells you about the concept of equivalence?

Answer:

1. Now you can determine the Thévenin equivalent circuit of a battery. Be sure not to short circuit the battery. State the procedures required to obtain the parameters of the Thévenin equivalent circuit.

Answer: