UM-SJTU JI 2024FA VE215 Lab #2

We will evaluate the Thehevenin equivalent in this lab.

• Please hand in your post-lab assignment before the due date. Please do your post-lab assignment following the requirements in each problem. Both hand-written and printed are accepted.

• You are encouraged to print this lab manual and then finish the post-lab questions on it. For pictures or diagrams, you may print it in a paper, cut it down and paste on this worksheet.

Instruments

DC power supply

Multimeter

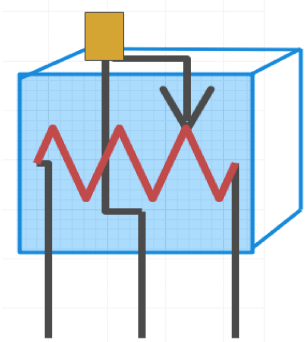
Breadboard and Wires

Resistors of $\mathbf{50\Omega}$ and $\mathbf{100\Omega}$

Rheostat of $\mathbf{200\Omega}$ (or $\mathbf{500\Omega}$)

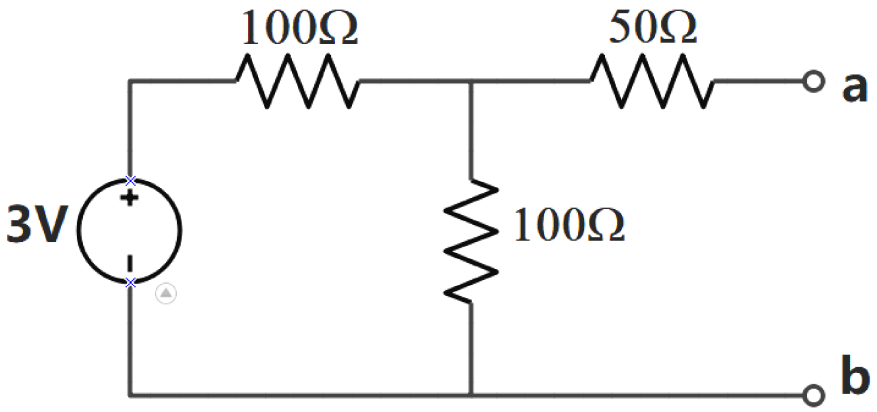
Instruments Introduction

For the **rheostats**, please connect the middle port and one of the sided ports inside the circuit (refer to the diagram). Please rotate the button at the top of rheostat using a mini-screwdriver to change its resistance.



Problem #1 Thevenin Equivalent

Please connect the circuit on your breadboard based on the schematic.



After the connection, please turn on the voltage source and measure the open-circuit voltage $\mathbf{V_{ab}}$ between port **a** and port **b** by multi-meter. Then, please turn off the voltage source and measure the equivalent resistance $\mathbf{R_{ab}}$ between port **a** and port **b** by multi-meter. Please record your data in the table:

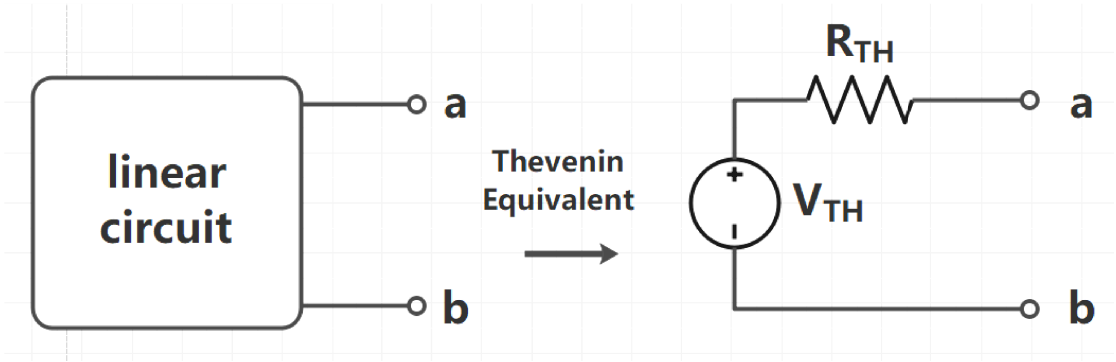
Term	Open-circuit voltage $\mathbf{V_{ab}}$	Equivalent resistance $\mathbf{R_{ab}}$
Value		

Post-Lab Questions for (P1)

(1) Please calculate the theoretical values of the Thevenin's equivalent voltage and the equivalent resistance between port **a** and port **b**. Then, please compare the experimental values with the theoretical ones and explain how this experiment verifies the Thevenin theorem.

Problem #2 Application of Thevenin Equivalent

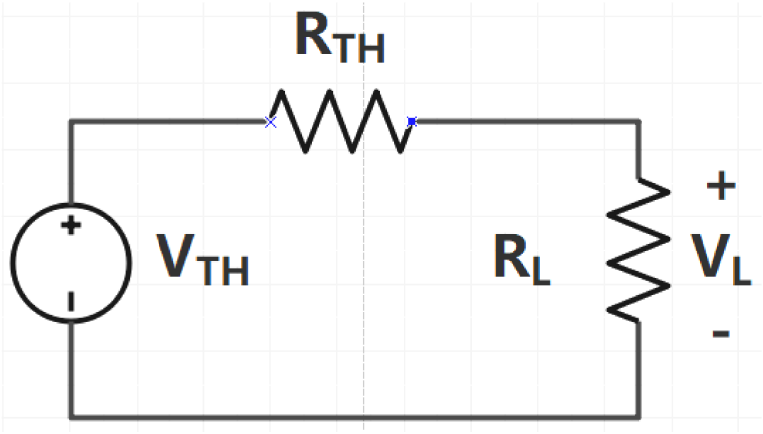
Based on Thevenin theorem, most of linear circuits could be replaced by equivalent models composed of an equivalent voltage source $\mathbf{V_{TH}}$ connected in series with equivalent resistance $\mathbf{R_{TH}}$, which is represented by the following diagram:



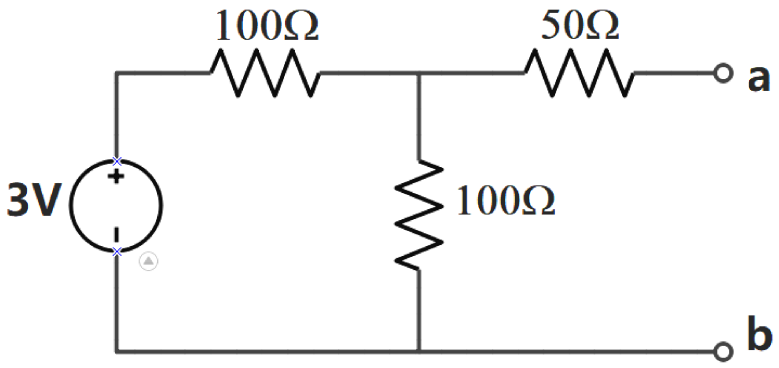
By adopting Thevenin transformation, the amount of calculation could be reduced significantly when analyzing complex circuits. For a linear

circuit, suppose the Thevenin equivalent voltage is $\mathbf{V_{TH}}$ and the equivalent resistance is $\mathbf{R_{TH}}$. If we connect a load resistance $\mathbf{R_L}$ between the two reference ports (please refer to the following schematics), the load voltage $\mathbf{V_L}$ will be:

$$\mathbf{V_L = V_{TH}\ \frac{R_L}{R_L + R_{TH}}}$$



Please connect a **50Ω** resistor and an **100Ω** resistor respectively between port **a** and port **b** as the load in the following circuit (same as the circuit in problem 1). Then, please turn on the source, measure the load voltage $\mathbf{V_{ab}}$ (the voltage between port **a** and port **b**) by multi-meter and fill in the table next page:



Load Resistance	**50Ω**	**100Ω**
$\mathbf{V_{ab}}$		

Post-Lab Questions for (P2)

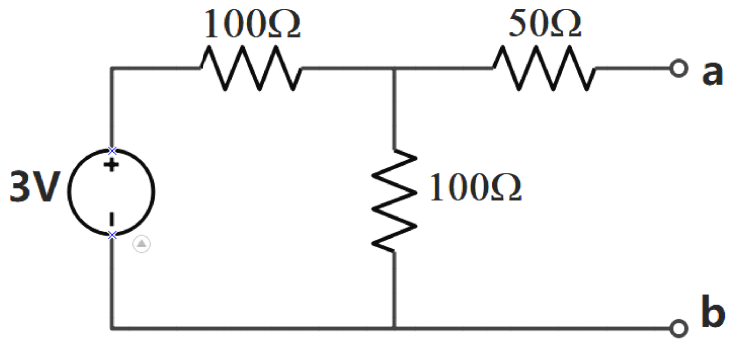
(1) Please calculate the theoretical values of the load voltage $\mathbf{V_{ab}}$ **for** the **50Ω** and **100Ω** loads. Then, please compare the experimental results with the theoretical ones.

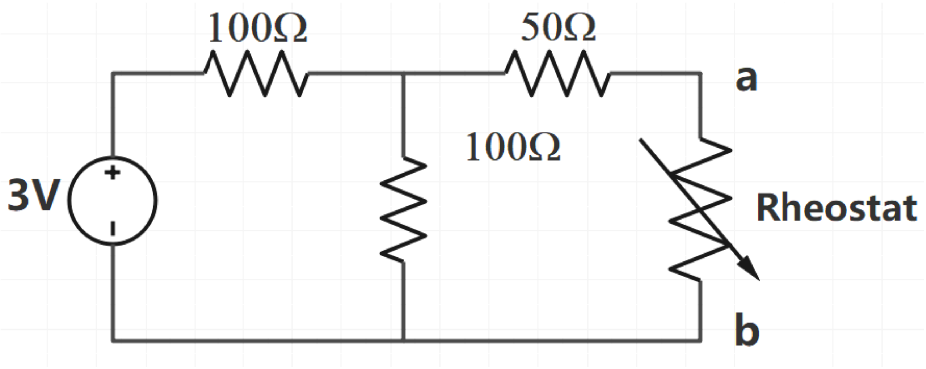
Problem #3 Maximum Power Transfer

According to the maximum power transformation theorem, for a linear circuit with Thevenin voltage $\mathbf{V_{TH}}$ and equivalent resistance $\mathbf{R_{TH}}$, the power transformed to the load will reaches its maximum if the load resistance $\mathbf{R_L = R_{TH}}$ and the maximum power absorbed by the load is:

$$\mathbf{P_{max} = \frac{V_{TH}^2}{4R_{TH}}}$$

In order to evaluate the maximum power transformation theorem, please connect a **200Ω** (or **500Ω**) rheostat between port **a** and port **b** in the schematic.





Please set your rheostat at its minimum resistance (about **0Ω**) at first, use multi-meter to measure the load resistance (resistance of rheostat) $\mathbf{R_L}$ and the load voltage $\mathbf{V_L}$. Then, please increase the resistance by **10Ω** or **20Ω** each time, measure $\mathbf{R_L}$ and $\mathbf{V_L}$ following the same procedure. Please record the data of $\mathbf{R_L}$, $\mathbf{V_L}$ in the table and calculate the power transformed to the load $\mathbf{P_L}$ for each $\mathbf{R_L}$.

Rheostat Resistance $\mathbf{R_L}$	Load Voltage $\mathbf{V_L}$	Power absorbed by load $\mathbf{P_L}$
0Ω		

200Ω		

Post-Lab Questions for (P3)

(1) Please calculate the theoretical values of the maximum power transferred to the load and the corresponding load resistance.

(2) Please plot the curve of $\mathbf{P_L}$ and $\mathbf{R_L}$. What is the maximum power transferred to the load and the corresponding load resistance based on the curve you obtained? Is it consistent with the expected?