$Objectives:

1* simplify resistive circuit in DC by using thevenin & Norton equivalents.
2* verify maximum power transfer theorem.
3* learn about potentiometers (variable resistors).

$Theory:

You can simplify any circuit by using the method you learn in the previous two experiments but now we will learn addition method to simplify the circuits.

A# Thevenin's Theorem:

The meaning of this theorem is that any linear network may, with respect to a pair of terminals be replaced by an equivalent voltage source V_{Th}(equal to the open circuit voltage) in series with a resistance R_{Th} seen between these terminals.

To evaluate V_{Th} and R_{Th} follow the steps:

1. Open-circuit the terminals to which Thevenin's equivalent is desired.
2. R_{Th} is the total resistance at open circuit terminals, when all voltage source replaced by short circuits, & all current sources replace by open circuits.
3. V_{Th} is the voltage across the open-circuit terminals.
4. replace the original circuit with Thevenin's equivalent circuit.

B# Norton's Theorem:

The concept of this theorem that any linear network may, with respect to a pair of terminals, be replaced by a current source I_N (equal to the short-circuit current) in parallel with the resistance R_{Th} seen between the two terminals.

To evaluate I_N and R_N follow the steps:

1. Open-circuit the terminals to which Norton's equivalent is desired.
2. $R_N=R_{Th}$.

3. I_N represent the short circuit current passing through the terminals.
4. replace the original circuit with Norton equivalent circuit.

C# Maximum Power Transfer Theory:

The concept of this theory is that an independent voltage source in series with a resistance R_s, or an independent current source in parallel with a resistance R_s, delivers maximum power to the load resistance RL when $R_s=R_L$,& it's represented by:

$P_{MAX}=V_s^2/4R_s$

D# Potentiometer (variable resistors):

It's 3-terminal device,& the amount of resistance material between the point of contact & one of the end terminals determine the resistance between those two points, the Potentiometer has an arm which used to increase or decrease the resistance between the center terminal & one of the end terminals , it can used as a rheostat if the center arm & one of the end terminals are connected into the circuit & the other terminal is disconnected.

$Equipment:

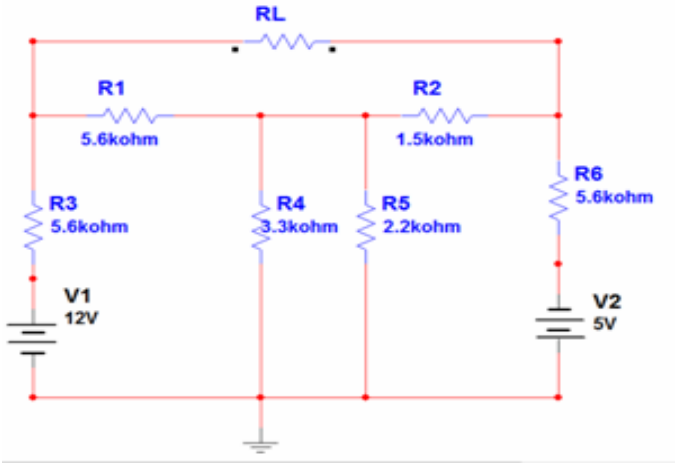
PS, DMM, Breadboard, Resistors, Potentiometer, wires, leads.

$Procedure:

*part A^Thevenin & Norton Equivalents^:

1.take 6 resistors(5.6, 1.5,5.6, 3.3, 2.2, 5.6kΩ)& fix them in the breadboard as shown in the figure.

2. provide the circuit of two PS of 12,5 v.



3.provide the DMM to measured the voltage & be sure the two source connected to the circuit & it have the desired values then record the values in the table.
4.disconnect RL & keep the DMM to measured the voltage then measured the voltage between these two terminal (this voltage represent Vth =Voc) & record the value.
5.provide the DMM to measured the current.
6.keep RL disconnected & connect the DMM across the two open terminal & record the value (this current represent Isc).
7.provide the DMM to measured the resistance.
8. first keep RL disconnected then disconnect the two source from the circuit & replaced it by wires (shorted the source) then connect the DMM across the two opened terminals & record the value (this resistance represent Rth) .

Quantity	Vth(v)	Isc(mA)	Rth(kΩ)	Vs1(v)	Vs2(v)
Value	6.945	1.834	3.999	11.981	4.9993

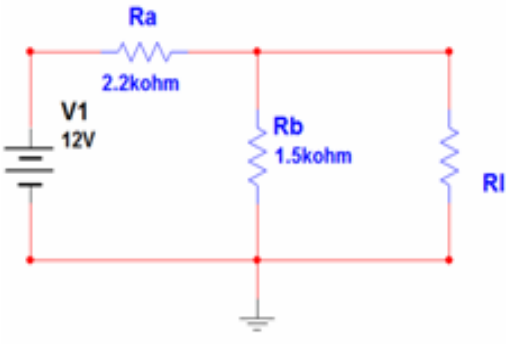
*part B: potentiometer:

1^ Measured the max & min value of the resistance in the potentiometer^:

1. put the potentiometer in the breadboard in different node & put 2 wires in the same node that the center terminal & one of the end terminal is .
2. provide DMM to measured the resistance & connect it to the previous two terminals .
3. rotate the potentiometer arm until it arrive the max value of the resistance then rotate it to the opposite direction until it reach the min value of the resistance then record the values.
**Note: 1.there is no need to connect the potentiometer to the circuit in this part.
2. the max value of the resistance is 1.25kΩ & the min is 0.07kΩ.

2^ Measured values of the voltage when different values of RL connect^:

1. take 2 resistance (2.2, 1.5 kΩ) & fixed them in the breadboard & connect it to the potentiometer ,, supply the circuit with 12v as shown below.



2. take the previous potentiometer & measured a certain values of the resistance (0.25, 0.5, 0.75, 1 kΩ) you can controlled of this values by using the fixing arm in the potentiometer & rotate it to left & right until we reach the desired values.
3. provide DMM to measured the voltage & measure VL for a certain value of RL which provide by the potentiometer as in the table below:

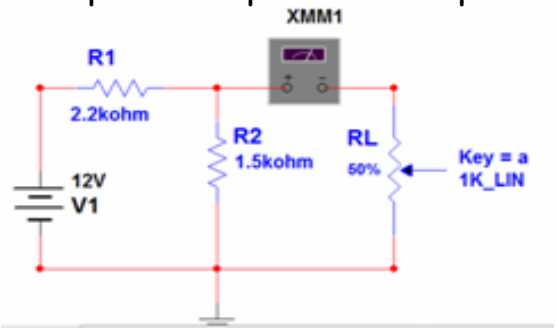
RL(KΩ)	0.25	0.5	0.75	1.00
VL(V)	1.103	1.81	4.895	2.597

Note: when you determine the value of the desired resistance by using the potentiometer we first disconnect the potentiometer from the circuit then rotate it to the desired resistance (by using DMM to read the true value) after that we will connect it to the circuit.

Part c: determine the value of the resistance in the potentiometer:

1. take the circuit in the previous part with all parameter .
2. provide the DMM to measured the current will follwed in the RL .
3. rotate the arm of the potentiometer to change the resistance & stop when we see that the current in RL become 4mA .

4. then disconnect the potentiometer from the circuit & measured the value of the resistance which case this value of current(by DMM). & record the value.
5. repeat the previous steps for IL=(3, 2.5, 2.75 mA)



IL(mA)	4.00	3.00	2.50	2.75
RL(kΩ)	0.2816	0.591	0.94	0.82

$Conclusion:

1. the experimental result allow the verification of the theoretical analysis.
2. in Norton & thevnin analysis the equivalency is with respect to a selected pair of terminals(& it's used to reduced amore complex circuit).
3. when you find Rth we should replace all voltage source as short circuit & current as open circuit.
4. the different between Norton & thevnin method is that Norton will reduce the circuit as current source with equivalent resistance in parallel , but in thevnin it's voltage source in series with the equivalent resistance.
5. in the potentiometer in you connect the DMM between the two end terminal the value of the measured resistance will be not change.