

# **ECE132: Basic Electrical and Electronics Engineering Lab**

**Experiment 3:** verification of Thevenin's and Norton's theorems in DC circuits.

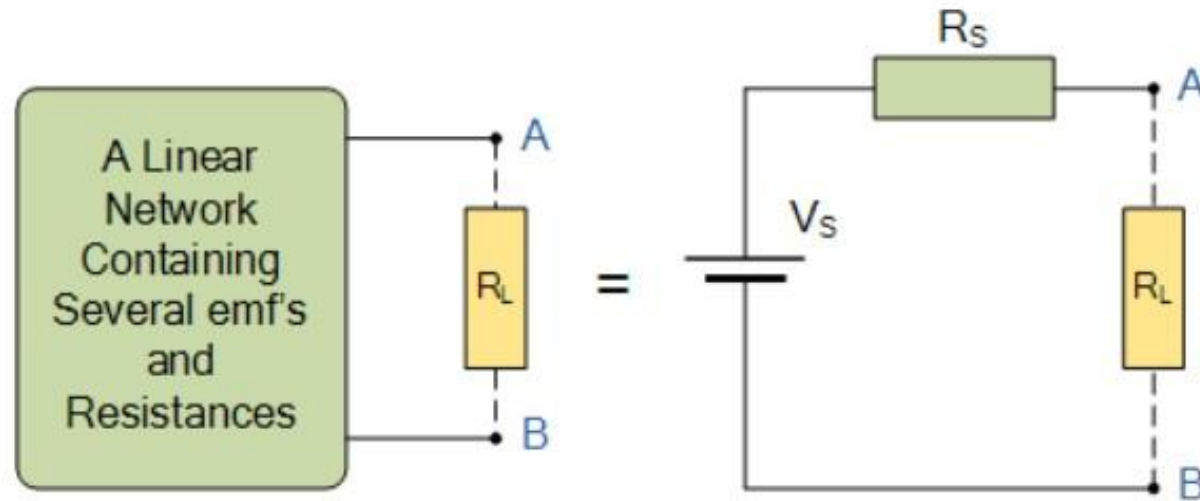
# Introduction

## Thevenin's Theorem

It states that “*Any linear circuit containing several voltages and resistances can be replaced by just one single voltage in series with a single resistance connected across the load*”. In other words, it is possible to simplify any electrical circuit, no matter how complex, to an equivalent two-terminal circuit with just a single constant voltage source in series with a resistance (or impedance) connected to a load as shown below.

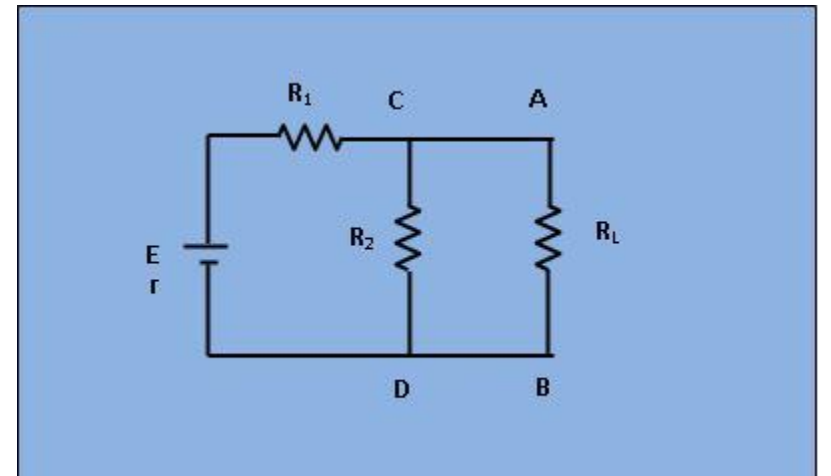
# Introduction

## Thevenin's Equivalent Circuit



# An Example

Find the current across the load resistor by applying the Thevenin's theorem.

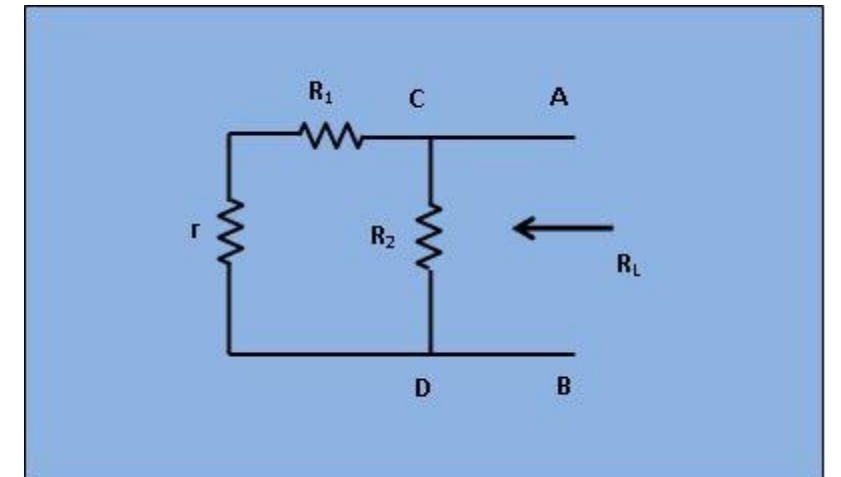
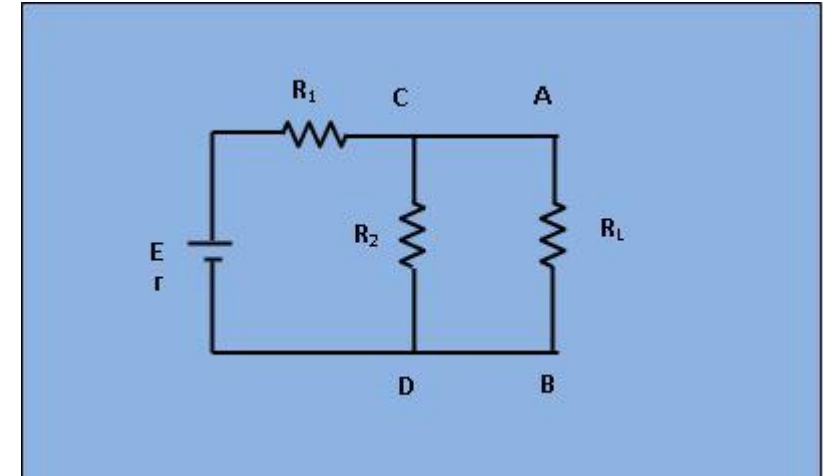


# An Example

## Find Equivalent Resistance, $R_s$

**Step 1:** Firstly, we have to remove the  $R_L$  load resistor connected across the terminals A-B

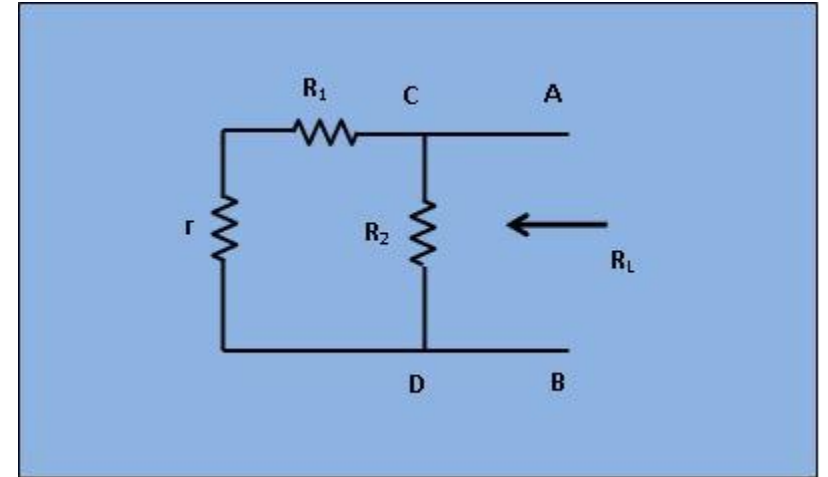
**Step 2:** Remove any internal resistance associated with the voltage source(s). This is done by shorting out all the voltage sources connected to the circuit with their internal resistance  $r$ .



# An Example

## Find Equivalent Resistance, $R_{th}$

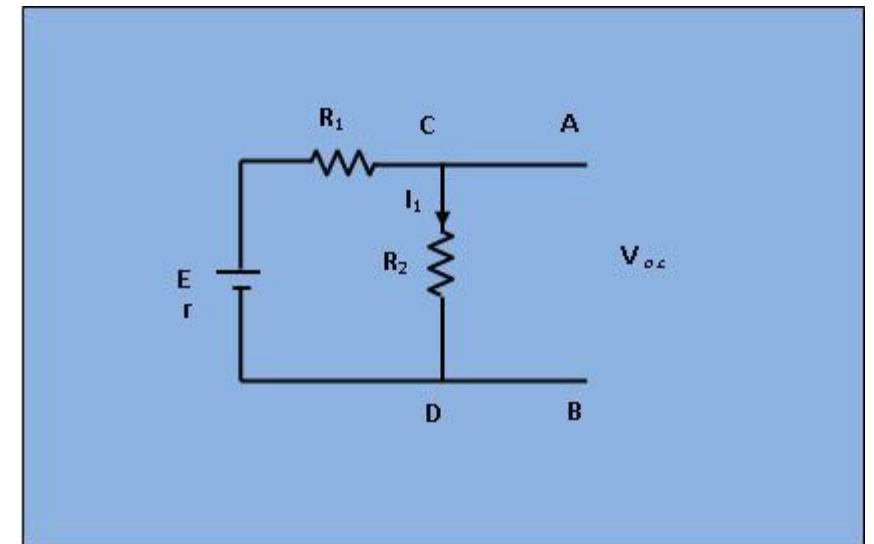
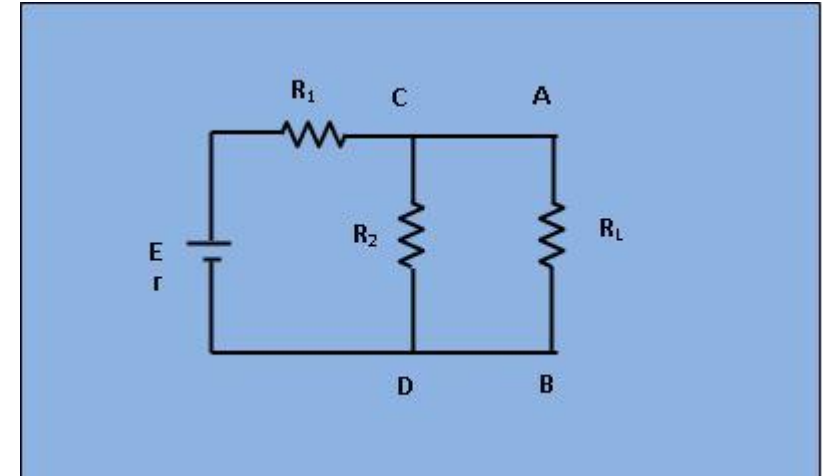
**Step 3:** The value of the equivalent resistance,  $R_{th}$  is found by calculating the total resistance looking back from the terminals A and B with all the voltage sources shorted.



# An Example

Find Equivalent Voltage,  $V_s$

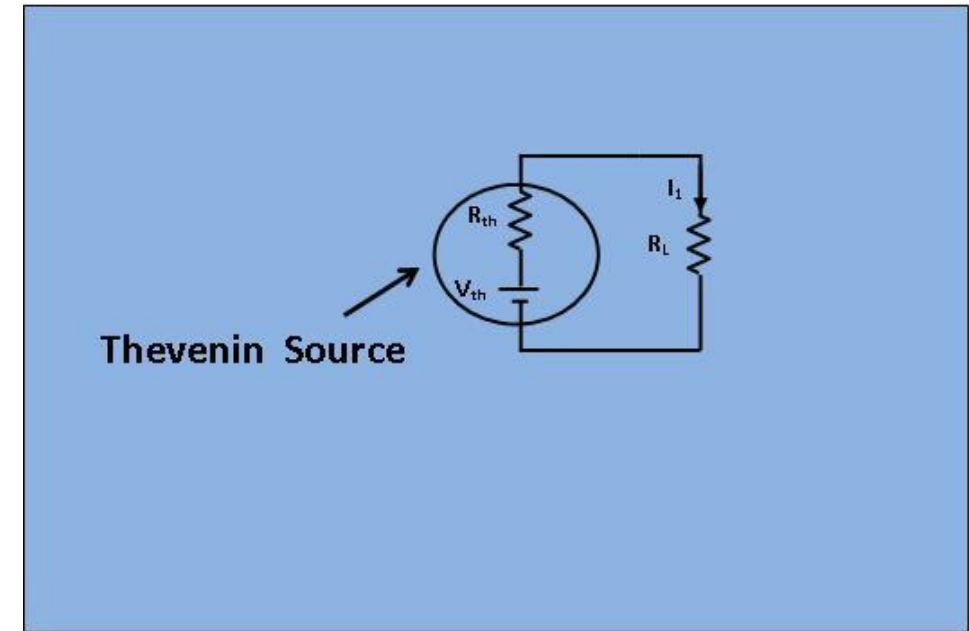
**Step 4:** We now need to reconnect the two voltages back into the circuit, and find the  $V_{th} = V_{oc}$  by applying the KVL law



# An Example

**Step 5:.** Consequently, as viewed from terminals A and B, the whole network (excluding RL) can be reduced to single source (called thevenin's source) whose e.m.f equal to V.O.C. and whose internal resistance equal to  $R_{th}$  as shown in figure.

RL is now connected back across terminals A and B from where it was temporarily removed earlier. Current flowing through RL is given by,





# Let Verify using Virtual Lab

## Procedure:

Keep all the resistances ( $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_L$ ) close to their respective maximum values. Choose any arbitrary values of  $V_1$  and  $V_2$ .

## Experiment Part Select:

### Case 1:

Select switch of  $S_1$  to Power and  $S_2$  to load. Simulate the program. Observe the result from Table 1.

### Case-2:

#### a) Thevenin Voltage analysis:

Apply switch  $S_1$  to power and  $S_2$  to intermediate. Simulate the program. Read Thevenin voltage ( $V_{th}$ ) from Case 2 tab.

#### b) Thevenin Resistance analysis:

Apply switch  $S_1$  to short and  $S_2$  to power. Simulate the program. Read Thevenin resistance ( $R_{th}$ ) from Case 2 tab.

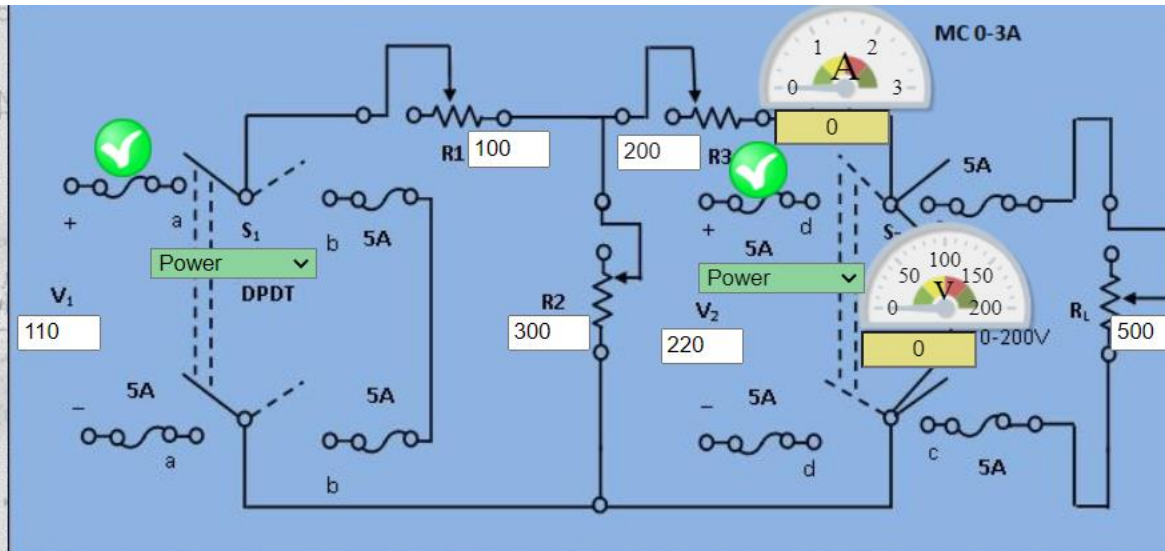
### Case-3: Using $V_{th}$ and $R_{th}$ determine Load Current:

Specify the load resistance in case of the result table as the same load resistance entered in the main circuit. Simulate the program. Read Load current ( $I_L$ ) from Case 3 tab. Compare the load currents ( $I_L$ ) obtained from above two cases.

### MC-Moving Coil.

### DPDT- Double pole Double throw.

N.B.:- All the resistances are in ohms.



Case 1

Case 2(a)

Case 2(b)

Case 3

## Circuit analysis to determine Load Current ( $I_L$ )

To get the load current select switches  
 $S_1$  to Power and  $S_2$  to Load.

And then click on Simulate.

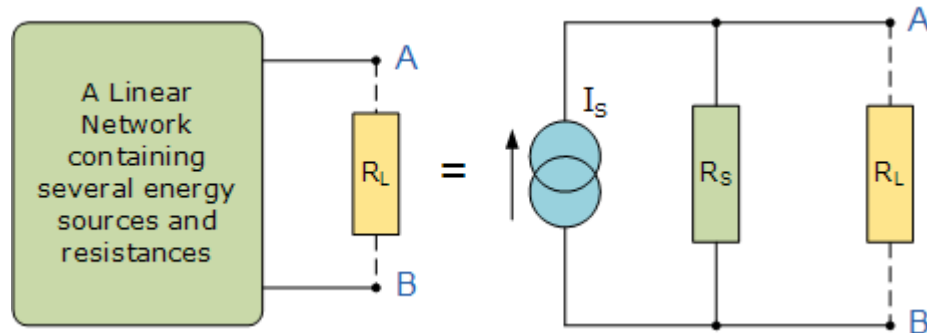
Load current ( $I_L$ ): 0

Simulate

# Introduction

## Norton's Theorem

It states that “*Any linear circuit containing several energy sources and resistances can be replaced by a single Constant Current generator in parallel with a Single Resistor*”.

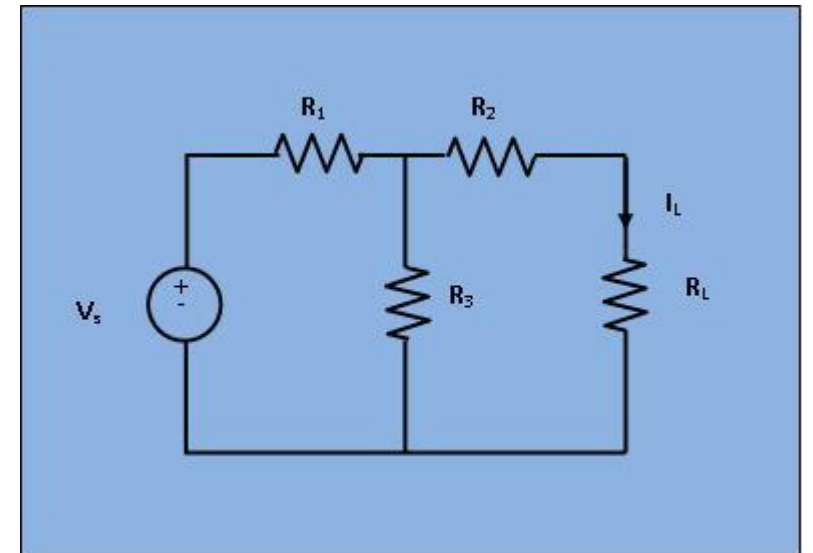


# An Example

Find the current across the  $40\Omega$  load resistor by applying the Norton's theorem.

**Find Equivalent Resistance,  $R_{th}$**

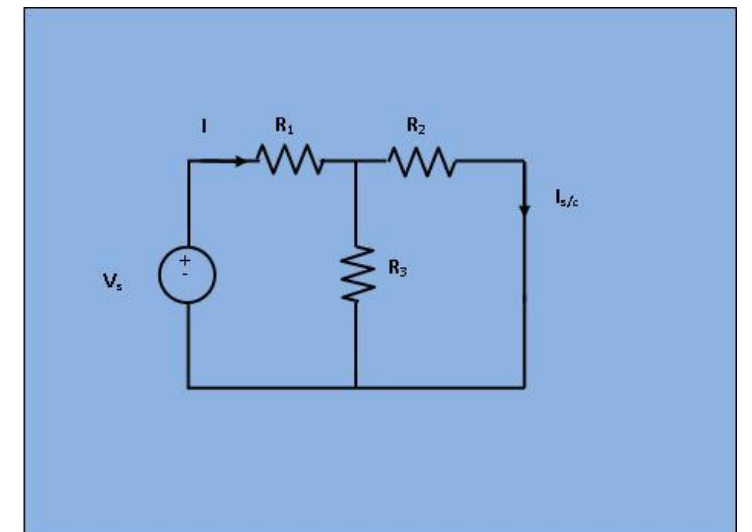
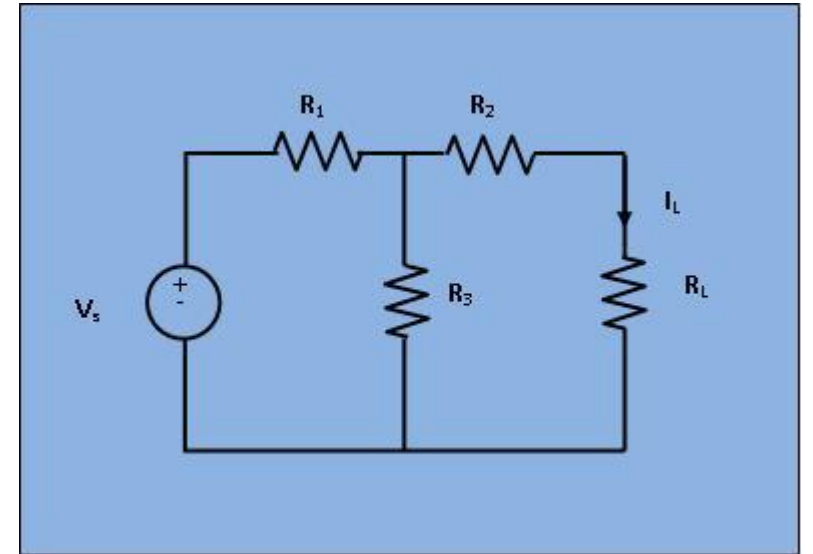
Step 1-3



# An Example

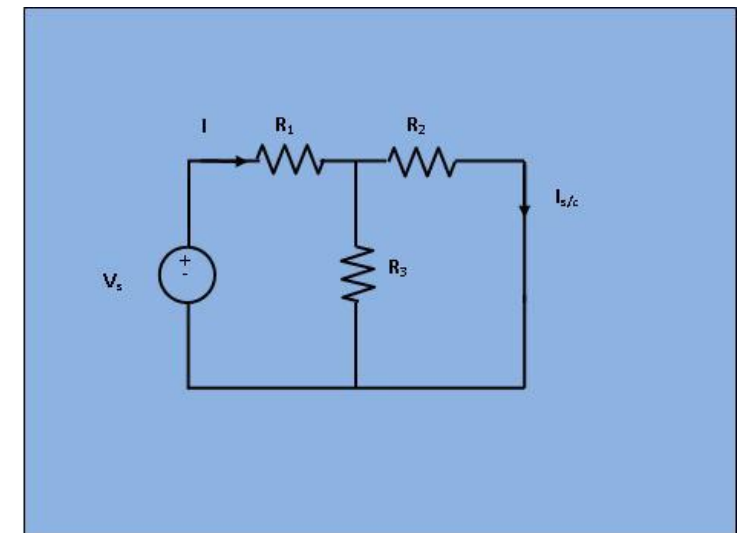
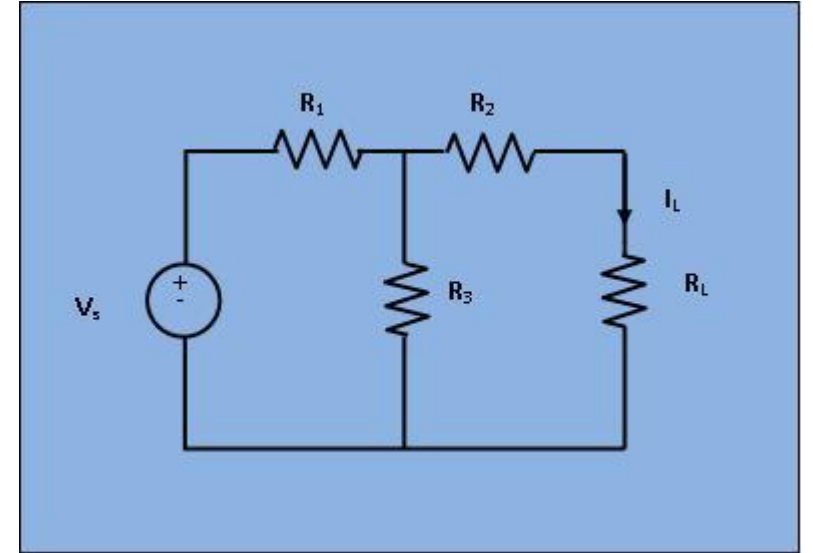
**Find Short circuit Current,  $I_s$**

**Step 4:** To find the Norton's equivalent of the above circuit we firstly have to remove the centre load resistor and short out the terminals A and B to give us the following circuit and find the short circuit current by applying the KCL.



# An Example

**Step 5:** As per Norton's theorem , the equivalent circuit as shown in figure, would contain a current source in parallel to the internal resistance, the current source being the short circuited current across the shorted terminals of the load resistor.





# Let Verify using Virtual Lab

## Procedure:

Allow JavaScript alerts in your browser.

Keep all the resistances ( $R_1$ ,  $R_2$ ,  $R_3$  &  $R_L$ ) close to their respective maximum values. Choose any arbitrary values of  $V_1$  and  $V_2$ .

## Experiment Part Select:

### Case 1:

Select switch of  $S_1$  to Power and  $S_2$  to Load and Simulate the program from Case 1 tab. Observe the result of load current.

### Case 2:

#### a) Norton Short circuit current analysis:

Apply switch  $S_1$  to power and  $S_2$  to Short and Simulate the program and read Norton short circuit current ( $I_{sc}$ ) from Case 2(a) tab.

#### b) Norton Resistance analysis:

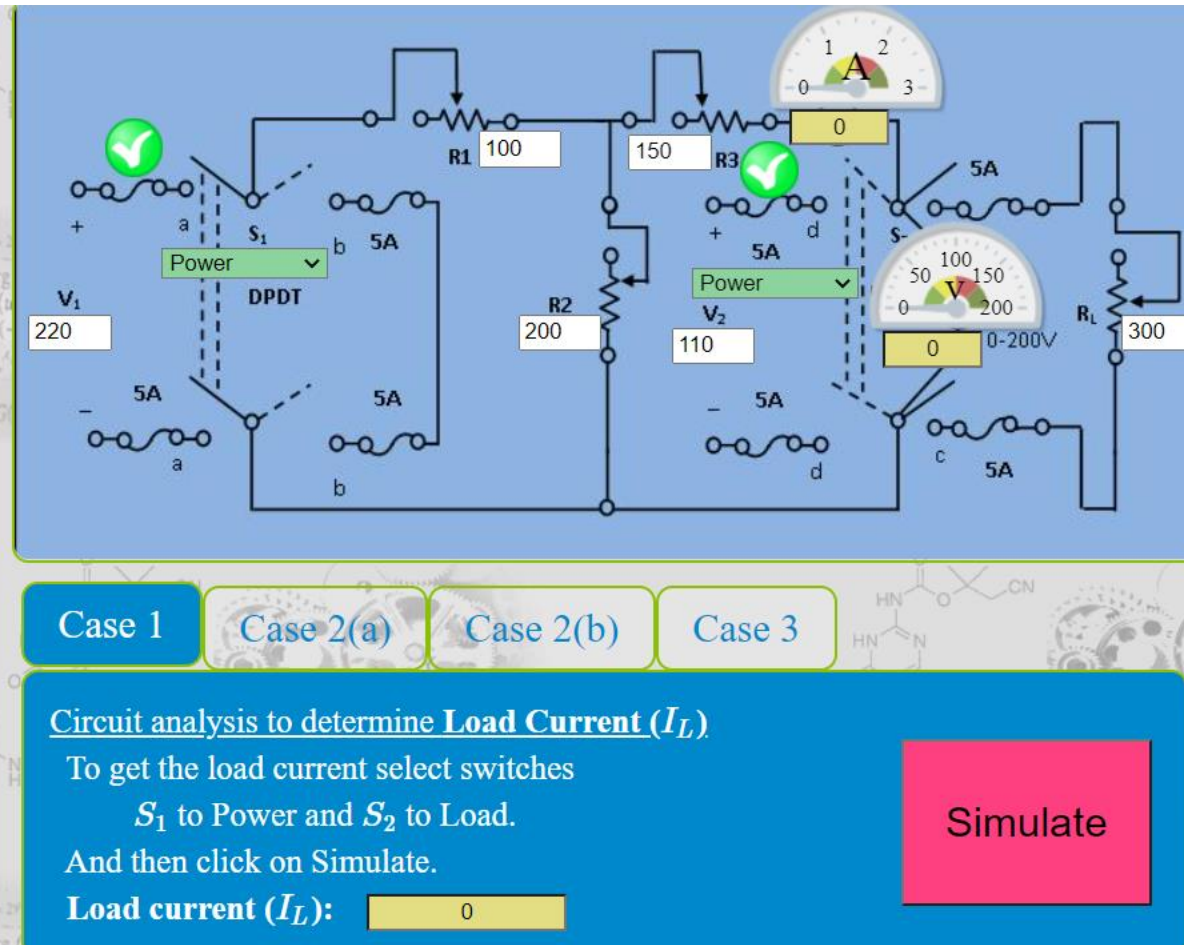
Apply switch  $S_1$  to short and  $S_2$  to power and Simulate the program and read Norton resistance ( $R_n$ ) from Case 2(b) tab.

### Case 3: Using $I_{sc}$ and $R_n$ determine Load Current

Simulate the program and read Load current ( $I_L$ ) from Case 3 tab. Compare the load currents ( $I_L$ ) obtained from Case 1 tab. Then click the button to fill the data to the observation table.

MC-Moving Coil.

DPDT Double pole Double throw



Thanks You