DEPT. OF ELECTRICAL & ELECTRONICS ENGINEERING
SRM INSTITUTE OF SCIENCE AND TECHNOLOGY, Kattankulathur – 603 203

Title of Experiment	: **2. VERIFICATION OF THEOREMS- (THEVENIN, NORTON, MAXIMUM POWER TRANSFER)**
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Register Number	: RA2011004010051
Date of Experiment	:30th April 2021

Sl. No.	Marks Split up	Maximum marks (50)	Marks obtained
1	Pre Lab questions	5	
2	Preparation of observation	15	
3	Execution of experiment	15	
4	Calculation / Evaluation of Result	10	
5	Post Lab questions	5	
Total		**50**	

Staff Signature

PRE LAB QUESTIONS

1. Define Lumped and distributed elements.

Lumped Elements:
A section of transmission lines designed so that electric or magnetic energy is concentrated in it at specified frequencies, and inductance or capacitance may therefore be regarded as concentrated in it, rather than distributed over the length of the line.
Distributed Elements:
These are composed of lengths of transmission lines or other distributed components. The circuits containing distributed elements perform the same functions as conventional circuits of passive components. In such elements, electric or magnetic energy is not concentrated at specific points and are distributed over the length of transmission lines.

2. State Thevenin's theorem?

Thevenin's theorem states that "any linear circuit containing several voltages and resistors can be replaced by just one single voltage in series with a single resistance connected across the load."

3. State Norton's theorem?

Norton's theorem states that "a linear active network consisting of the independent or dependent voltage source and current sources and the various elements can be substituted by an equivalent circuit consisting of a current source in parallel with a resistance."

4. List the applications of Thevenin's and Norton's theorems?

Thevenin's theorem can be applied to determine the charge in load voltage, to predict range of load voltage variation due to charge in load resistance, to obtain the norton's equivalent circuit, to determine maximum power that can be transferred to load from the network.

Norton's theorem helps to simplify any linear circuit, no matter how complex, to an equivalent circuit with just a single current source and parallel resistance connection to a load, It can also be used to represent any network of impedances at a given frequency.

5. What are the different types of dependent or controlled sources?

The different types of dependent or controlled sources are;

a. Voltage controlled voltage source(VCVS)
b. Voltage controlled current source(VCCS)
c. Current controlled voltage source(CCVS)
d. Current controlled current source(CCCS)

Experiment No. 2 a) Date :	THEVENIN'S THEOREM

Aim:

To verify Thevenin's theorem and to find the full load current for the given circuit.

Apparatus Required:

Sl.No.	Apparatus	Range	Quantity
1	RPS (regulated power supply)	(0-30V)	2
2	Ammeter	(0-10mA)	1
3	Resistors	1KΩ, 330Ω	3,1
4	Bread Board	--	Required
5	DRB	--	1

Statement:

Any linear bilateral, active two terminal network can be replaced by a equivalent voltage source (V_{TH}). Thevenin's voltage or V_{OC} in series with looking pack resistance R_{TH}.

Precautions:

1. Voltage control knob of RPS should be kept at minimum position.
2. Current control knob of RPS should be kept at maximum position

Procedure:

1. Connections are given as per the circuit diagram.
2. Set a particular value of voltage using RPS and note down the corresponding ammeter readings.

To find V_{TH}

3. Remove the load resistance and measure the open circuit voltage using multimeter (V_{TH}).

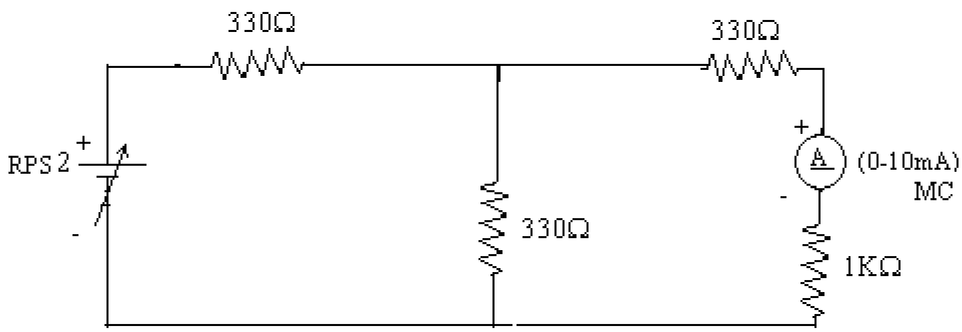
To find R_{TH}

4. To find the Thevenin's resistance, remove the RPS and short circuit it and find the R_{TH} using multimeter.
5. Give the connections for equivalent circuit and set V_{TH} and R_{TH} and note the corresponding ammeter reading.
6. Verify Thevenins theorem.

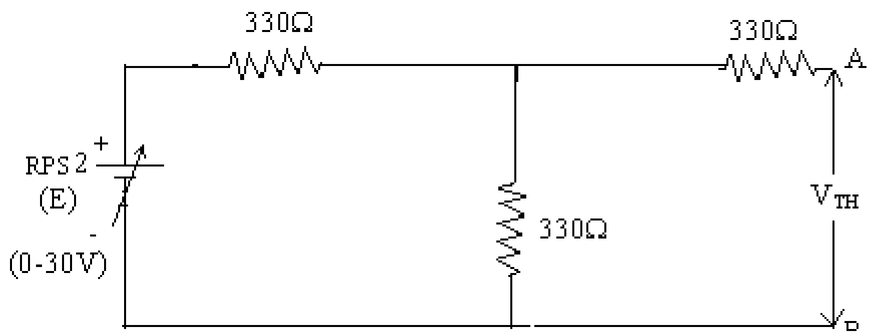
Theoretical and Practical Values

	E(V)	V_{TH}(V)	R_{TH}(Ω)	I_L (mA)	
				Circuit - I	Equivalent Circuit
Theoretical	10	5	495	3.34	3.34
Practical	10	5	495	3.34	3.34

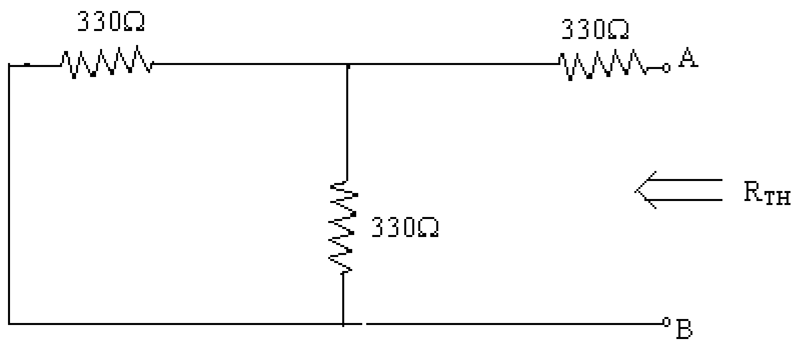
Circuit - 1 : To find load current



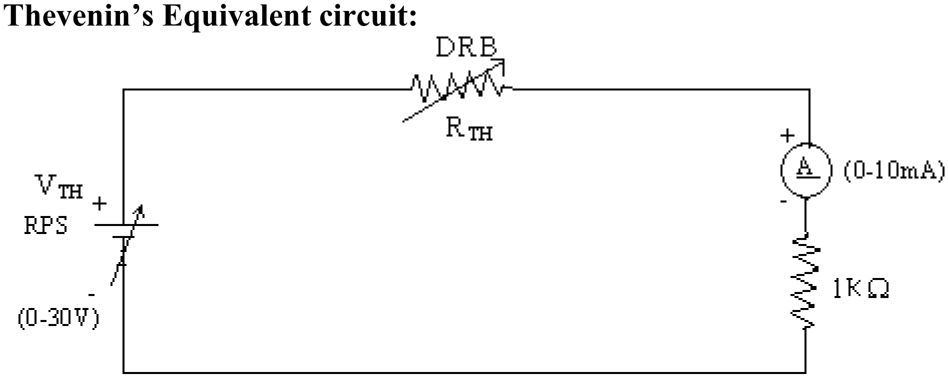
To find V_{TH}



To find R_{TH}



Thevenin's Equivalent circuit:



Model Calculations:

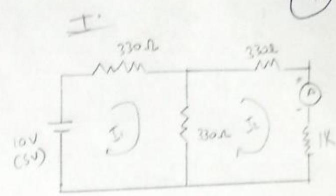
Circuit - I : (1)

Mesh Analysis (For E = 10V)

Mesh - I (KVL) :

$330 I_1 + 330 I_1 - 330 I_2 = 10$ — (1)

$I_1 = \dfrac{10 + 330 I_2}{660}$



Mesh - II (KVL) :

$1000 I_2 + 330 I_2 + 330 I_2 - 330 I_1 = 0$ — (2)

Sub (1) in (2)

we get

$1660 I_2 = 330 I_1$

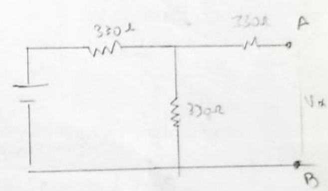
$1660 I_2 = 330 \times \dfrac{(10 + 330 I_2)}{660_2}$

$1660 I_2 = 5 + 165 I_2$

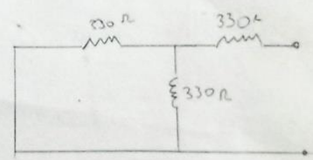
$1495 I_2 = 5$

$I_2 = 3.34 \text{ mA}$

To find V_{TH}



To find R_{TH}



For Thevenin's Equivalent Circuit : (2)

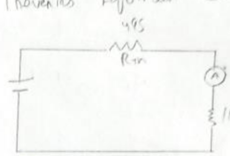
$V_{th} = V_{330} = \dfrac{10 \times 330}{660} = 5V.$

$V_{R_1} = \dfrac{V \times R_1}{R_1 + R_2}$

$R_{Th} = 330 + \dfrac{330 \times 330}{330 + 330}$

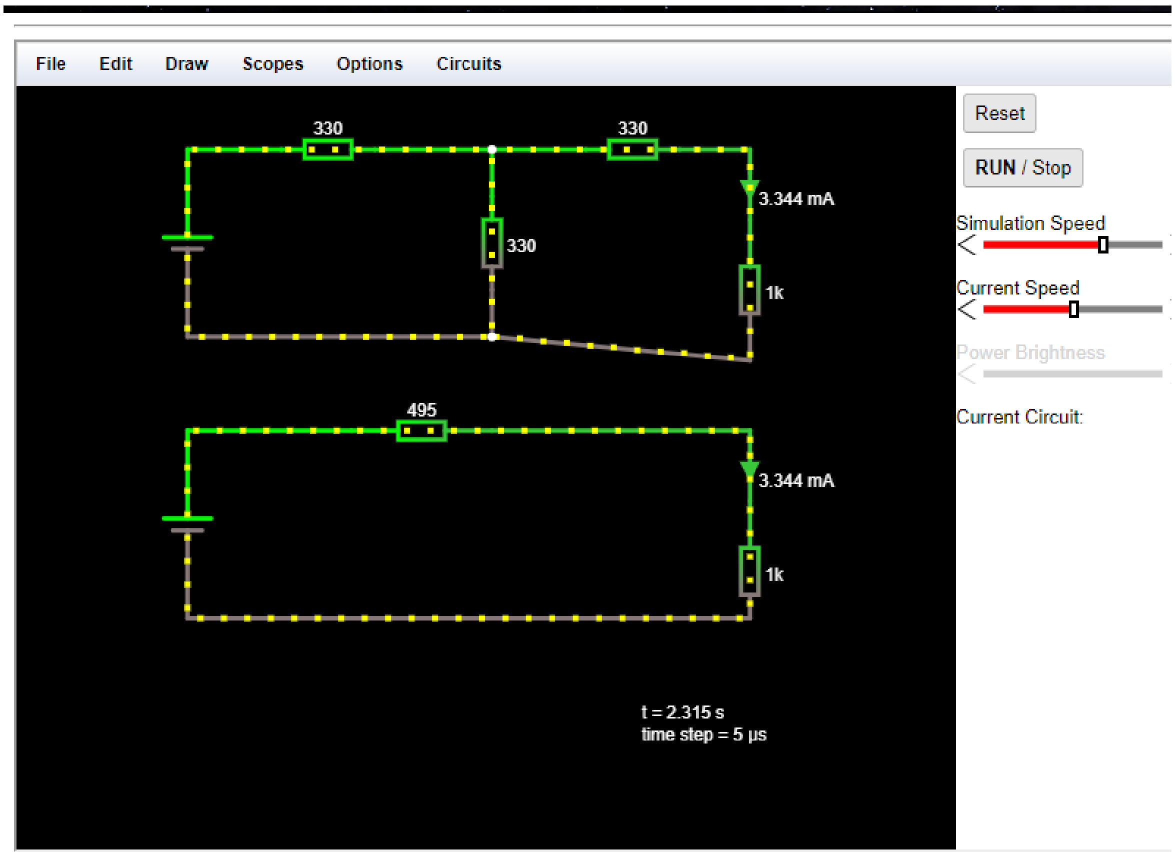
$= 330 + 165 = 495 \ \Omega.$

Thevenin's Equivalent Circuit



$I = \dfrac{V}{R_{eq}} = \dfrac{5}{495 + 1000} = \dfrac{5}{1495} = 3.34 \text{ mA}$

Result:


File
Edit
Draw
Scopes
Options
Circuits
330
330
3.344 mA
330
1k
495
3.344 mA
1k
t = 2.315 s
time step = 5 μs
Reset
RUN / Stop
Simulation Speed
Current Speed
Power Brightness
Current Circuit:

Experiment No. 2 b) **Date :**	**VERIFICATION OF NORTON'S THEOREM**

Aim:

To verify Norton's theorem for the given circuit.

Apparatus Required:

Sl.No.	Apparatus	Range	Quantity
1	Ammeter	(0-10mA) MC (0-30mA) MC	1 1
2	Resistors	330, 1KΩ	3,1
3	RPS	(0-30V)	2
4	Bread Board	--	1
5	Wires	--	Required

Statement:

Any linear, bilateral, active two terminal network can be replaced by an equivalent current source (I_N) in parallel with Norton's resistance (R_N)

Precautions:

1. Voltage control knob of RPS should be kept at minimum position.
2. Current control knob of RPS should be kept at maximum position.

Procedure:

1. Connections are given as per circuit diagram.
2. Set a particular value in RPS and note down the ammeter readings in the original circuit.

To Find I_N:

3. Remove the load resistance and short circuit the terminals.
4. For the same RPS voltage note down the ammeter readings.

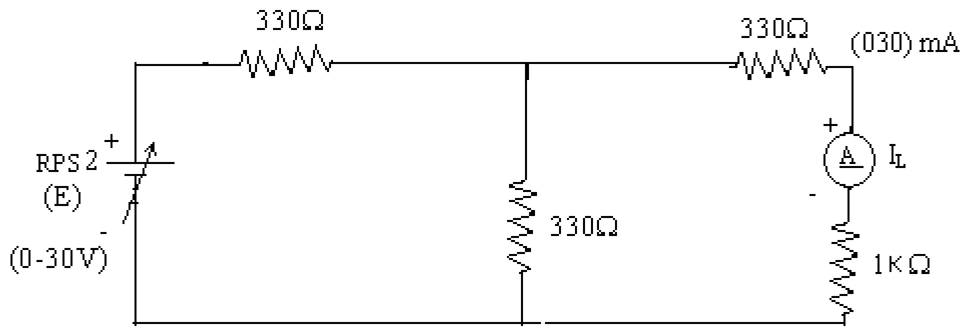
To Find R_N:

5. Remove RPS and short circuit the terminal and remove the load and note down the resistance across the two terminals.

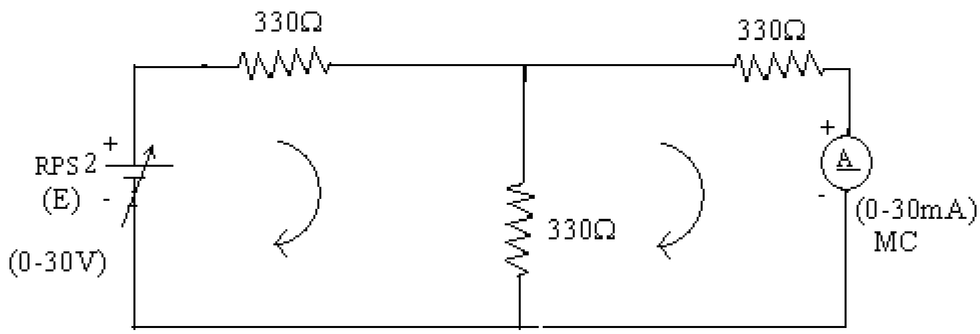
Equivalent Circuit:

6. Set I_N and R_N and note down the ammeter readings.
7. Verify Norton's theorem.

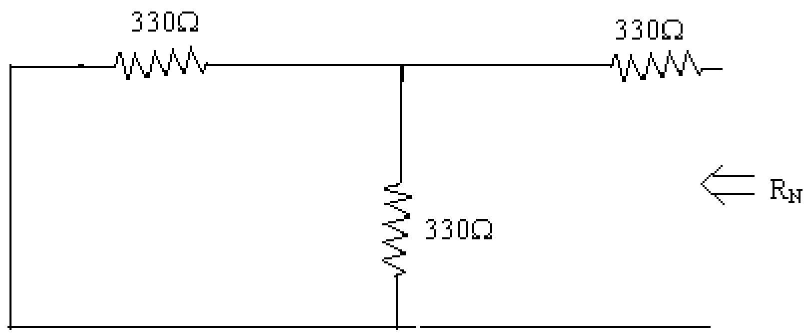
To find load current in circuit 1:



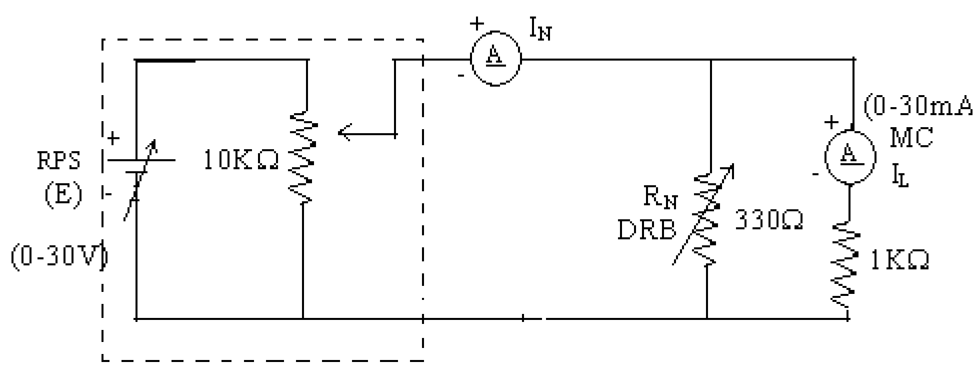
To find I_N



To find R_N



Norton's equivalent circuit



Constant current source

Theoretical and Practical Values

	E (volts)	I_N (mA)	R_N (Ω)	I_L (mA)	
				Circuit - I	Equivalent Circuit
Theoretical Values	10	10.1	495	3.34	3.34
Practical Values	10	10.1	495	3.34	3.34

Model Calculations:

6) Nortons Theorem:

Circuit - I

Mesh Analysis.

Mesh - I (KVL)

$330 I_1 + 330 I_1 - 330 I_2 = 10 \quad -①$

$I_1 = \frac{10 + 330 I_2}{660}$

Mesh-II (KVL) ③

$1000 I_2 + 330 I_2 + 330 I_2 - 330 I_1 = 0$

$1660 I_2 = 330 I_1$

$I_1 = 5.030 I_2 \quad -②$

Putting ② in ①

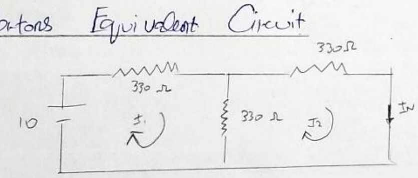
$5.030 I_2 = \frac{10 + 330 I_2}{660} \Rightarrow 3320 I_2 = 10 + 330 I_2$

$\cancel{\frac{3320 - 10}{330}} \cdot I_2$

$2990 I_2 = 10$

$\boxed{I_2 = 3.34 \text{ mA}}$

For Nortons Equivalent Circuit



Mesh-I (KVL)

$330 I_1 + 330 I_1 - 330 I_2 = 10$

$I_1 = \frac{10 + 330 I_2}{660}$

Mesh - II (KVL) (4)

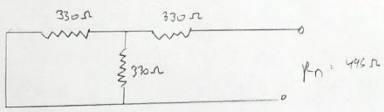
$330 I_2 + 330 I_2 - 330 I_1 = 0$

$660 I_2 = 330 I_1 \Rightarrow I_2 = \frac{5}{495} = 10.1\ mA.$

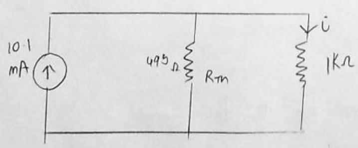
(substituting from above)

$I_N = 10.1\ mA.$

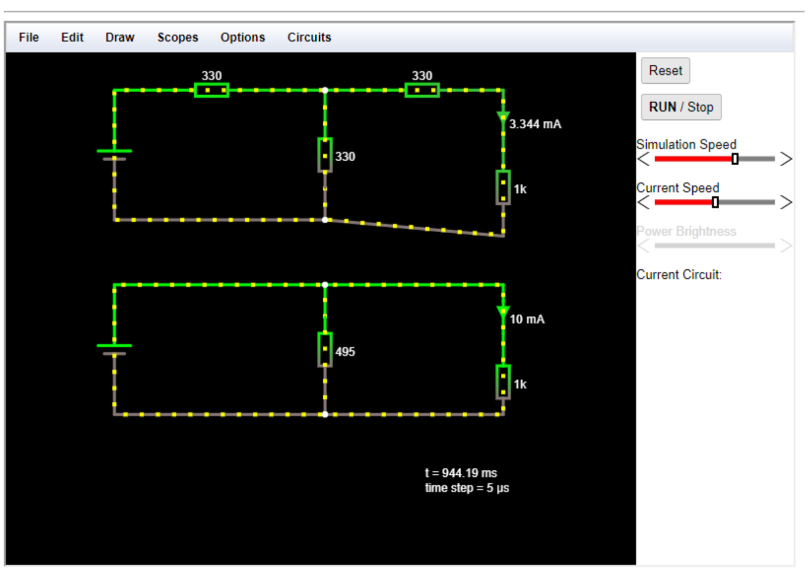
$R_N = 330 + \frac{330 \times 330}{660} = 495\ \Omega$



$I_{(1k\Omega)} = i = \frac{I \times R_{495}}{R_{495} + R_{1k}} \cdot \frac{10.1 \times 495}{1495} = 3.34\ mA.$



Result:



Experiment No. 2 c) **Date :**	**VERIFICATION OF MAXIMUM POWER TRANSFER THEOREM**

Aim:

To verify maximum power transfer theorem for the given circuit

Apparatus Required:

Sl.No.	Apparatus	Range	Quantity
1	RPS	(0-30V)	1
2	Voltmeter	(0-10V) MC	1
3	Resistor	1KΩ, 1.3KΩ, 3Ω	3
4	DRB	--	1
5	Bread Board & wires	--	Required

Statement:

In a linear, bilateral circuit the maximum power will be transferred from source to the load when load resistance is equal to source resistance.

Precautions:

1. Voltage control knob of RPS should be kept at minimum position.
2. Current control knob of RPS should be kept at maximum position.

Procedure:

Circuit – I

1. Connections are given as per the diagram and set a particular voltage in RPS.
2. Vary R_L and note down the corresponding ammeter and voltmeter reading.
3. Repeat the procedure for different values of R_L & Tabulate it.
4. Calculate the power for each value of R_L.

To find V_{TH}:

5. Remove the load, and determine the open circuit voltage using multimeter (V_{TH})

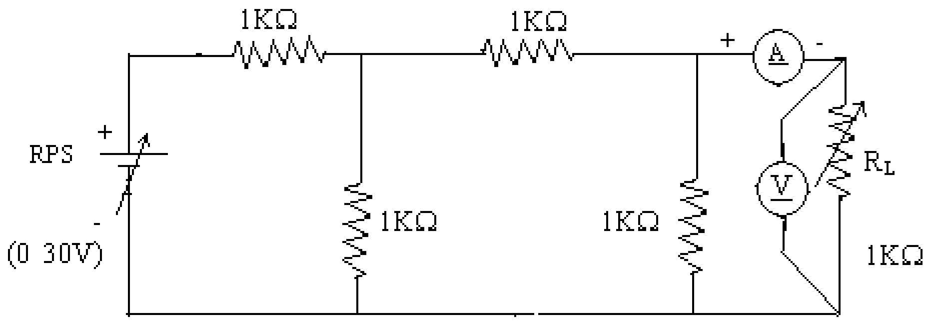
To find R_{TH}:

6. Remove the load and short circuit the voltage source (RPS).
7. Find the looking back resistance (R_{TH}) using multimeter.

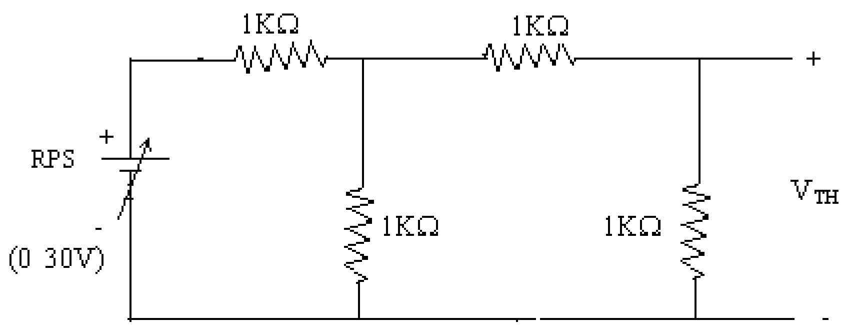
Equivalent Circuit:

8. Set V_{TH} using RPS and R_{TH} using DRB and note down the ammeter reading.
9. Calculate the power delivered to the load ($R_L = R_{TH}$)
10. Verify maximum transfer theorem.

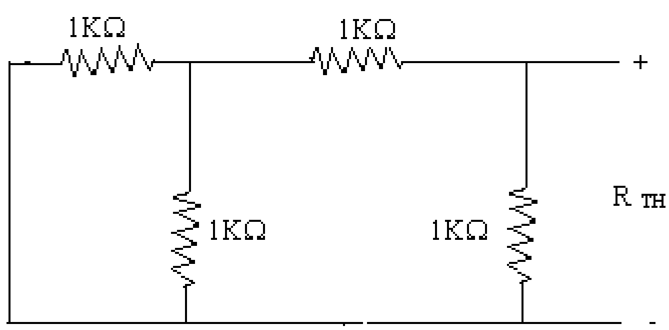
Circuit - 1



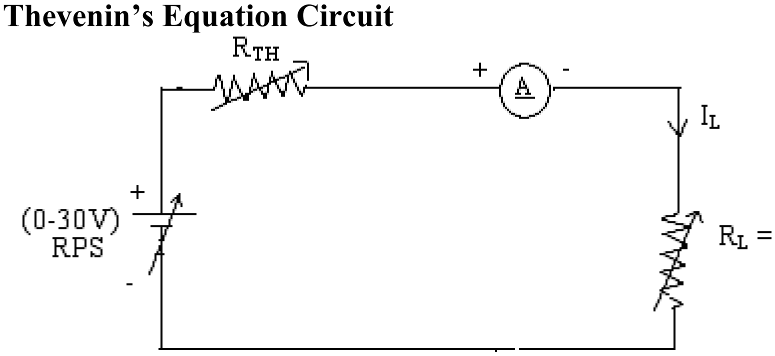
To find V_{TH}



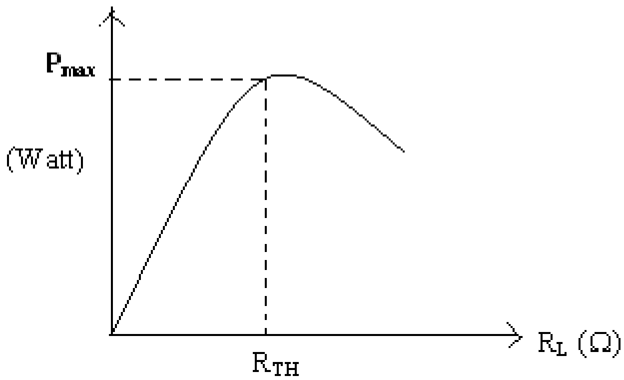
To find R_{TH}



Thevenin's Equation Circuit



Power Vs RL



Circuit – I

Sl.No.	RL (Ω)	I (mA)	V(V)	P=VI (mW)
1.	200	2.5	0.5	1.25
2.	400	2	0.8	1.6
3.	600	1.67	1	1.67
4.	800	1.43	1.14	1.63
5.	1000	1.25	1.25	1.56

To find Thevenin's equivalent circuit

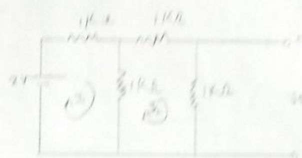
	V_{TH} (V)	R_{TH} (Ω)	I_L (mA)	P (milli watts)
Theoretical Value	2	600	1.67	1.67
Practical Value	2	600	1.67	1.67

Model Calculations:

Maximum Power Transfer Theorem

$V_{th} = I_2 \times 1000$

Mesh I (KVL)



$1000 I_1 + 1000(I_1 - I_2) = 10$ — ①

Mesh II (KVL)

$1000 I_2 + 1000 I_2 + 1000(I_2 - I_1) = 0$ — ②

from ① and ②

$I_2 = 2\ mA$

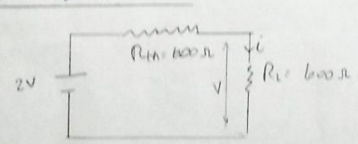
$\therefore V_{th} = 2\ mA \times 1000$

$= 2V$

Max Power $= \frac{V_{th}^2}{4 \times R_{th}} = \frac{4}{4 \times R_{th}} = \frac{1}{600} = 1.67\ mW$

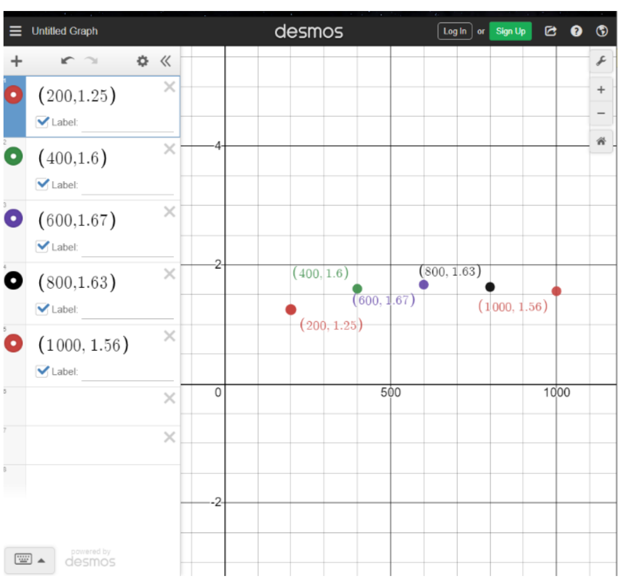
$R_{Th} = 1000 \parallel (1000 + 1000 \parallel 1000) = 600\ \Omega$

Thevenin's equ Circuit

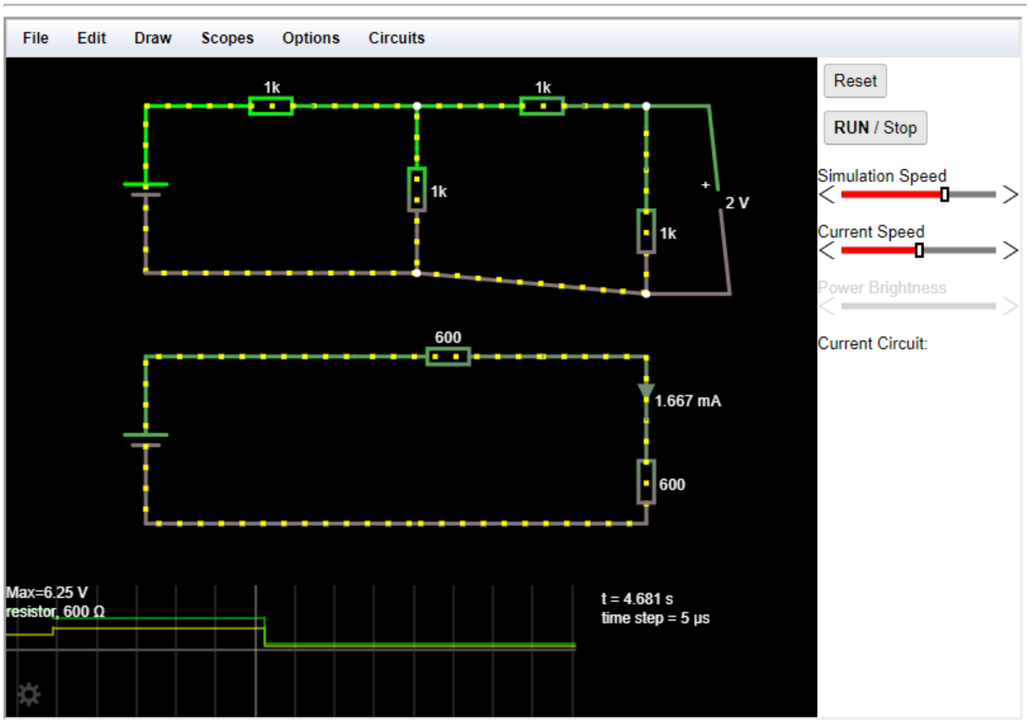


$i = \frac{V}{R} = \frac{2}{1200} = 1.67\ mA$

Graph:



Result:

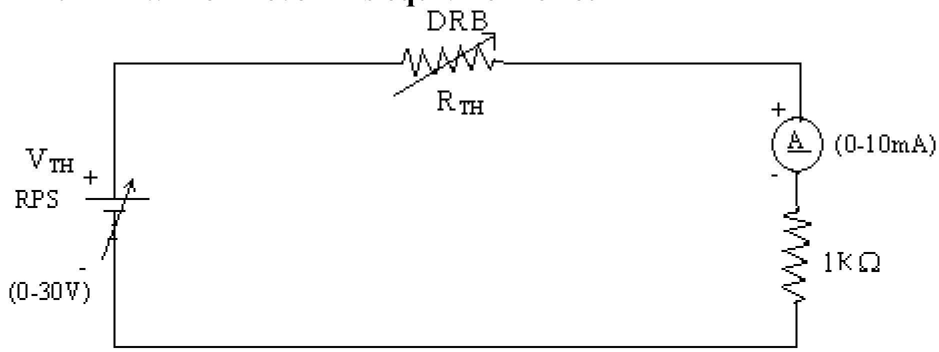

File
Edit
Draw
Scopes
Options
Circuits
1k
1k
1k
1k
2 V
600
1.667 mA
600
Max=6.25 V
resistor, 600 Ω
t = 4.681 s
time step = 5 µs
Reset
RUN / Stop
Simulation Speed
Current Speed
Power Brightness
Current Circuit:

POST LAB QUESTIONS

1. **State Thevenin's Theorem.**

   Thevenin's theorem states that any linear circuit containing several voltages and resistances can be replaced by just one single voltage in series with the load resistance.

2. **Draw the Thevenin's equivalent circuit**



3. **State maximum power transfer theorem.**

   Maximum power transfer theorem states that the DC voltage source will deliver maximum power to the variable load resistance only when $R_L = R_{th}$ (load resistance = source resistance)

4. **Write some applications of maximum transfer theorem.**

   1. This method ensures the power to be dissipated in the load resistance.
   2. Maximum power transfer theorem is applied mostly in radio communication.

5. **Write the steps to find I_N**

   1. Remove load resistance.
   2. Find Rs by shorting all the voltage once or find it by short circuiting R_c.
   3. Find I_N(current through R_c line) by mesh analysis, node analysis or both.

6. **What are the steps to solve Maximum power transfer Theorem?**
   1. Remove the load resistance.
   2. Find V_{th} at the open circuited end.
   3. Find R_{th}.
   4. Draw the 'thevenin's equivalent circuit with V_{th} and R_{th}'
   5. Put $R_c = R_{th}$.
   6. Find the power dissipated by using the foumula $P = V_{th}^2/4R_{th}$.