INDRAPRASTHA INSTITUTE *of*
INFORMATION TECHNOLOGY
DELHI

Department
of
Electronics & Communication Engineering

ECE113|Basic Electronics

Lab :2

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Date:27-06-21

Aim: 1) Verify Thevenin's and Norton's equivalent representations using Virtual Labs.
2) To verify maximum power transfer theorem and superposition theorem using Virtual labs.

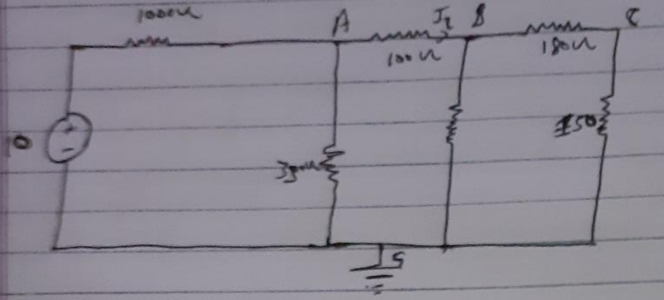
Components: Power supply, Amperage Multimeter, resistor, wires.

Software/Tools Used :

- TinkerCad
- Virtual Labs

Theoretical Calculation :

Lab-3



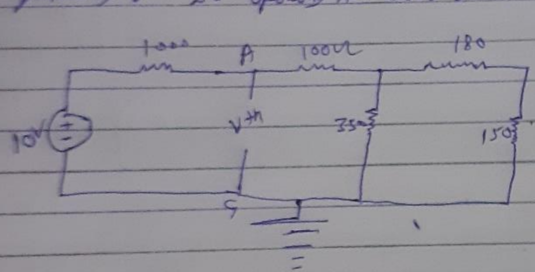
150
180
330
165

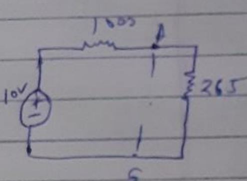
~~100~~
265
V_{GS}

$V_0 = \frac{10 \times 1000}{1265}$

7.905

finding V_{th} so opening the Load resistance R_L i.e (AS) Node



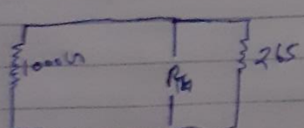


$\cancel{V_{th}} = \quad I = \frac{10}{1265} = 7.904\,mA$

$V_{th} = I \times 265$

$= 7.904 \times 10^{-3} \times 265$

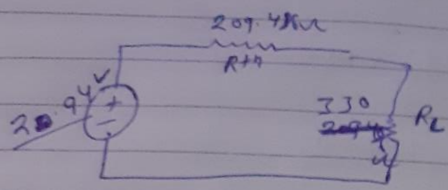
$\boxed{V_{th} = 2.094\,V}$



$R_{th} = \frac{265 \times 1000}{265 + 1000}$

$\boxed{R_{th} = 209.486\,\Omega}$

Thevenin's circuit



$P = i^2 \times R$ $\quad [i = 3.88\text{ mA}]$

$P = \left(\frac{3.88}{1000}\right)^2 \times 330$

$\boxed{P = 4.96\text{ mW}}$

case 1) $R_L = 209.486 = R_{TH}$

$P = i^2 \times R = \left(\frac{5}{1000}\right)^2 \times 209.486$

$\boxed{P = 5.25\text{ mW}}$

$\boxed{P_{max} = \frac{V_{th}^2}{4R_{Th}} = \frac{(2.094)^2}{4(209.486)} \approx 5.24\text{ mA}}$

Hence verified max power is when R_{th} & R_L are equal

case 2) ~~80~~ $R_L = 50$ ohm

$P = i^2 \times R = \left(\frac{8.07}{1000}\right)^2 \times 50 = 3.26\text{ mW}$

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Case 4: $R_L = 400\,\Omega$

$$P = i^2 R = \left(\frac{3.44}{1000}\right)^2 \times 400$$

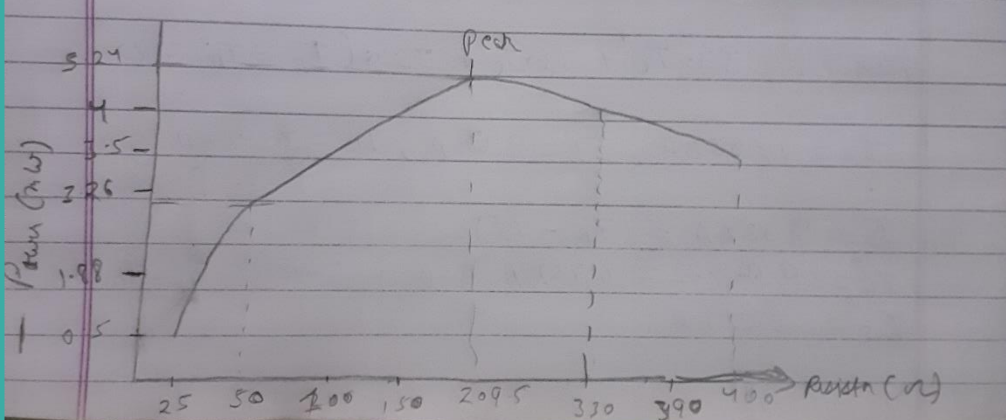
$$P = \cancel{1.311}\ 4.71\,mW$$

Case 5: $R_L = 25\,\Omega$

$$P = i^2 R = \left(\frac{8.93}{1000}\right)^2 \times 25$$

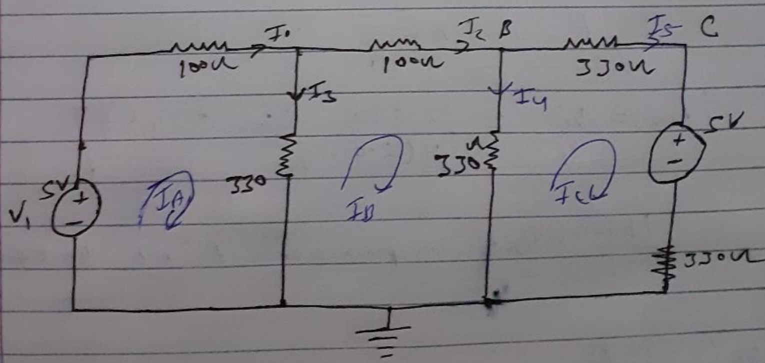
$$P = \cancel{2.23\,mW}\ 1.99\,mW$$

Hence verified



Superposition theorem:

2) verification of superposition theorem



Case 1) $V_1 = 5$, $V_2 = 5V$

Mesh 1 : $5 = 100 I_A + 300 (I_A - I_B)$ — (1)

Mesh 2 : $100 I_B + 330 (I_B - I_C) + 330 (I_B - I_A) = 0$ (2)

Mesh 3 : $300 I_C + 330 I_C + 330 (I_C - I_B) = -5$ (3)

from ① ② & ③ after solving;

$I_A = 15.826\ mA$

$I_C = -3.22\ mA$

$I_B = 5.47\ mA$

$I_3 = 15.826 - 5.47 = 10.356\ mA$ [$I_A - I_B$]

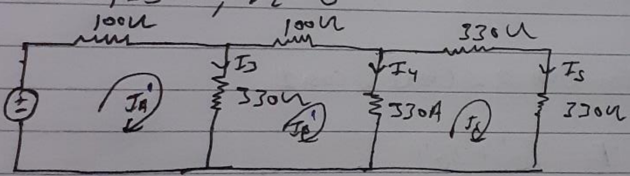
$\boxed{I_3 = 10.356\ mA}$

$I_4 = I_B + I_C \Rightarrow 5.47 + 3.22$

$\boxed{I_4 = 8.67\ mA}$

$\boxed{I_5 = -3.22\ mA}$

Case 2) $V_1 = 5V$, $V_2 = 0$



Mesh 1: $5 = 100 I_A + 330(I_A - I_B)$

Mesh 2: $100 I_B + 330(I_B - I_C) + 330(I_B - I_A) = 0$

Mesh 3: $330 I_C + 330 I_C + 330(I_B - I_A) = 0$

$I_A = 19.05\ mA$, $I_B = 9.67\ mA$, $I_C = 3.22\ mA$

$I_3' = 9.38\ mA$ [$I_A - I_B$]

$I_4' = 9.67 - 3.22 = 6.45\ mA$

$I_5' = 3.22\ mA$

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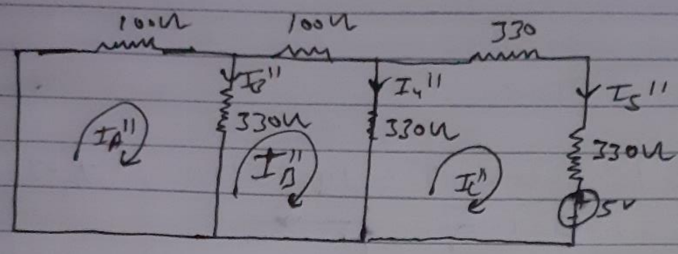
Case 3: $V_1 = 0$, $V_2 = 5V$



Mesh 1: $0 = 100 I_A'' + 330 (I_A'' - I_B'')$

Mesh 2: $100 I_B'' + 330 (I_B'' - I_C'') + 330 (I_B'' - I_A'') = 0$

Mesh 3: $330 I_C'' + 330 I_C'' + 330 (I_C'' - I_A'') = -5$

$I_A'' = -3.22\,mA$, $I_B'' = -4.20\,mA$

$I_C'' = 6.45\,mA$

so $I_3'' = 0.98\,mA$, $I_4'' = +2.25\,mA$, $I_5'' = -6.45\,mA$

From Case 2 & Case 3 & Case 1

$I_3 = I_3' + I_3''$

$I_4 = I_4' + I_4''$

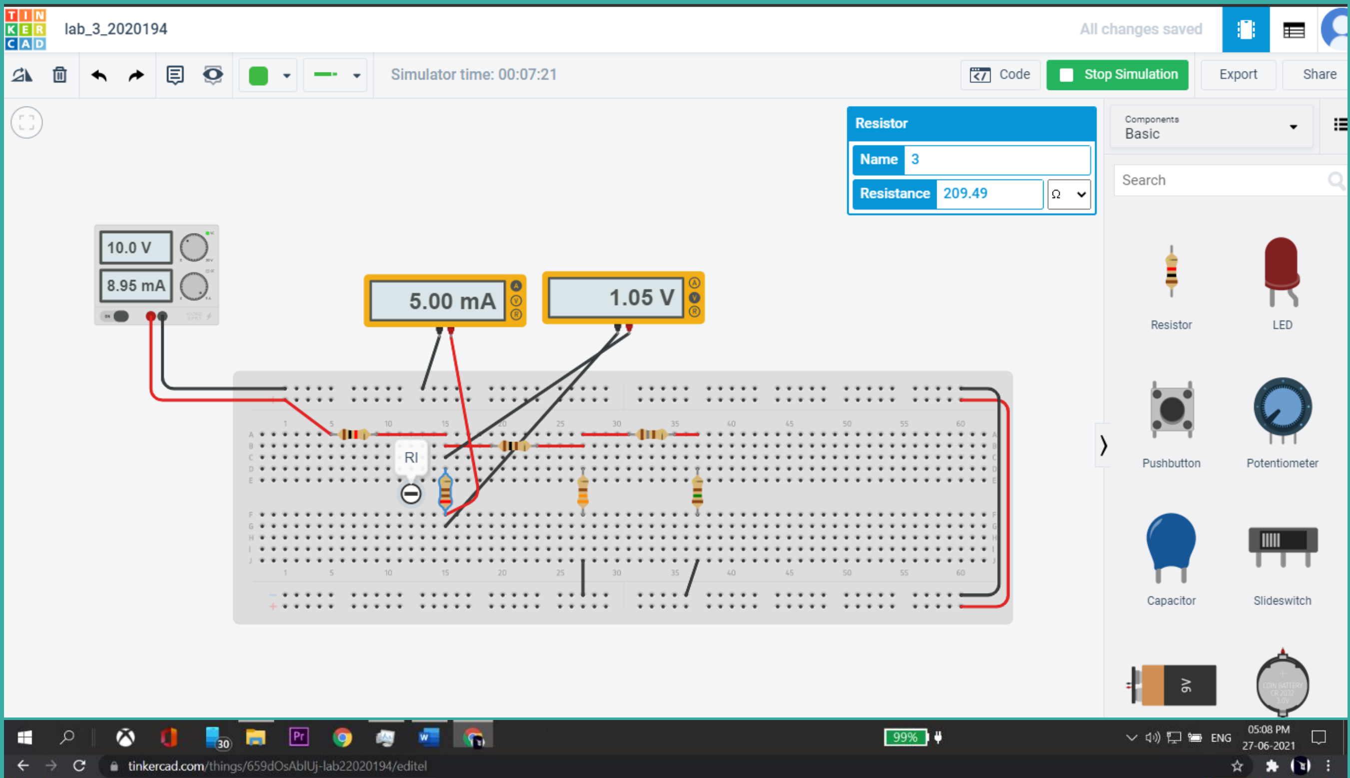
$I_5 = I_5' + I_5''$

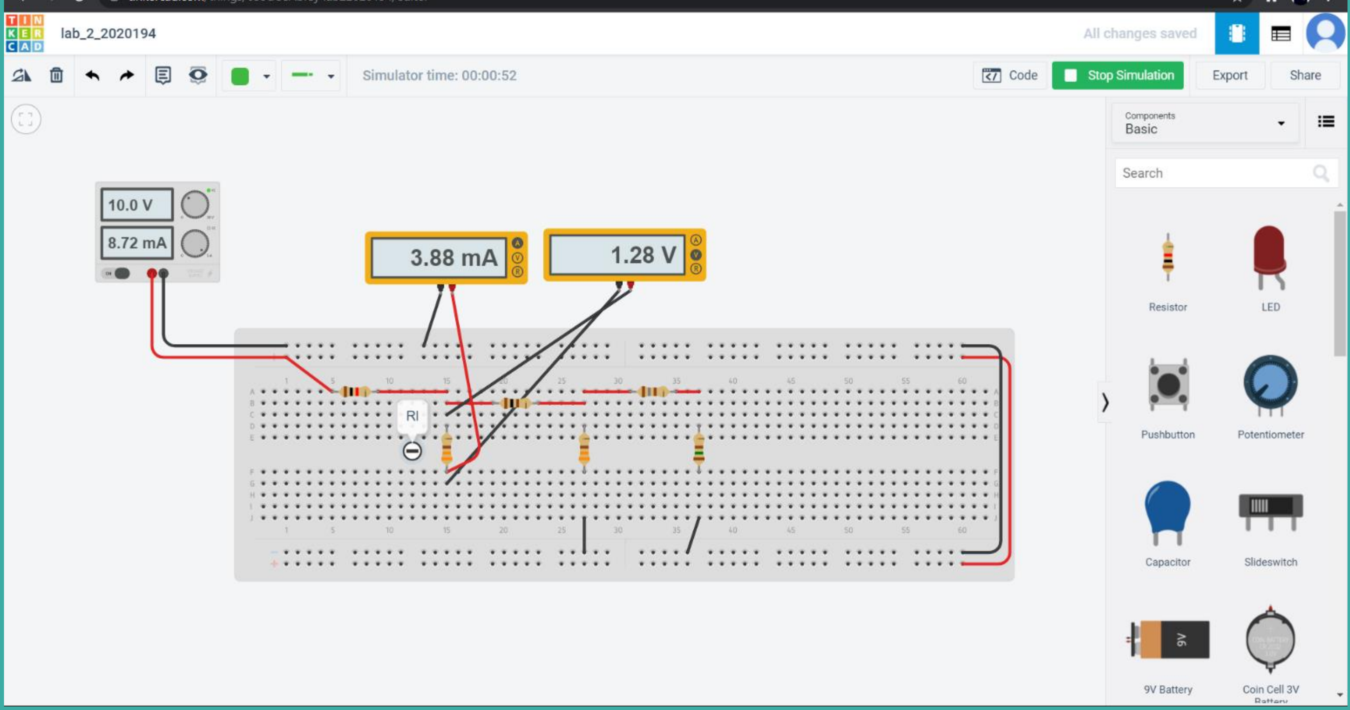
Hence verified

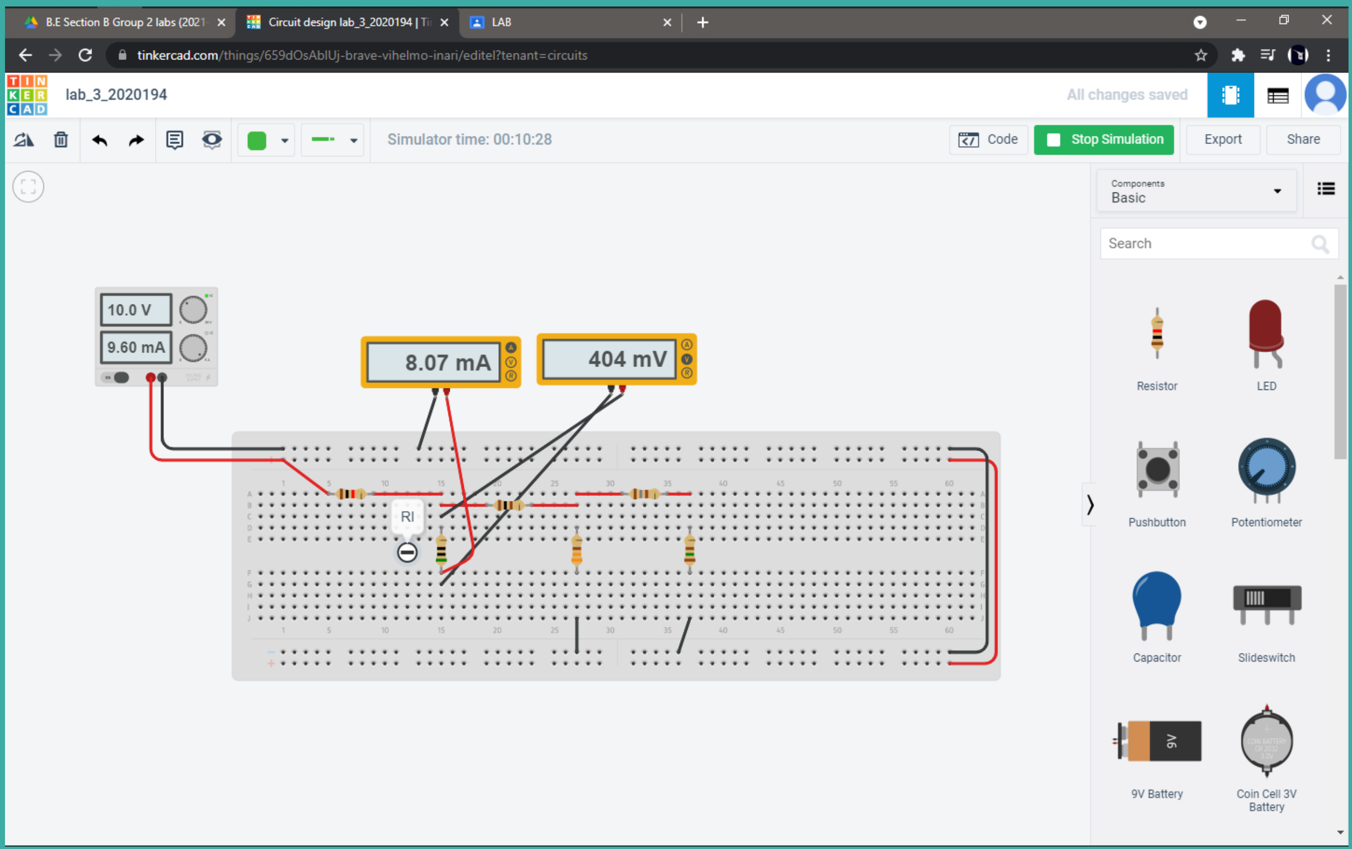
Circuit Diagram and Link:

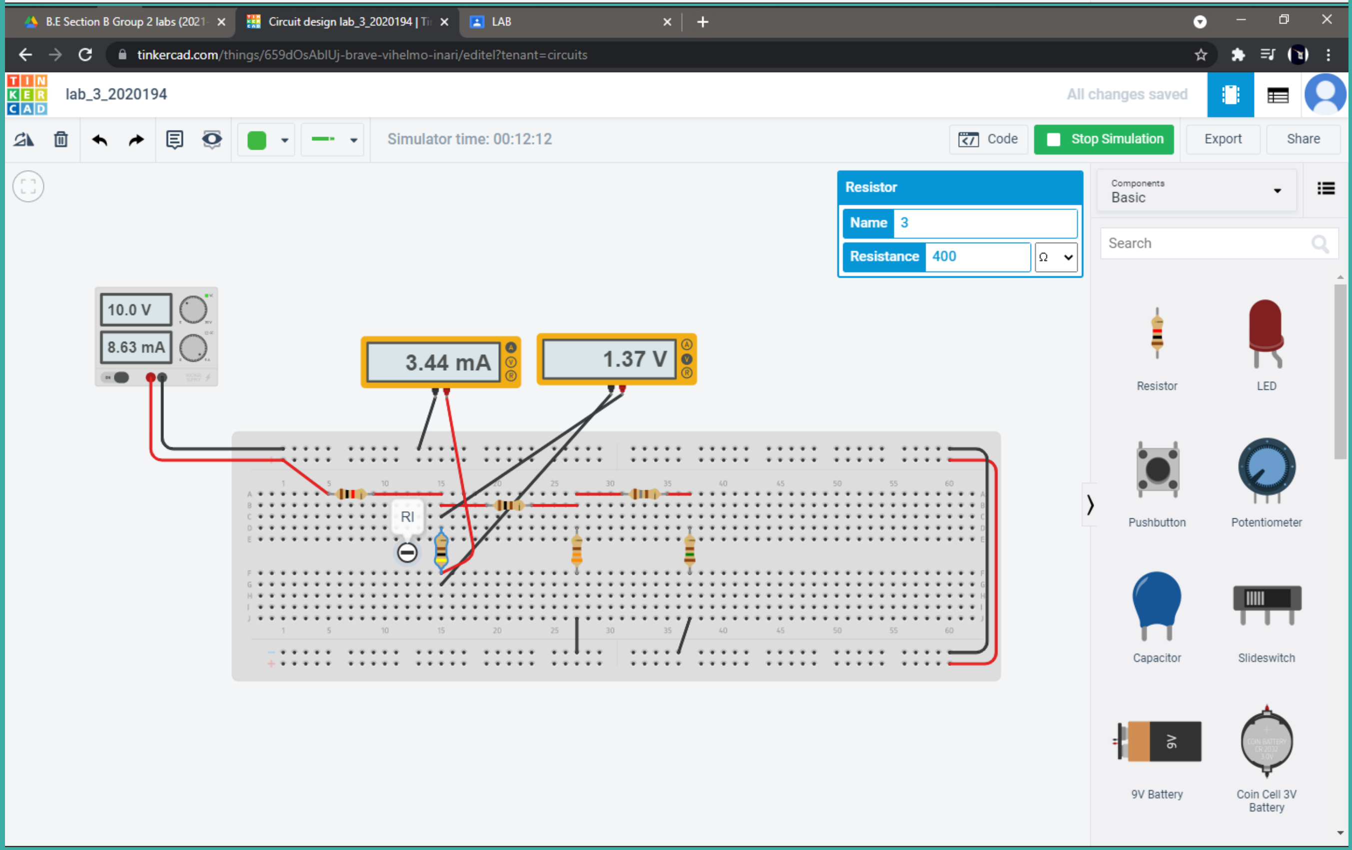
Maximum power transfer Theorem

https://www.tinkercad.com/things/659dOsAblUj-lab22020194/editel?sharecode=Isw58uNqDlZOCjc_Lb9LfqXZMBDM_ustYrafxZMirm8






B.E Section B Group 2 labs (2021
Circuit design lab_3_2020194 | Ti
LAB
tinkercad.com/things/659dOsAblUj-brave-vihelmo-inari/editel?tenant=circuits
lab_3_2020194
All changes saved
Simulator time: 00:10:28
Code
Stop Simulation
Export
Share
10.0 V
9.60 mA
8.07 mA
404 mV
Rl
Components
Basic
Search
Resistor
LED
Pushbutton
Potentiometer
Capacitor
Slideswitch
9V Battery
Coin Cell 3V Battery


B.E Section B Group 2 labs (2021
Circuit design lab_3_2020194 | Ti
LAB
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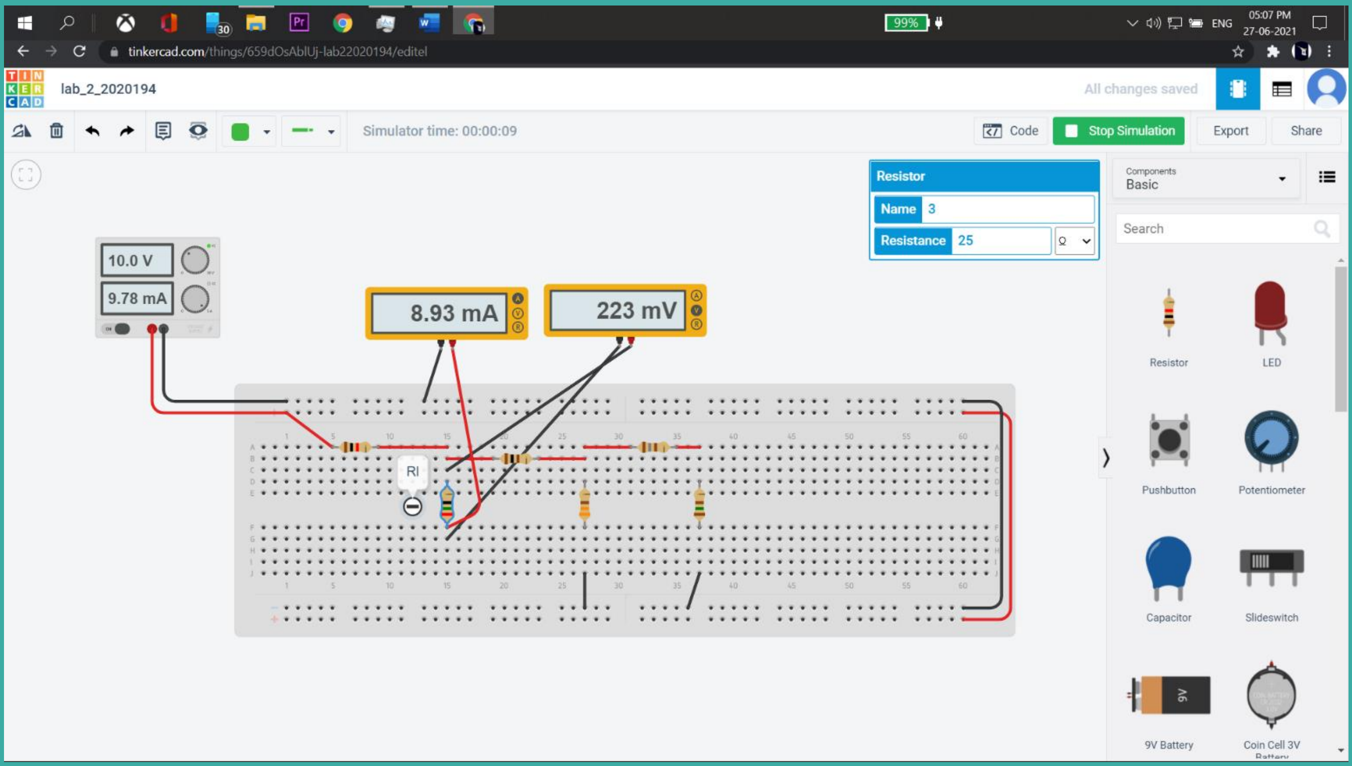
lab_3_2020194
All changes saved
Simulator time: 00:12:12
Code
Stop Simulation
Export
Share
Resistor
Name 3
Resistance 400 Ω
10.0 V
8.63 mA
3.44 mA
1.37 V
Rl
Components
Basic
Search
Resistor
LED
Pushbutton
Potentiometer
Capacitor
Slideswitch
9V Battery
Coin Cell 3V Battery



Superposition Theorem

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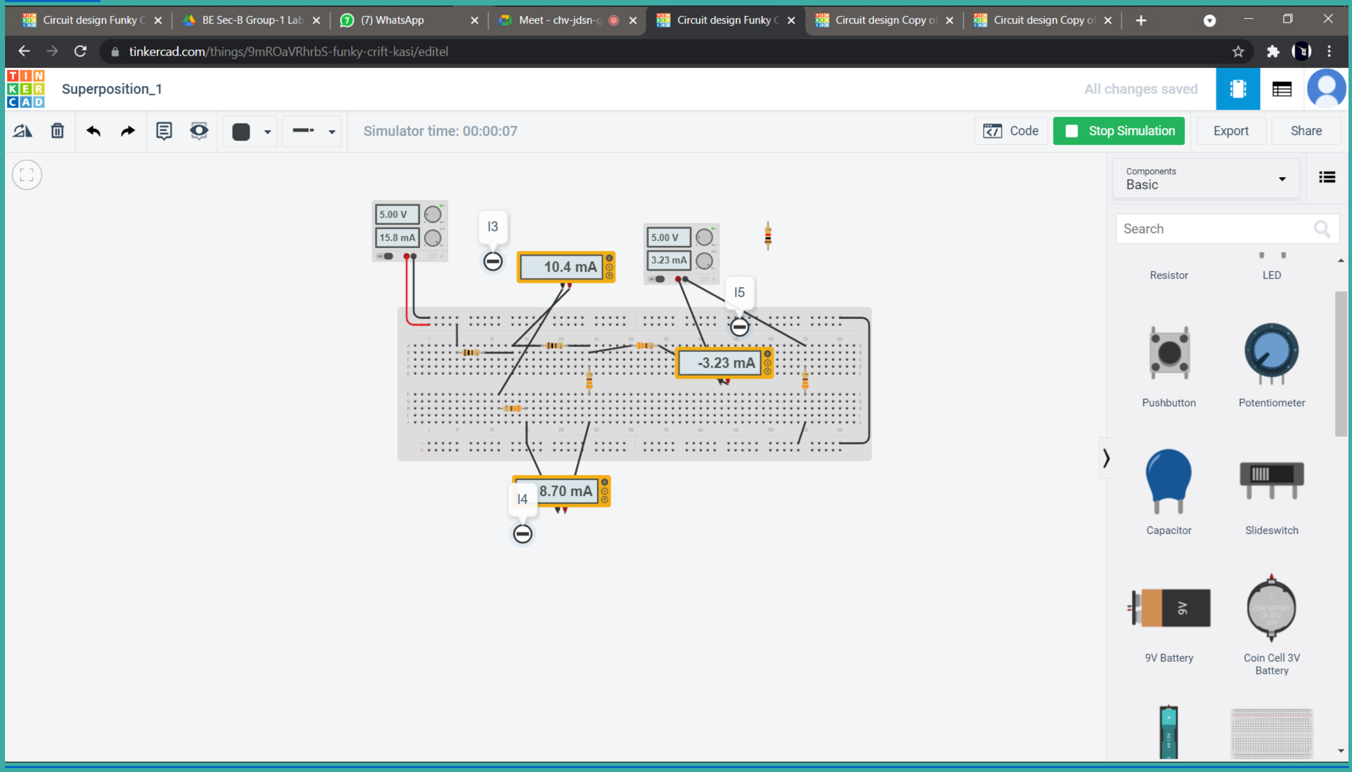

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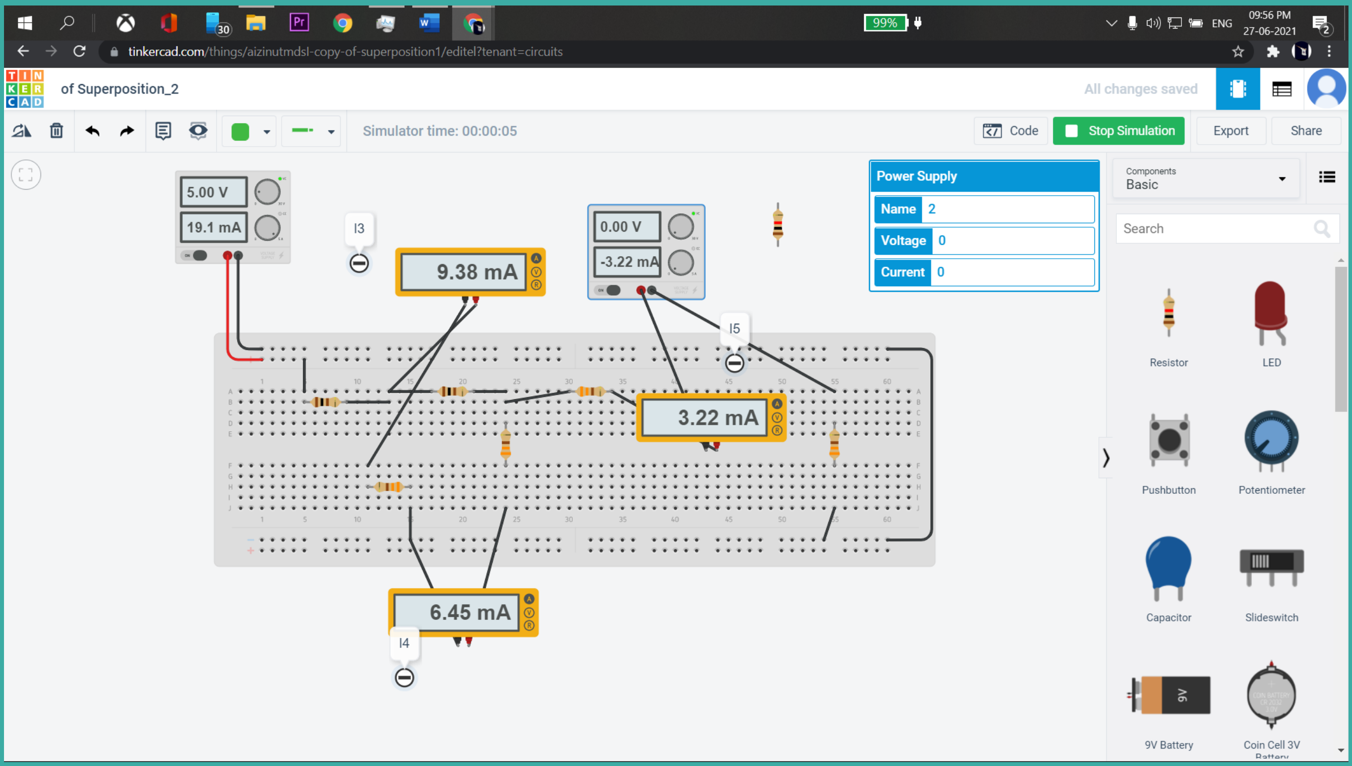

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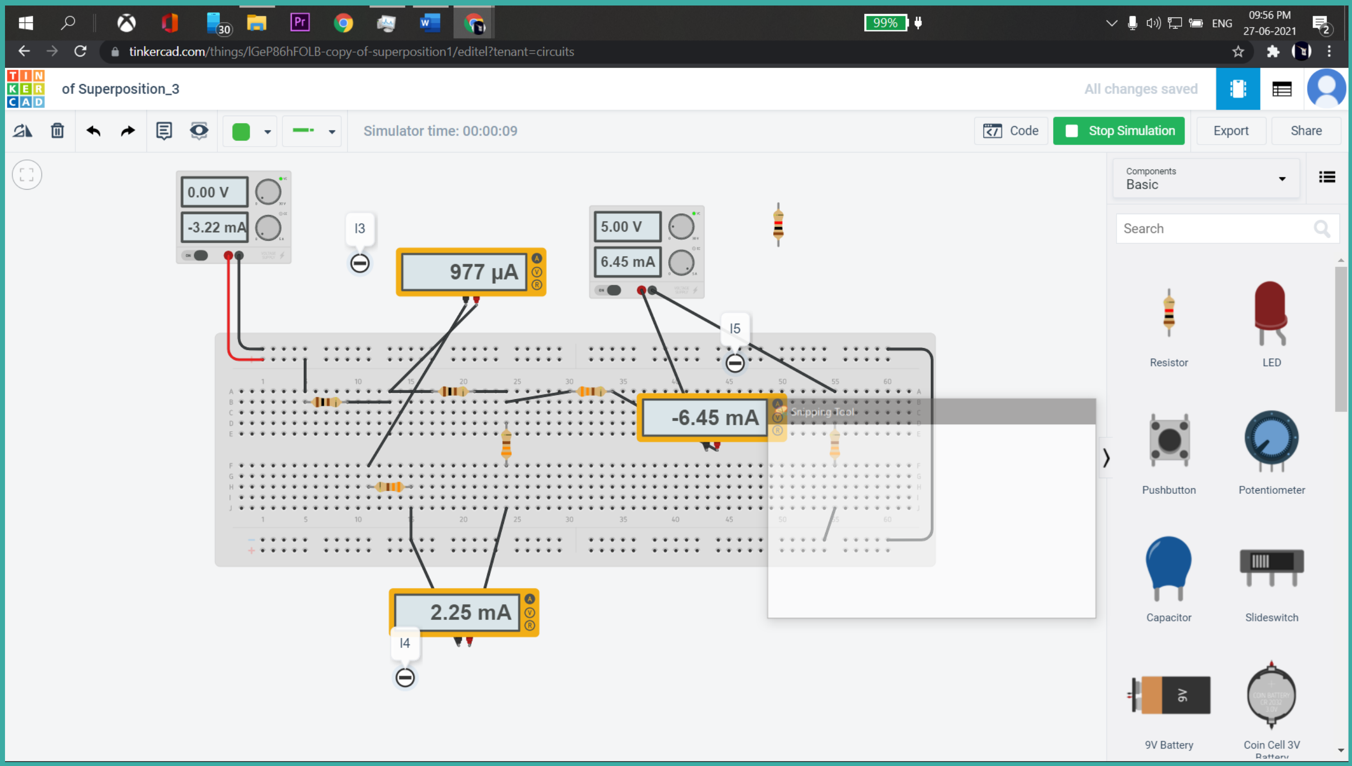
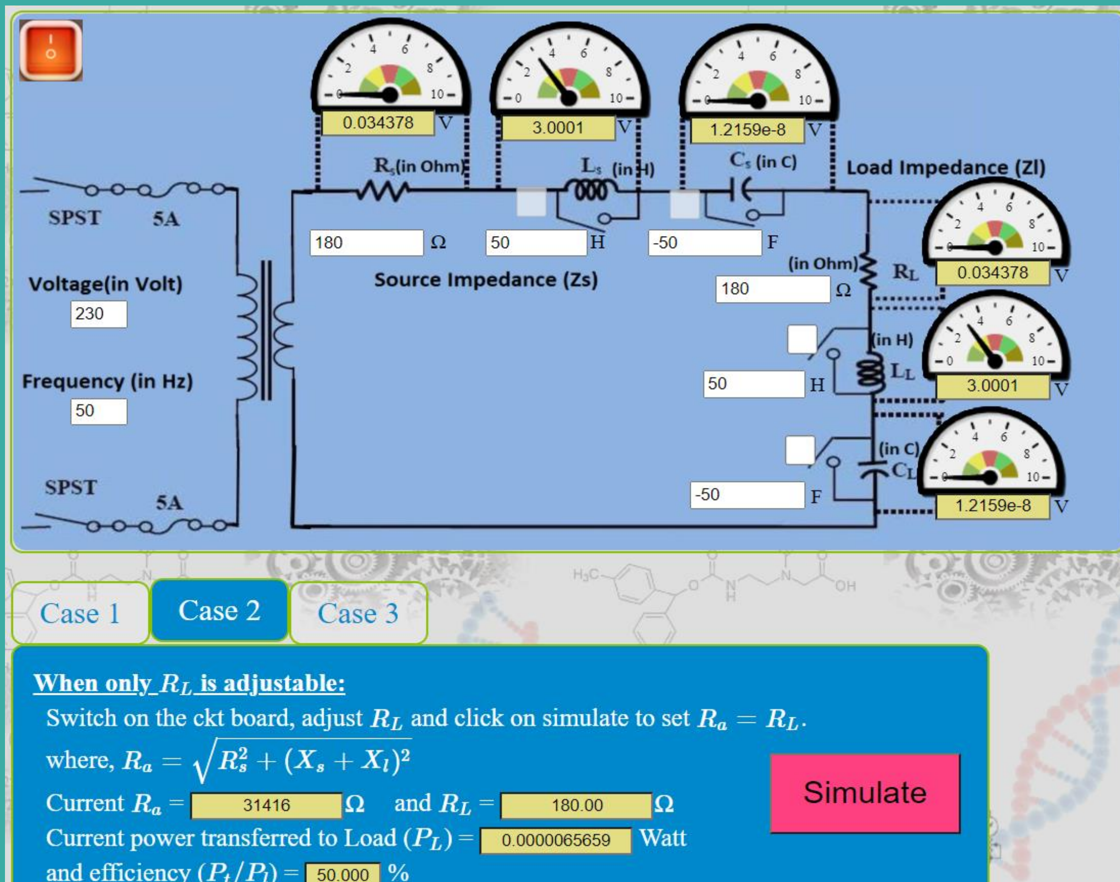

tinkercad.com/things/lGeP86hFOLB-copy-of-superposition1/editel?tenant=circuits
of Superposition_3
All changes saved
Simulator time: 00:00:09
Code
Stop Simulation
Export
Share
0.00 V
-3.22 mA
I3
977 µA
5.00 V
6.45 mA
I5
-6.45 mA
2.25 mA
I4
Components
Basic
Search
Resistor
LED
Pushbutton
Potentiometer
Capacitor
Slideswitch
9V Battery
Coin Cell 3V

V_LAB:



OBSERVATION Table:

Maximum power transfer Theorem:

Sno	Rl	IL	Power= IL^2 * RL	Vth
1	209.486ohm	5mA	5.25mW	1.05v
2	330ohm	3.88mA	4.96mW	1.28v
3	50ohm	8.07mA	3.26mW	404mV
4	400ohm	3.44mA	4.71mW	1.37v
5	25ohm	8.93mA	1.99mW	223mv

Superposition Theorem :

Sno.	V1	V2	I3	I4	I5
1	5v	5v	10.356mA	8.67mA	-3.22mA
2	5v	0	9.38mA	6.45mA	3.22mA
3	0	5v	-3.22		

V_LAB OBSERVATION TABLE:

Superposition Theorem

Serial no. of Observation	In presence of both V_1 and V_2			In presence of V_1 only			In presence of V_2 only		
	Brach current I_1 (in amps)	Brach current I_2 (in amps)	Brach current I_3 (in amps)	Brach current I_1 (in amps)	Brach current I_2 (in amps)	Brach current I_3 (in amps)	Brach current I_1 (in amps)	Brach current I_2 (in amps)	Brach current I_3 (in amps)
1st	0.39032	-0.10645	0.28387	0.56774	-0.35484	0.21290	-0.17742	0.24839	0.070968
2nd	0.25385	-0.016923	0.23692	0.33846	-0.16923	0.16923	-0.084615	0.15231	0.067692
3rd	0.15316	0.041772	0.19494	0.22278	-0.13924	0.083544	-0.069620	0.18101	0.11139
4th	0.62857	-0.23571	0.39286	0.94286	-0.62857	0.31429	-0.31429	0.39286	0.078571
5th	0.16923	0.084615	0.25385	0.28205	-0.22564	0.056410	-0.11282	0.31026	0.19744

Observations/Results: Maximum power transfer occurs when the Thevenin Resistance (Rth) is equal Load resistance (RL) of the circuit.
The current in each branch of a circuit is equal to the contribution of each voltage source and/or current source taken independently.
We verified max power transfer theorem and superposition theorem

Applications:

- communications systems, maximum power power is always preferred.

- Superposition theorem can be applied when we have to calculate the current across a specific branch containing several current/voltage sources