Kirchhoff's laws

Experiment no. **Date:**

Aim:

- To verify Kirchhoff's current law (KCL) and Kirchhoff's voltage law (KVL)

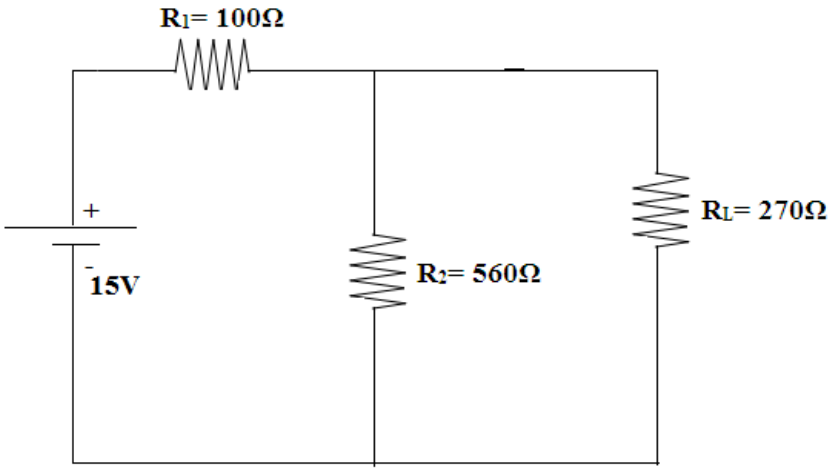
Objectives:

- To calculate voltage and current in a DC circuit for each element analytically
- To measure voltage and current in a DC circuit for each element practically
- To compare analytical and practical values
- To verify KVL and KCL

Apparatus Required:

S.No.	Name of the Components/Equipment	Range	Type	Quantity required
1	Resistor	100 Ω, 560 Ω, 270 Ω	Wire wound	Each 1
2	DC power supply	(0-30) V	RPS	1
3	Voltmeter	(0-15) V	MC	1
4	Ammeter	(0-100) mA	MC	1
5	Wires	-	Single strand	As required
6	Bread board	-	-	1

Circuit Diagram:



Formulae:

Voltage division rule

$$V_1 = V \frac{R_1}{R_1 + R_2}$$

$$V_2 = V \frac{R_2}{R_1 + R_2}$$

Current division rule

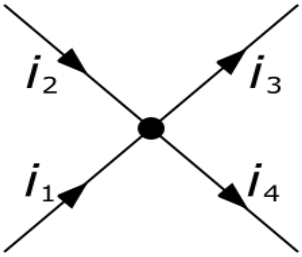
$$I_1 = I \frac{R_2}{R_1 + R_2}$$

$$I_2 = I \frac{R_1}{R_1 + R_2}$$

Theory:

KCL

The algebraic sum of currents in a node is zero (OR) At any node (junction) in an electrical circuit, the sum of the currents entering the node is equal to the sum of the currents leaving the node.

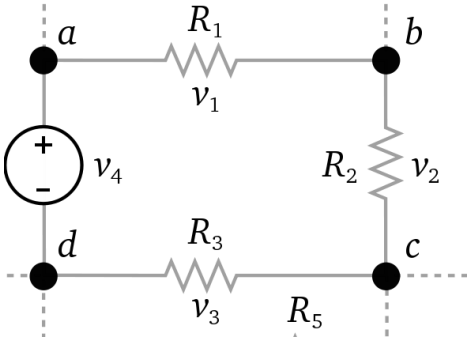


$$i_1 + i_2 = i_3 + i_4$$

KVL

The sum of the electrical potential differences (voltage) around any closed path is zero. (OR)

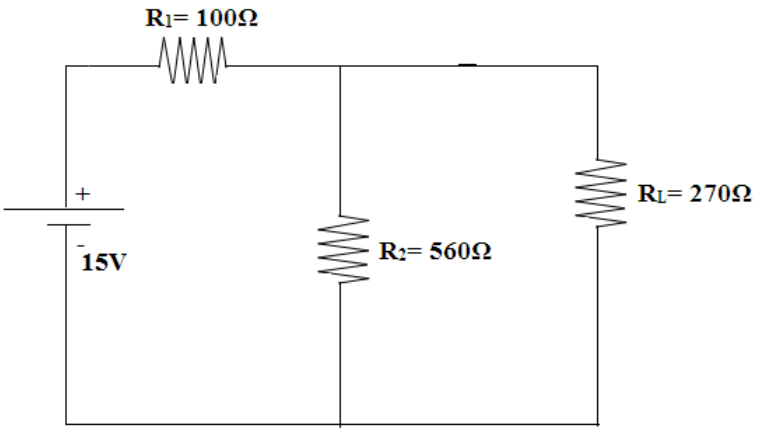
The sum of the potential rises in any closed loop equal to the sum of the potential drops in that loop.



$v_4 = v_1 + v_2 + v_3$

Analytical calculation:

KCL:



Find the current through each element by circuit simplification method

R_2 and R_L are in parallel and the combination is in series with R_1

$R_T = [560*270/(560+270)] + 100 = 151200/830 +100 = 182.17 + 100 = 282.17\ \Omega$

$I_T = 15/282.17 = 0.05316 = 53.16$ mA

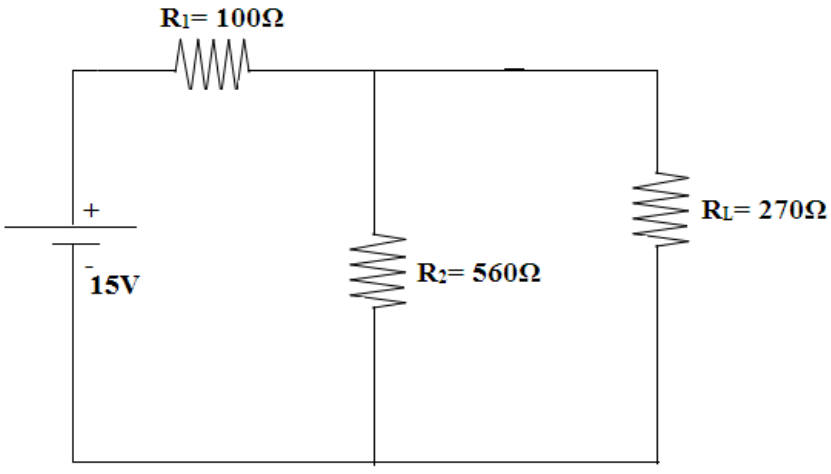
Current through R1 is 53.16 mA

Apply current division rule to find current through R_2

$I_2 = I_T*R_L/(R_2+R_L) = 53.16 * 270/ (270+560) = 17.29$ mA

Current through resistor R_L is $I_L = 53.16$ mA – 17.29 mA = 35.87 mA

KVL:



Find the voltage across each element

$V_1 = I_T * R_1 = 53.16\ mA * 100 = 5316\ mV = 5.32\ V$

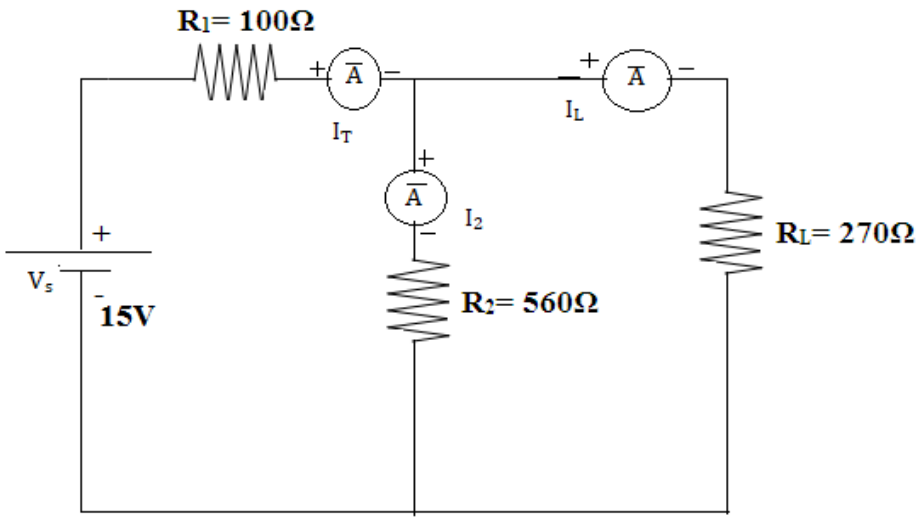
$V_2 = R_2 * I_2 = 17.29\ mA * 560 = 9682.4\ mV = 9.68\ V$

(OR) $V_2 = V_s - V_1 = 15 - 5.32 = 9.68\ V$

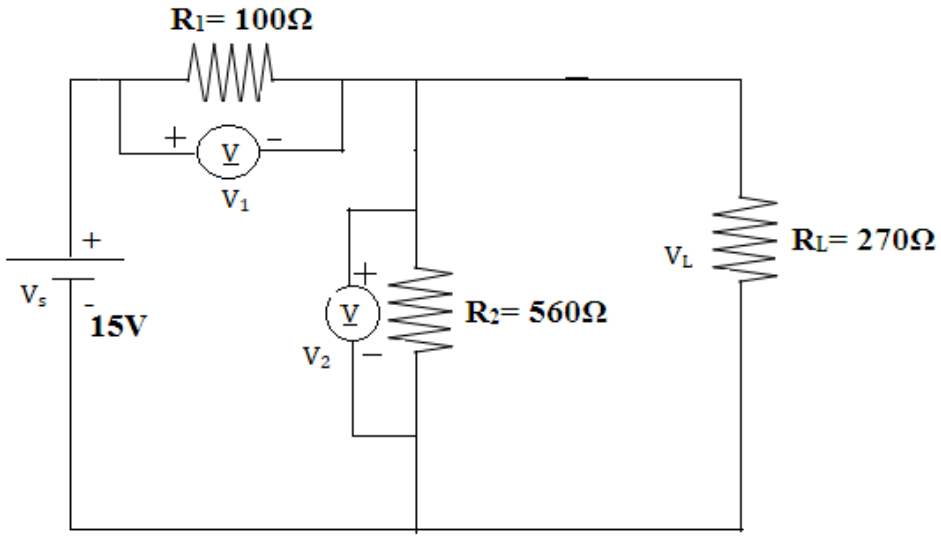
$V_2 = V_L = 9.68\ V$

Practical Circuit Diagram:

KCL



KVL



Procedure

KCL

- Connections are given as per circuit diagram.
- Supply voltage is given using regulated power supply.
- The ammeter readings are noted and tabulated.

KVL

- Connections are given as per circuit diagram.
- Supply voltage is given using regulated power supply.
- The voltmeter readings are noted and tabulated.

Tabulation:

Kirchhoff's current law:

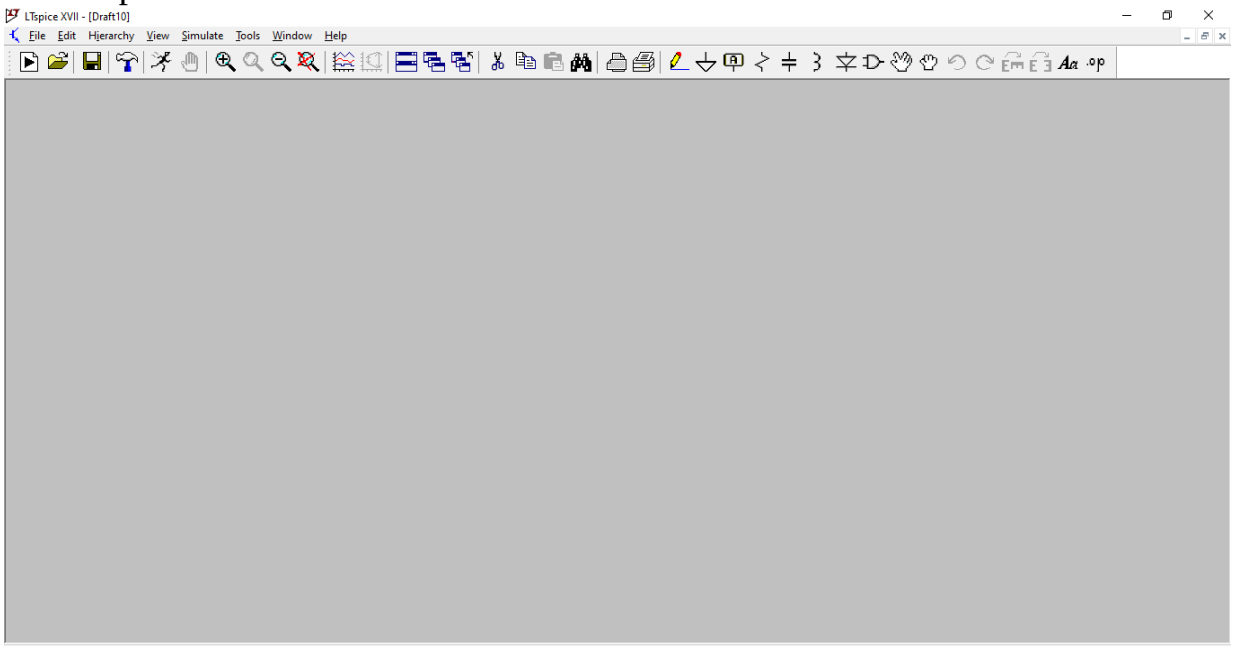
S. No	V_s (V)	I_T (mA)		I_2 (mA)		I_L (mA)	
		Theo	Prac	Theo	Prac	Theo	Prac

Kirchhoff's voltage law:

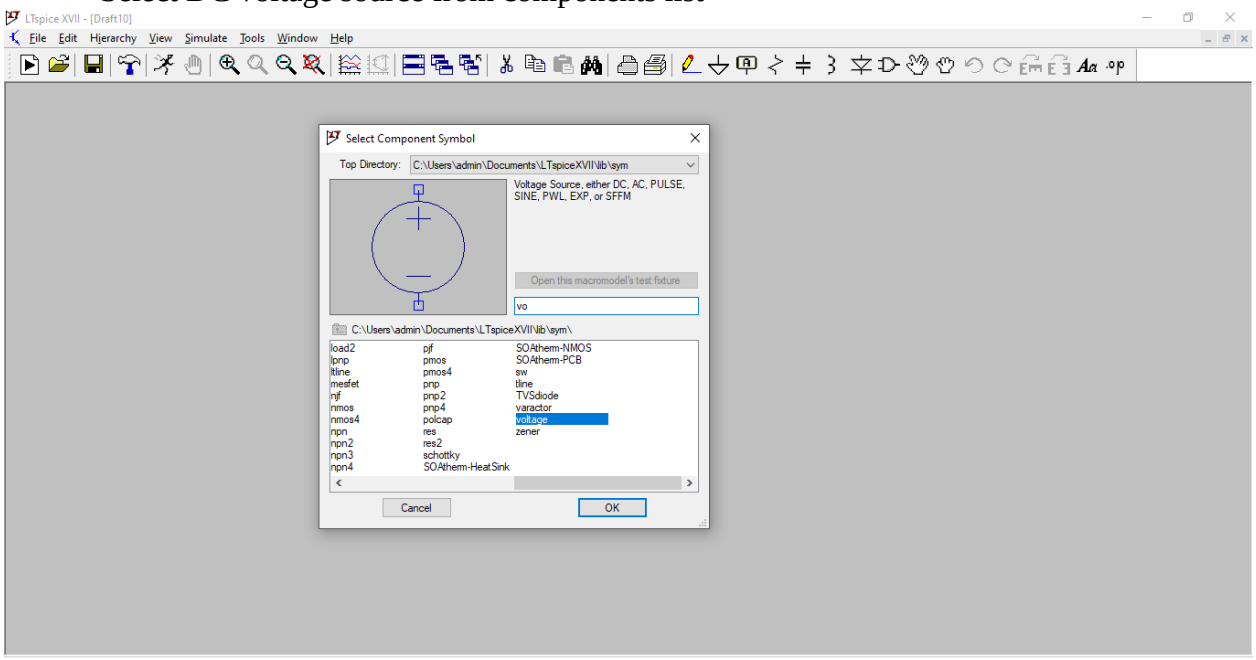
S. No	V_s (V)	I_T (mA)		I_2 (mA)		I_L (mA)	
		Theo	Prac	Theo	Prac	Theo	Prac

LTspice simulation
Procedure:

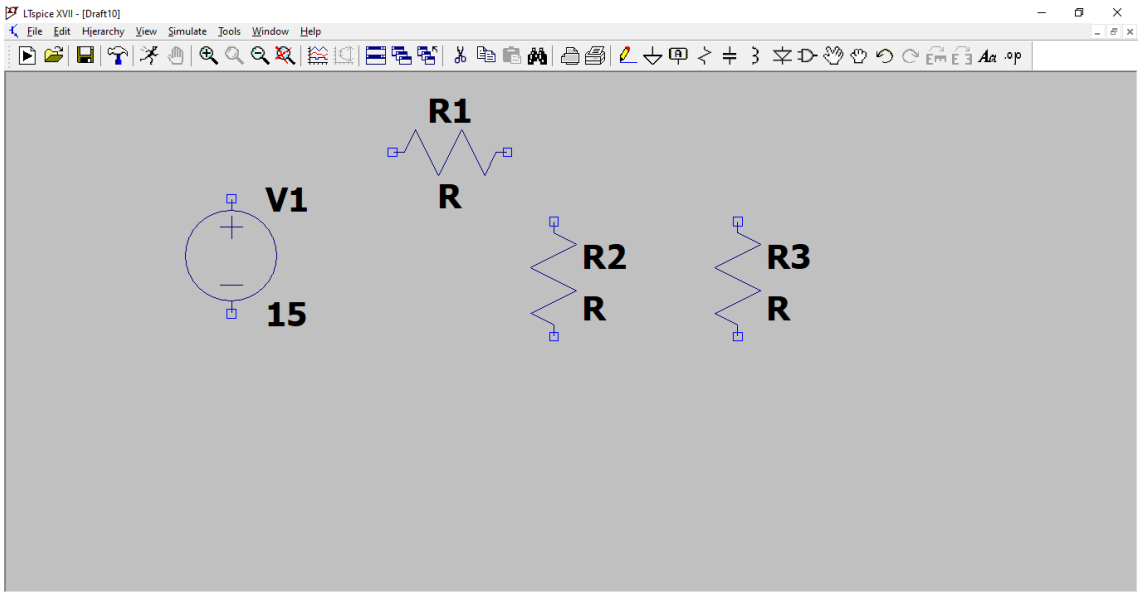
- open a new file



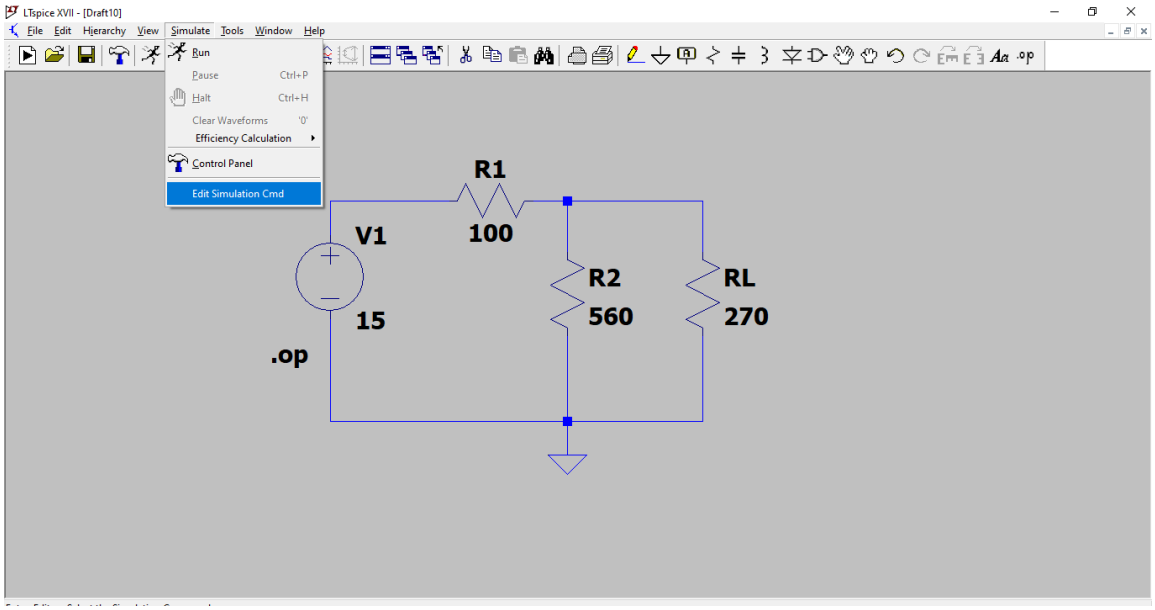
- Select DC voltage source from components list



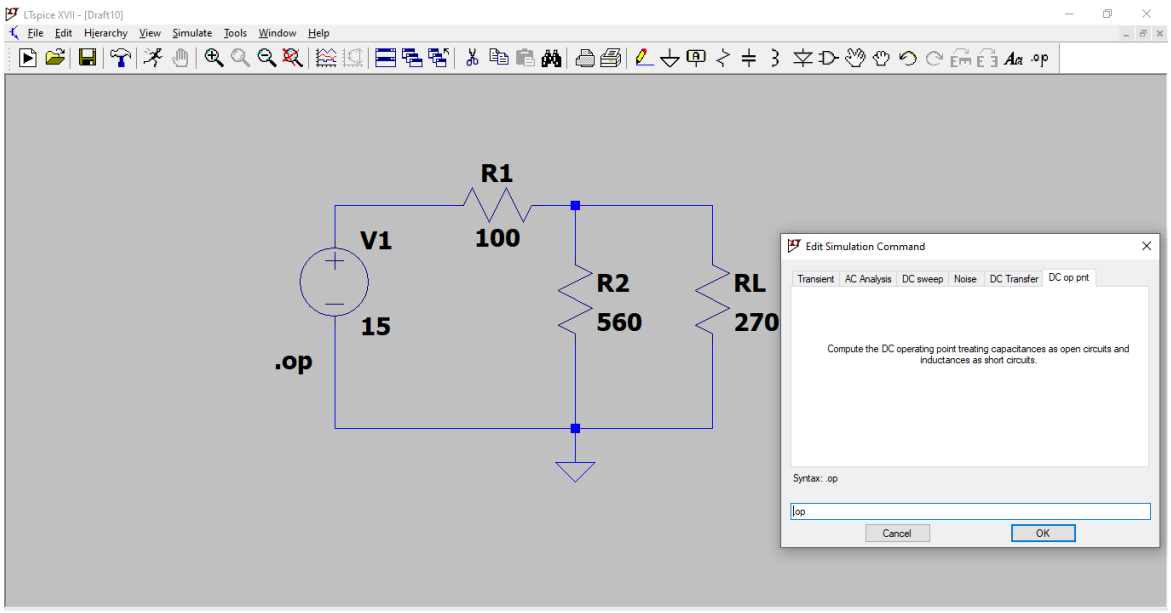
- Track and paste it
- right click to feed voltage value
- Take resistor from the components list
- right click to feed resistor value and rename the components as per the components name in circuit diagram

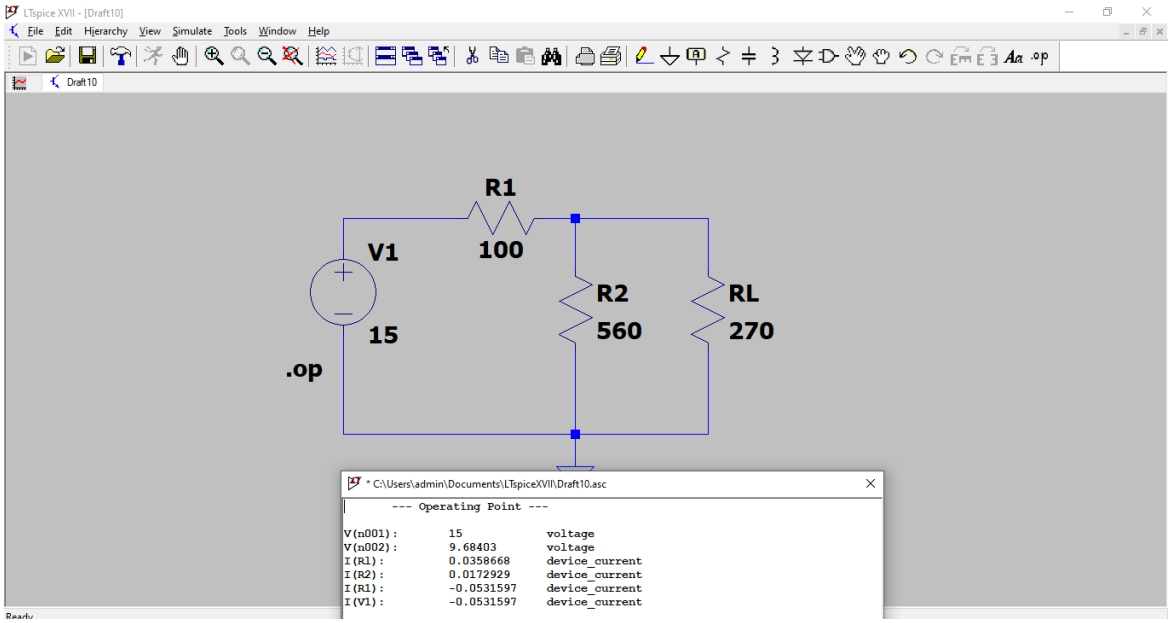


- connect the components using connector
- save the file
- Edit simulate cmd



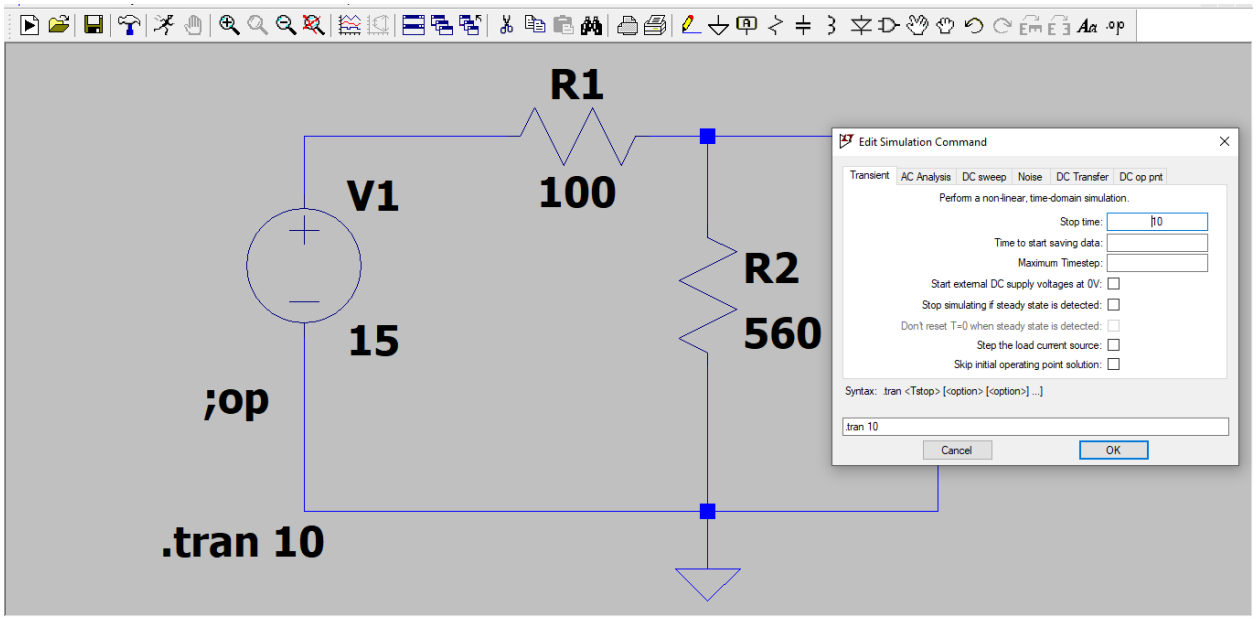
- choose DC op ppt
- run the file
- results will be displayed
- verify it with theoretical value



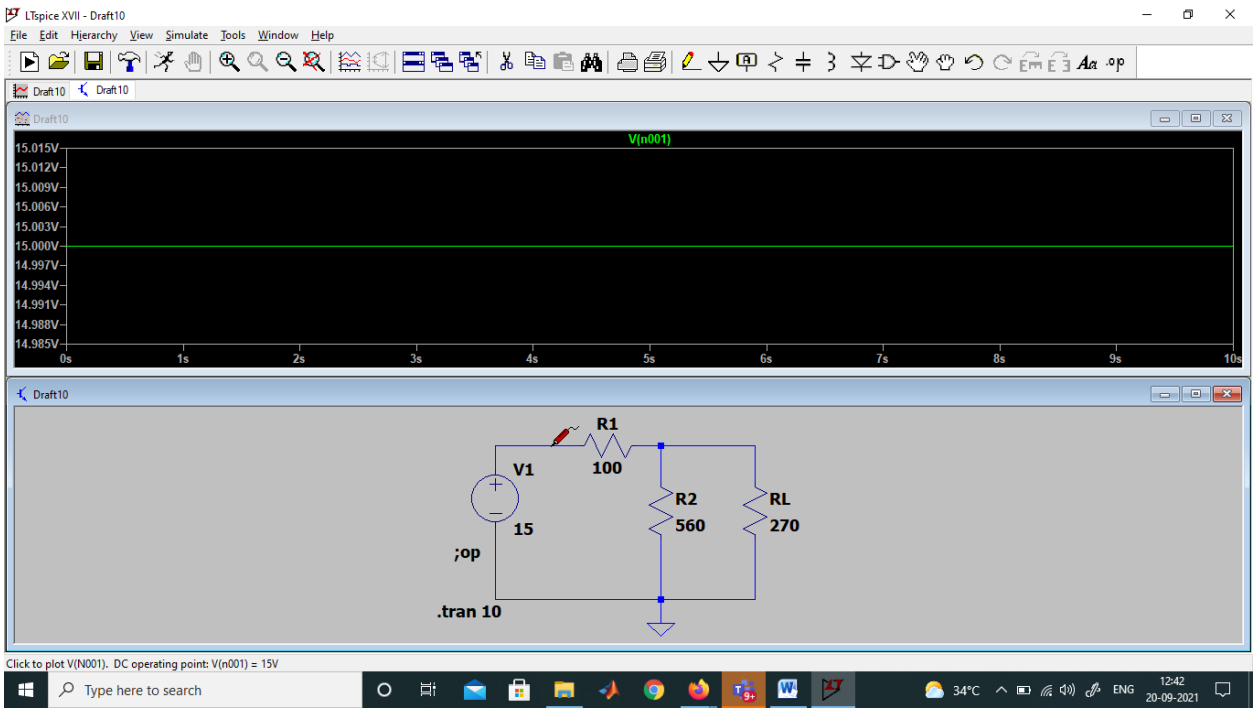


To see current and voltage waveform graphically

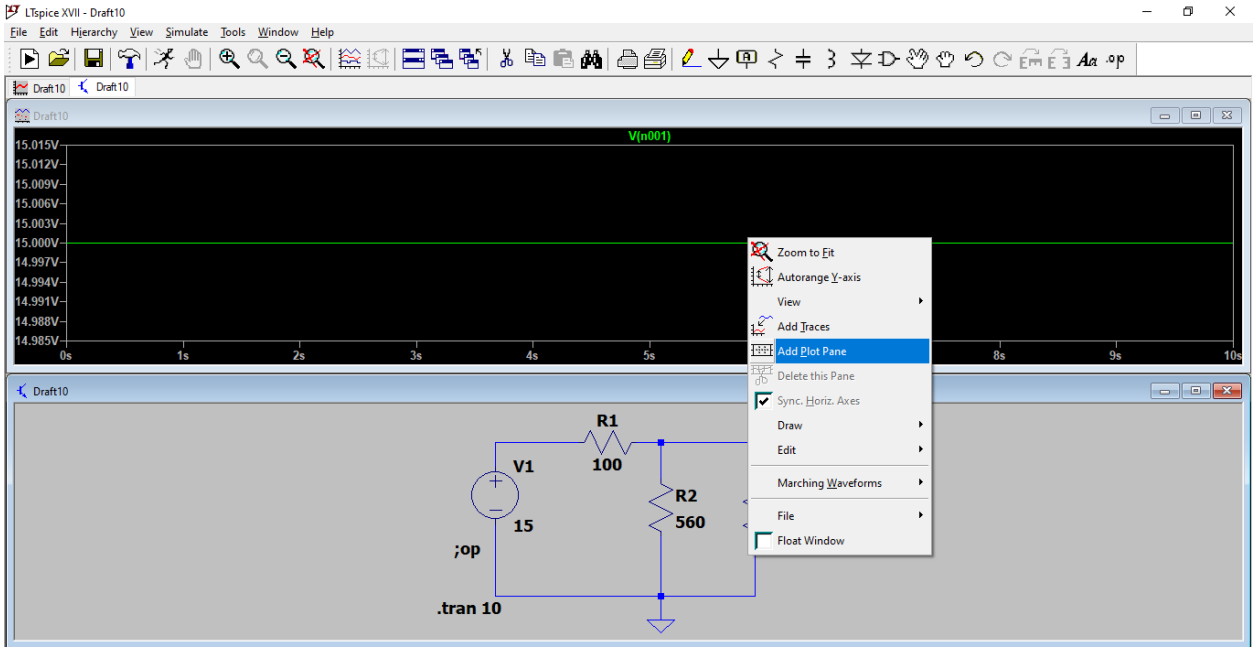
- Edit simulate cmd
- select transient
- specify the stop time
- click ‘ok’

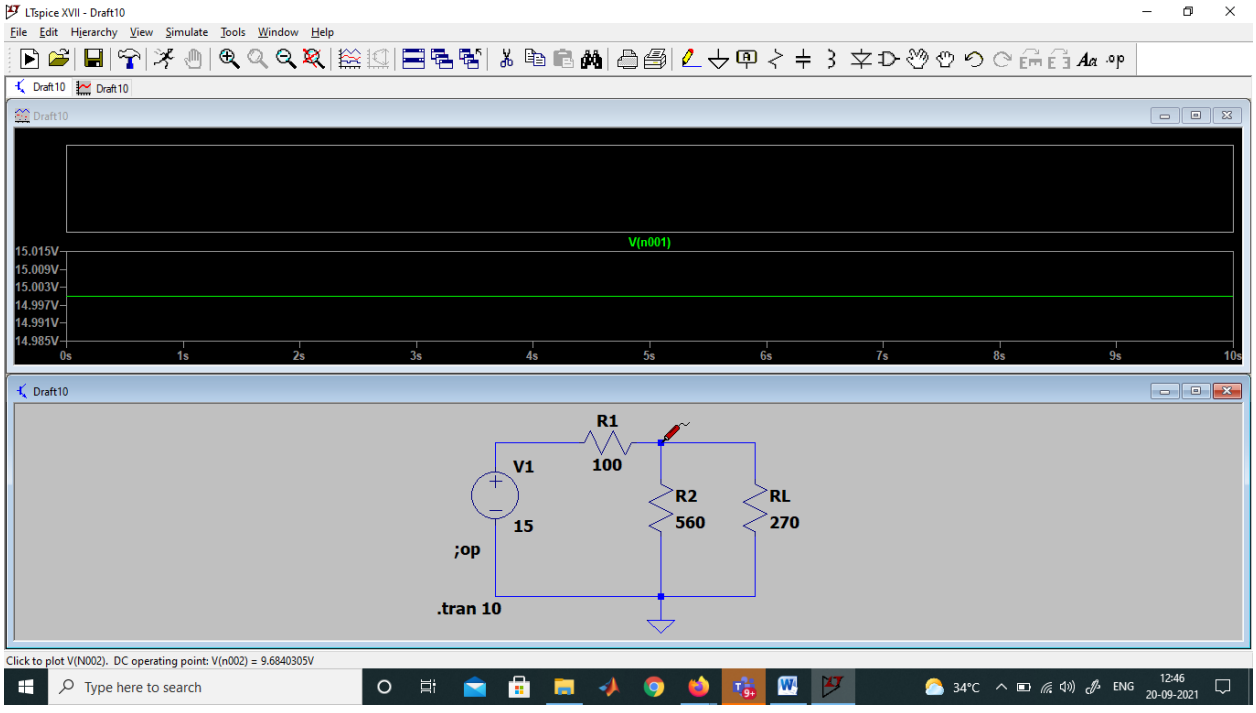


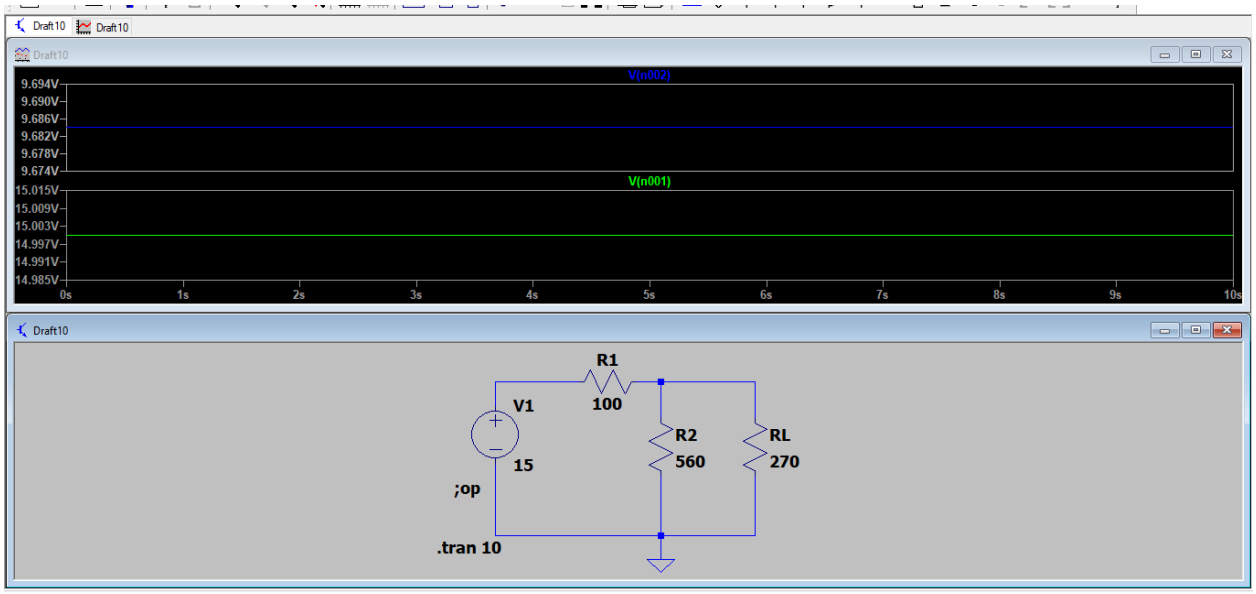
- run the file
- keep the cursor in source point to see the source voltage waveform and measure it



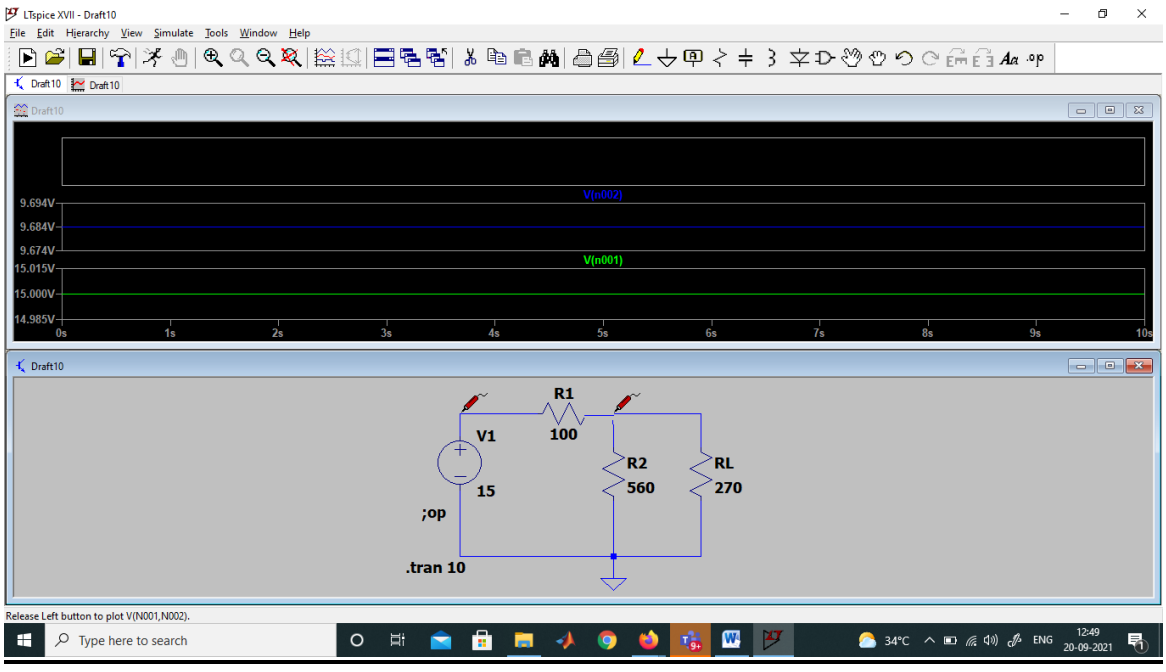
- right click in the plot and add plot pane to open another window
- keep the cursor in R_1 and R_2 junction point to see the voltage waveform across R_2 and measure it

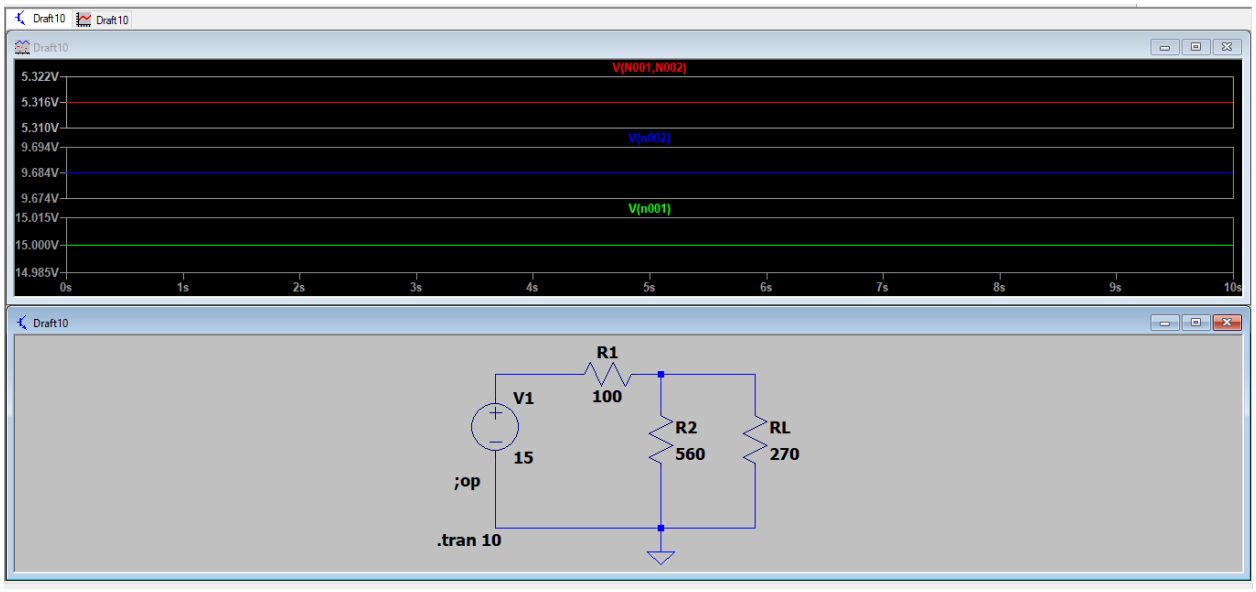

LTspice XVII - Draft10
File Edit Hierarchy View Simulate Tools Window Help
Draft10
V(n001)
15.015V
15.012V
15.009V
15.006V
15.003V
15.000V
14.997V
14.994V
14.991V
14.988V
14.985V
0s 1s 2s 3s 4s 5s 8s 9s 10s
Zoom to Fit
Autorange Y-axis
View
Add Traces
Add Plot Pane
Delete this Pane
Sync. Horiz. Axes
Draw
Edit
Marching Waveforms
File
Float Window
R1
100
V1
15
;op
.tran 10
R2
560


LTspice XVII - Draft10
File Edit Hierarchy View Simulate Tools Window Help
Draft10
V(n001)
15.015V
15.009V
15.003V
14.997V
14.991V
14.985V
0s 1s 2s 3s 4s 5s 6s 7s 8s 9s 10s
R1
100
V1
15
;op
.tran 10
R2
560
RL
270
Click to plot V(N002). DC operating point: V(n002) = 9.6840305V
Type here to search
34°C
ENG
12:46
20-09-2021

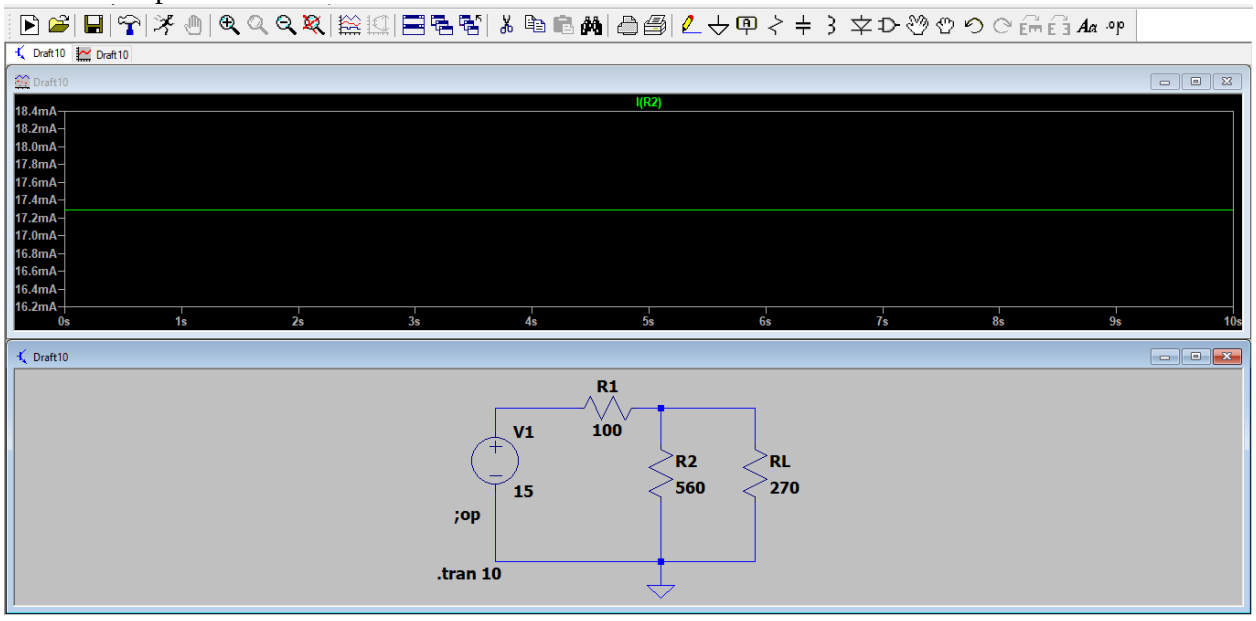


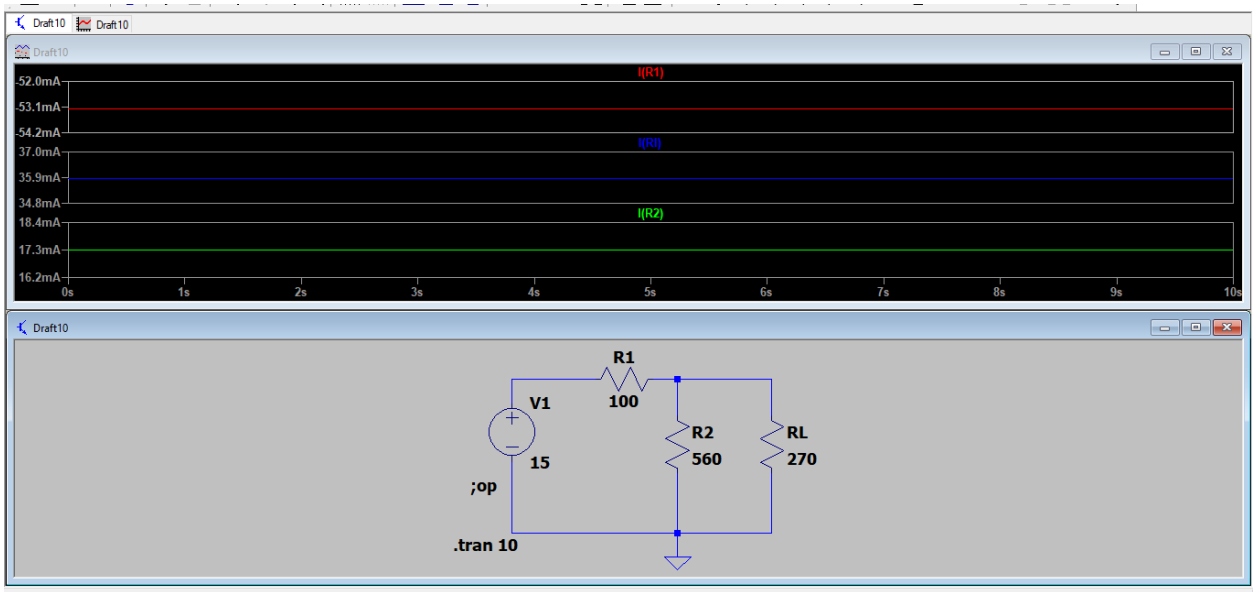
- right click in the plot and add plot pane to open another window
- hold the cursor across R_1 t to see the voltage waveform across R_1 and measure it





- hold the cursor through R_2 t to see the current waveform and measure it
- similarly, add plot pane and measure current through each element
- compare theoretical and simulation results





Result:

- Voltage and current in a DC circuit for each element are calculated analytically
- Voltage and current in a DC circuit for each element are measured practically
- Analytical and practical values are compared
- KVL and KCL are verified

Inference: