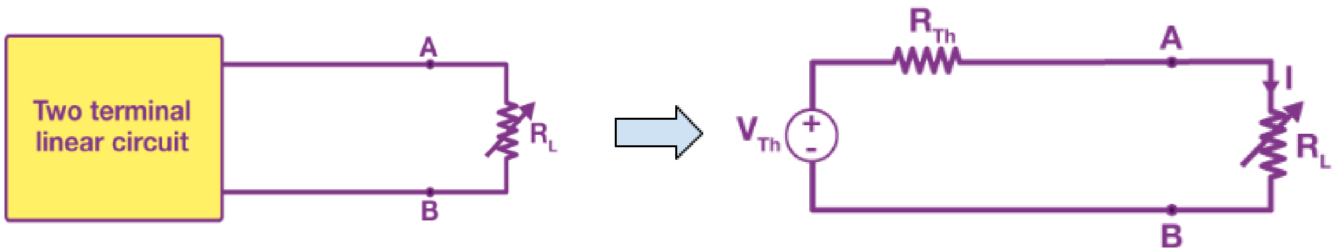
Lab 2

Experiments On Resistive Circuits

Aim: Verify maximum power transfer theorem and superposition theorem.

1. **Maximum power transfer Theorem:** ***It states that "to generate maximum external power through a finite internal resistance (DC network), the resistance of the given load must be equal to the resistance of the available source.***
In the case of AC voltage sources, maximum power is produced only if the load impedance's value is equivalent to the complex conjugate of the source impedance."
OR
"Maximum power transfer theorem states that the DC voltage source will deliver maximum power to the variable load resistor only when the load resistance is equal to the source resistance."



Maximum Power Transfer Formula is

Condition for maximum power dissipation across the load; $R_L = R_{Th}$

$$P_{max} = \frac{V_{Th}^2}{4R_{Th}}$$

Theoretical Calculations:

a) Refer to the circuit as shown in Fig. 1

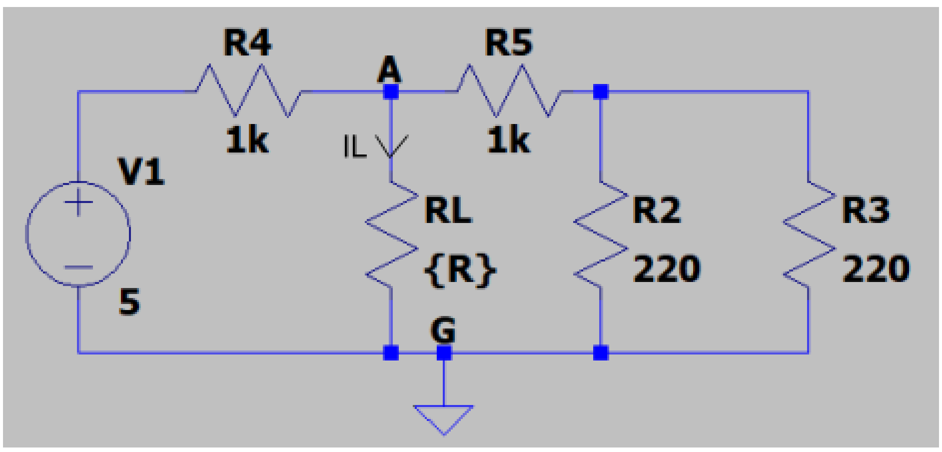


Fig. 1

b) Calculate Thevenin's resistance (R_{TH}), Thevenin's voltage (V_{TH}) across the load R_L.

c) Keep the value of R_L = 220Ω and find Power across load resistor using formula (P= I_L^2 * R_L) or (V_L * I_L).

d) Repeat the above step for R_L = 50Ω , 100Ω, R_{TH}, 700Ω.

e) Verify at which value of R_L , you are getting maximum power.

f) Manually draw the graph for P vs R_L.

S. No	Load (R_L)	Parameter	Theoretical results	LTspice results	Practical results
1	R_L= 50Ω, R_L= 100Ω, R_L=220Ω, R_L=R_{TH}, R_L=700Ω	V_L (Load voltage)			
2		I_L (Load Current)			
3		P = I_L^2 * R_L (Power)			

2. **Superposition Theorem:** ***It states that "any linear, bilateral network where more than one source is present, the output across any element in the circuit is the sum of the outputs obtained from each source considered separately."***

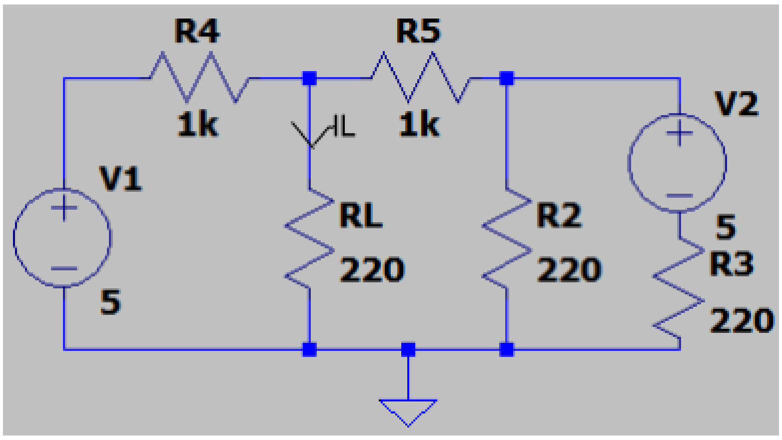


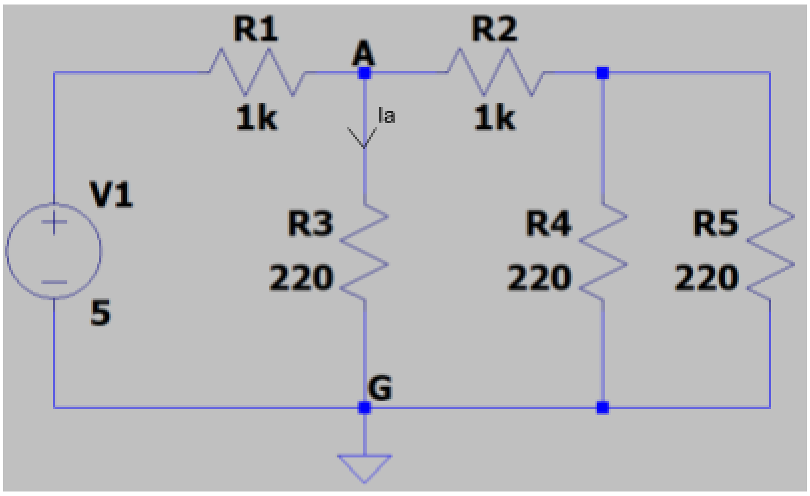
Fig.2

Theoretical Calculations:

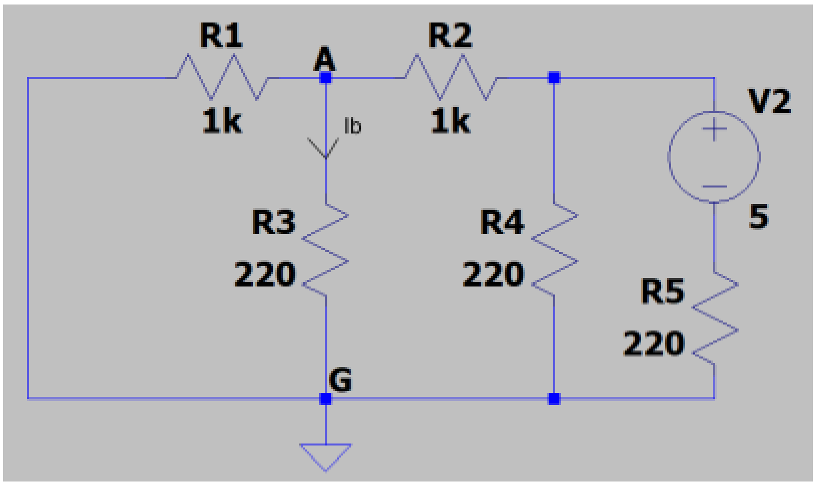
a) Refer to the circuit as shown in Fig. 2

b) Calculate the load current I_L & load voltage V_L across load resistor R_L using nodal/mesh analysis.

c) Now calculate the load current I_L & load voltage V_L by considering only one source at a time (i.e, first consider only V1) and call this current as I_a & voltage V_a.



d) Now consider V2 only and call this current as I_b & voltage V_b.



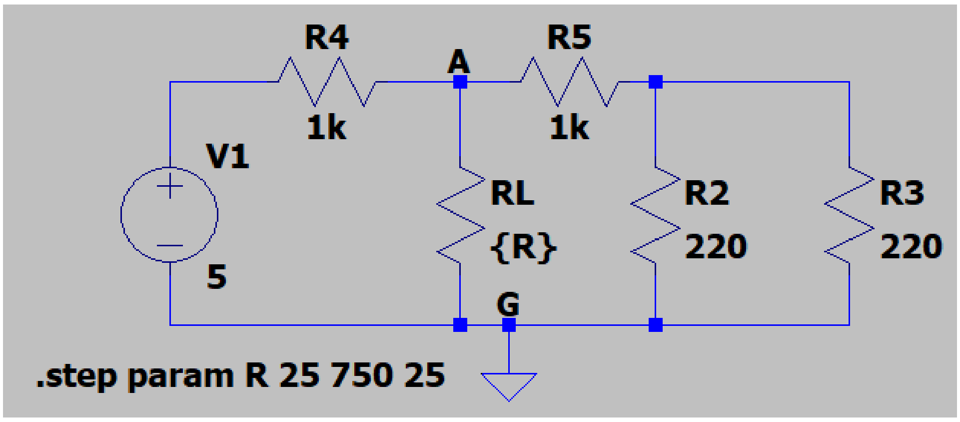
e) Calculate total load current $I_L = I_a + I_b$ and load voltage $V_L = V_a + V_b$

f) Compare the values obtained in point b) and e).

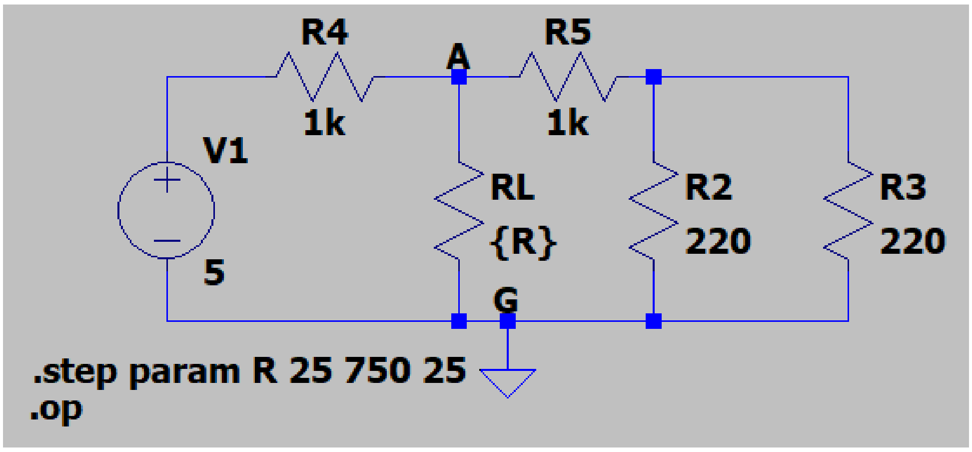
3. Experimental procedure using LTSpice :

(For Maximum Power Transfer Theorem)

a) Connect the circuit in the LTSpice schematic window as shown in Fig. 1
b) Assign values to the components (i.e. resistors, voltage source)
c) Assign the value '{R}' to the load resistor 'RL' as shown in the Fig.
d) Go to the toolbox and select the spice directive (.op) icon. Write the command **.step param R 25 750 25**' and place it on the schematic window as shown below. This command will vary the value of load resistor from 25Ω to 750Ω with a step increment of 25.



e) Run the simulation. Instead of transient analysis, run DC operating point (.op) (last tab- DC op pnt).



***Instead of points d) and e), you can manually keep different values of RL= 50Ω, 100Ω, 220Ω, R_{TH}, 700Ω and do the following calculations.*

f) Find V_L and I_L across RL like you did in Lab-1.

g) To calculate the power, keep the cursor on top of the resistor and alt+click on it. It will give you a graph of (V_L * I_L) wrt RL.

h) Now move the cursor and find out the power for all given R_L values.

i) Compare the values of maximum power in theoretical and LTSpice measurements.

(Superposition Theorem)

a) Connect the circuit in the LTSpice schematic window as shown in Fig. 2

b) Assign values to the components (i.e. resistors, voltage sources).

c) Calculate the load current I_L & load voltage V_L across load resistor R_L like you did in Lab-1.

d) Now consider only V1 (keep V2 value as 0 or remove it from the circuit). Measure the current and voltage across R_L and call it I_a & V_a respectively.

e) Now consider only V2 (keep V1 value as 0 or remove it from the circuit). Measure the current and voltage across R_L and call it I_b & V_b respectively.

f) Calculate total load current $I_L = I_a + I_b$ and load voltage $V_L = V_a + V_b$ from points d) and e).

g) Compare the values obtained in point f) with c).

4. Hardware Implementation:

Draw the same circuit as done on LTSpice and repeat all steps. Note down the practical values.

5. Observation Table:

(For Maximum Power Transfer Theorem)

S. No	Load (R_L)	Parameter	Theoretical results	LTspice results	Practical results
1	R_L= 50Ω, R_L= 100Ω, R_L=220Ω, R_L=R_{TH}, R_L=700Ω	V_L (Load voltage)			
2		I_L (Load Current)			
3		P = $I_L^2 * R_L$ (Power)			

(For Superposition Theorem)

S. No	Parameter	I_L (Load Current)	V_L (Load voltage)	Theoretical results	LTspice results	Practical results
1	V1=5v & V2=5v					
2	V1=5v & V2=0v	I_a	V_a			
3	V1=0v & V2=5v	I_b	V_b			
		$I_a + I_b = I_L$	$V_a + V_b = V_L$			

Deliverables:

When coming to the lab:

- Check the file format & grading rubrics (already posted on the classroom (BE Lab Flow).
- Submit the LTSpice file (.asc) of this experiment to the classroom (individual task).
- Keep the theoretical & LTSpice results of this experiment with you on a rough copy.
- Submit the practical file with completed experiment-1 and index on entering the lab.