At loop2: $6000(I_1'' - I_3'') + 12000 I_1'' = 0$

$18000 I_1'' - 6000 I_3'' = 0$

$18000 I_1'' - 6000 (6mA) = 0$

$\therefore I_1'' = \frac{36}{18000} = 2mA$

$I_1'' = 2mA$

Using Superposition theorem, current through $12k\Omega$ is

$I_1 = I_1' + I_1'' = 0.5mA + 2mA$

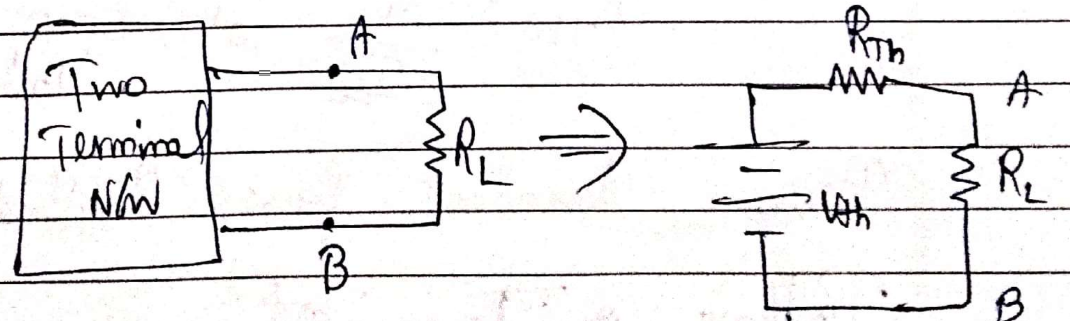
$$\boxed{I_1 = 2.5mA}$$

Thevenin's Theorem

(a n/w that behaves the same in both directions of current flow)
So the I-V relation is unchanged even if direction of I is changed.

Any two terminal bilateral linear N/W can be replaced by an equivalent circuit that consisting of a single voltage source (V_{Th}) connected in series with resistance (R_{Th}).

$R_L \Rightarrow$ Load Resistance



Thevenin's Equivalent Circuit.

classmate

Date

Page

Procedure:

Step 1: Remove the load resistance R_L & find the open circuit (V_{Th}) across the load terminal.

Step 2: Deactivate all voltage source & current source in the circuit & find the total equivalent resistance looking through the load terminal

Step 3: obtain Thevenin's equivalent circuit by placing R_{Th} in series with V_{Th}.

Step 4: Reconnect R_L across the load terminal & find the load current using the formula.

$$I_L = \frac{V_{Th}}{R_{Th} + R_L}$$

Where, R_{Th} = Thevenin's Resistance.

V_{Th} = Thevenin's Voltage.

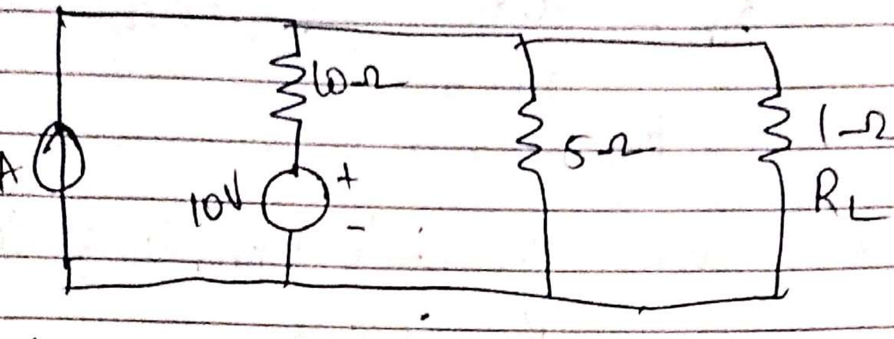
In circuit containing dependent source,

$$R_{Th} = \frac{V_{OC}}{I_{SC}}$$ at open circuited load terminal.

Because dependent sources shouldn't be deactivated.

Problems on Thevenin's Theorem

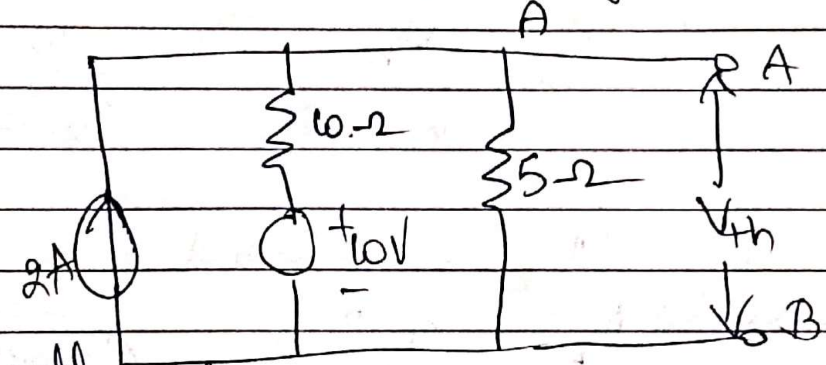
1. Find the power loss in 1Ω resistor in given circuit using Thevenin's Theorem



Solution:

Let us consider 1Ω resistance as load.

Step 1: Remove R_L & find V_{Th}.



Using nodal analysis.

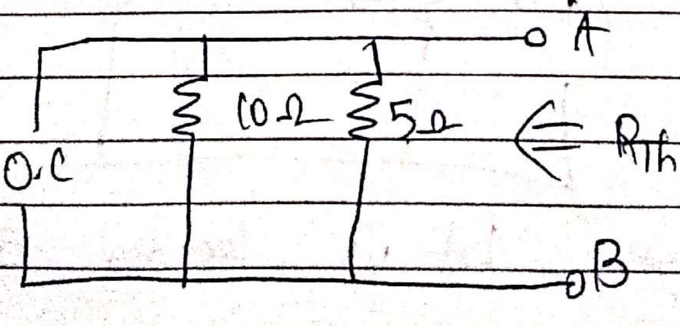
At node A: $\frac{V_A - 10}{10} + \frac{V_A}{5} = 2$

$$3V_A = 30$$

$$V_A = 10V$$

$$V_{Th} = V_A = 10V$$

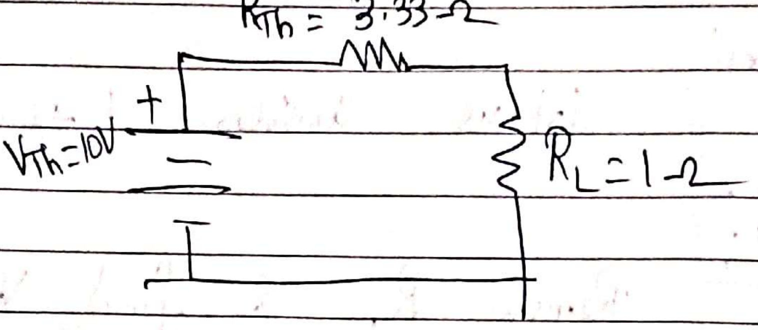
Step 2: Deactivate all sources & find R_{Th}.



$$R_{Th} = \frac{10 \times 5}{10+5} = 3.33\,\Omega$$

$R_{Th} = 3.33\,\Omega$

Step 3: Draw Thevenin's equivalent & Connect R_L.



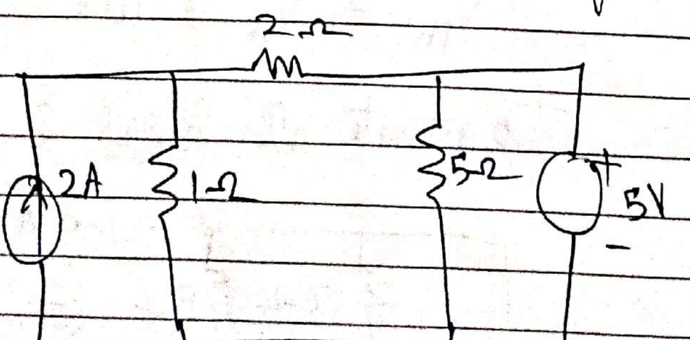
$$\therefore I_L = \frac{V_{Th}}{R_{Th}+R_L} = \frac{10}{3.33+1} = \frac{10}{4.33}$$

$I_L = 2.3095\,A$

Power Loss in $R_L = I_L^2 R_L = (2.3095)^2 (1\Omega)$

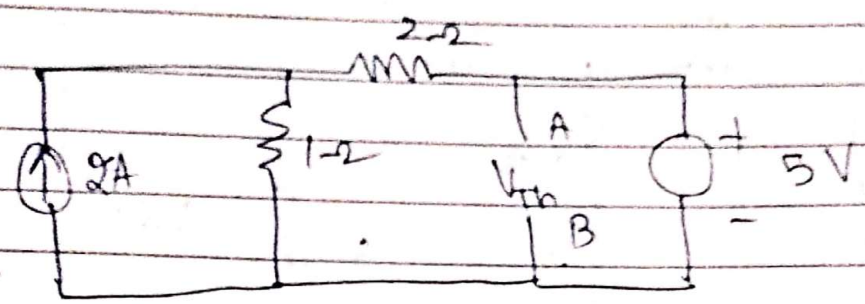
$$\boxed{P_{1\Omega} = 5.3336\ W}$$

(2) Find the current through 5Ω resistor using Thevenin's theorem in the given circuit.



Solution: Let us consider 5Ω resistor as load resistor R_L

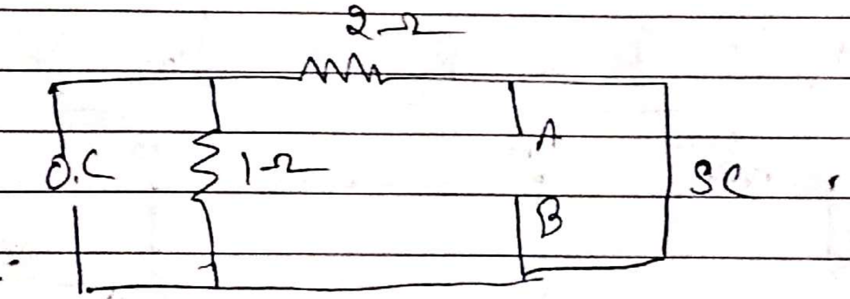
Step 1: Remove load R_L & find the V_{th}



From the circuit,

$$V_{Th} = V_{AB} = 5V$$

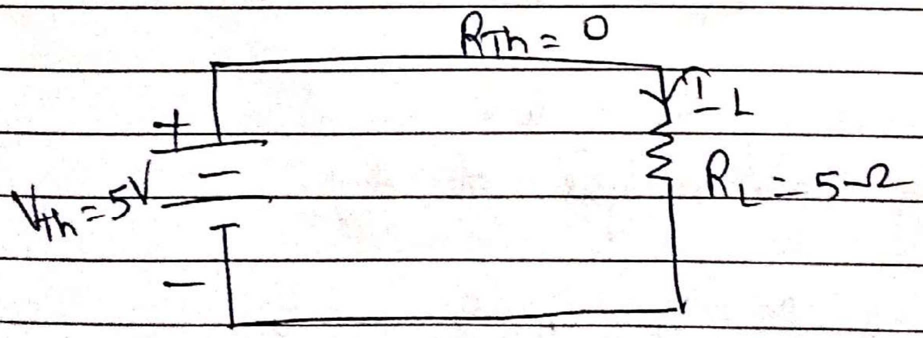
Step 2: Deactivate all sources & find R_{th}.



$$R_{Th} = R_{AB} = 0\,\Omega$$

Since AB is short circuited. (Resistance across a short circuit is zero)

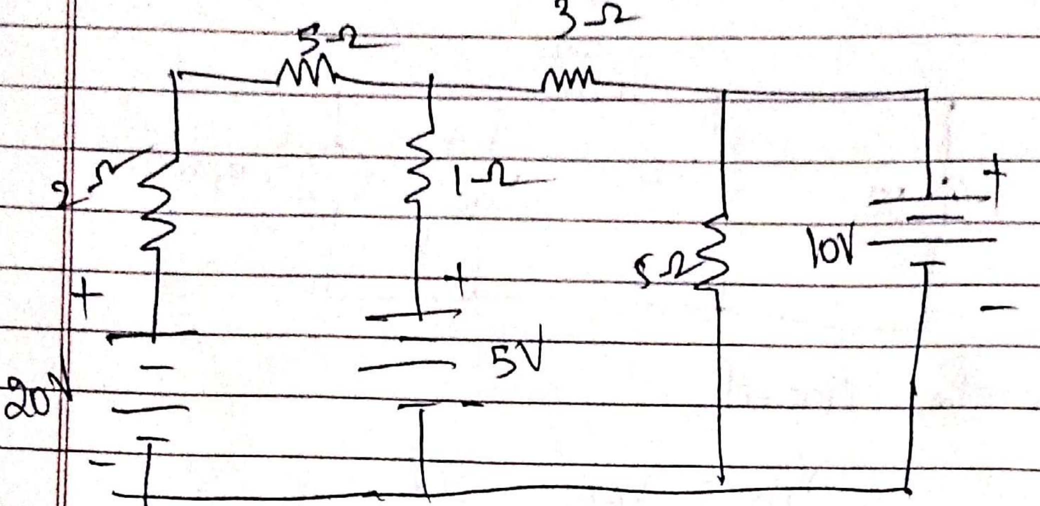
Step 3: Thevenin's Equivalent Circuit



$$I_L = \frac{V_{Th}}{R_{Th} + R_L} = \frac{5}{0+5}$$

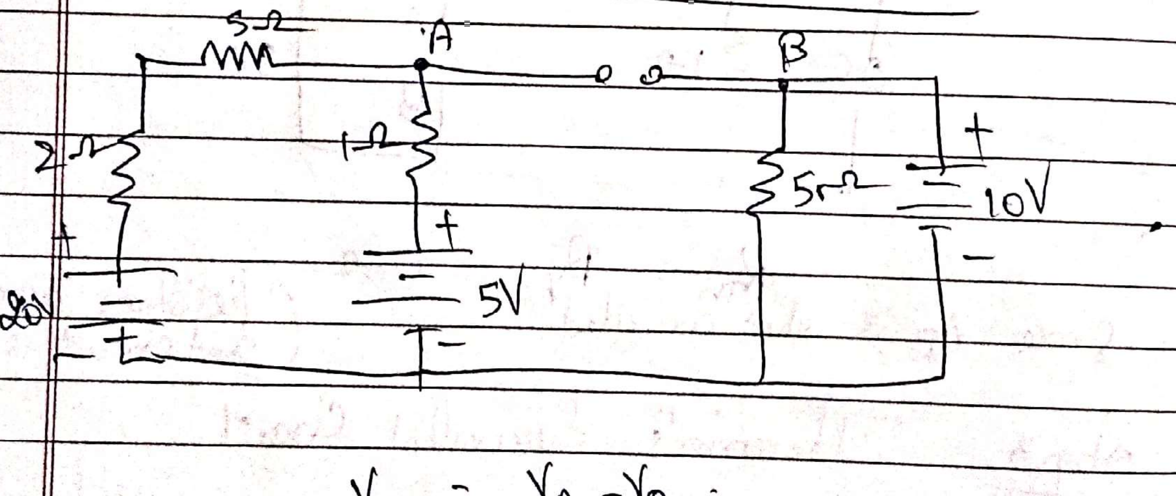
$$I_L = 1A.$$

③ Find the power across 3Ω using Thevenin's theorem.



Solution: Let $R_L = 3\Omega$.

Step 1: Remove R_L & find V_{Th}



$$V_{Th} = V_A - V_B$$

$$V_B = 10V$$

Using nodal analysis at A,

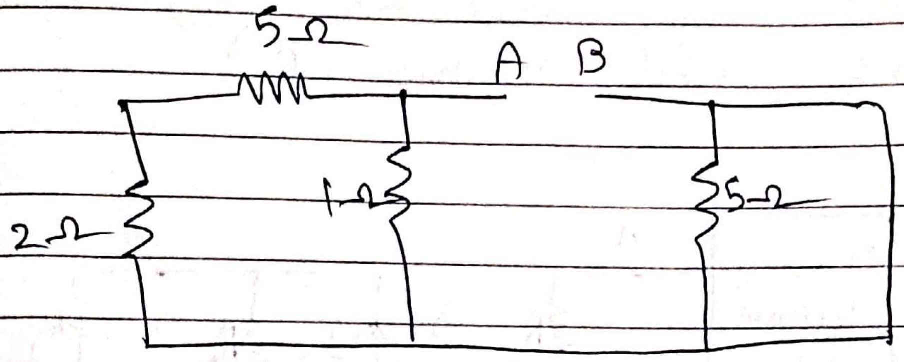
$$\frac{V_A - 20}{7} + \frac{V_A - 5}{1} = 0$$

$$V_A = 6.875 V$$

$V_{Th} = V_A - V_B = 6.875 - 10 = -3.125\,V$

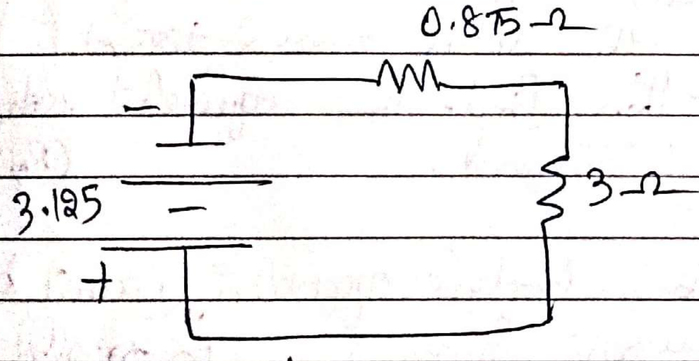
$V_{Th} = -3.125\,V$

Step 2 : Deactivate all sources & find R_{Th}.



$R_{Th} = (5+2) \| 1\,\Omega = \frac{7\times1}{7+1} = 7/8 = 0.875\,\Omega$

Ans $R_{Th} = 0.875\,\Omega$



Power loss $= I_L^2 R_L$

$I_L = \frac{V_{Th}}{R_{Th} + R_L} = \frac{(-3.125)}{0.875+3} = -0.8065A$

Power loss $= I_L^2 R_L = (-0.8065)^2 (3)$

$P = 1.9513\,W$