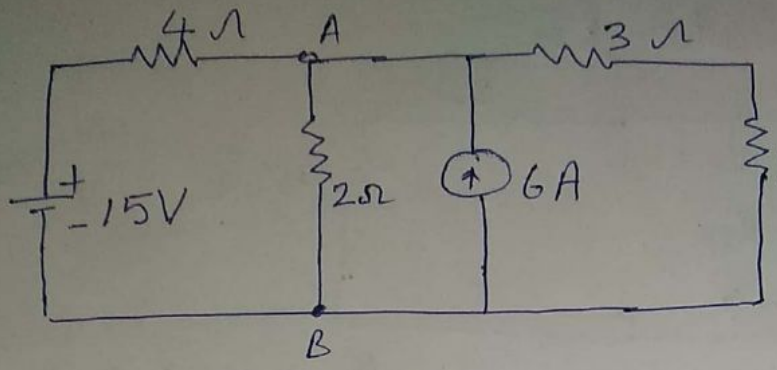
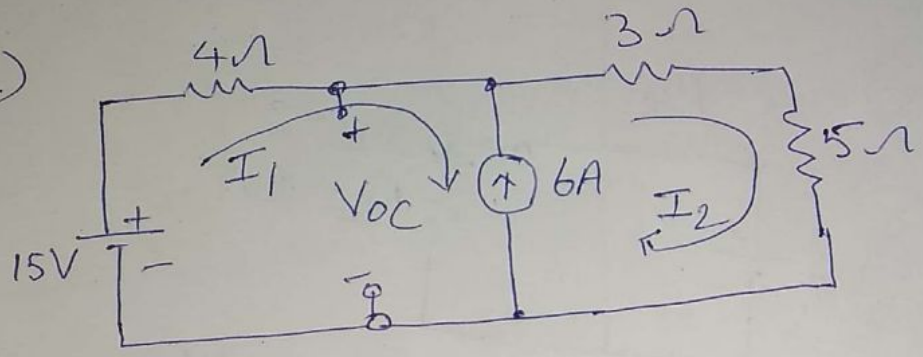
Tutorial Sheet No. 3

1) 

I_2 Ω? using Thevenin's Theorem.

Step 1) Load = 2 Ω

Step 2) 

Step 3) Find $V_{OC} = V_{th}$

$I_2 - I_1 = 6$ or $-I_1 + I_2 = 6$ — (1)

KVL in mesh (1)

$15 - 4I_1 - V_{OC} = 0$

$V_{OC} = 15 - 4I_1$ — (2)

KVL in mesh (2)

$-3I_2 - 5I_2 + V_{OC} = 0$

$V_{OC} = 8I_2$ — (3)

From eqn (2) and (3)

$15 - 4I_1 = 8I_2$

$-4I_1 - 8I_2 = -15$ — (4)

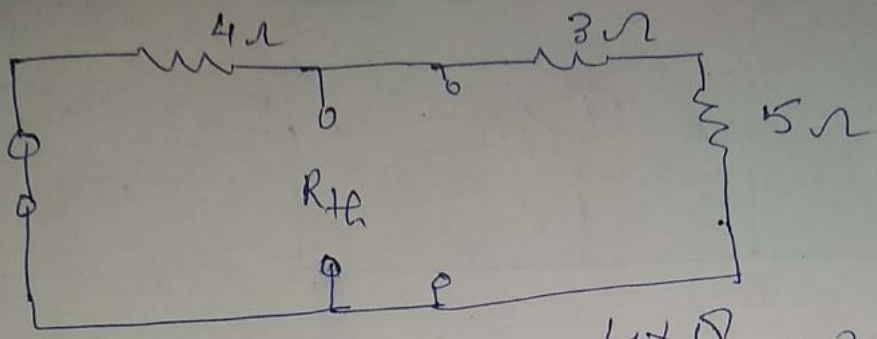
$I_1 = -2.75$ A, $I_2 = 3.25$ A

$V_{OC} = 8 \times 3.25$

$= 26$ V

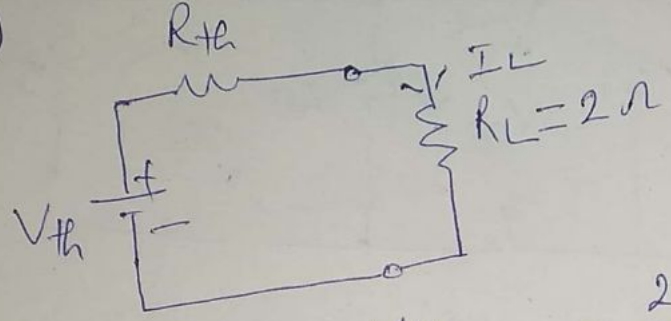
$V_{th} = 26$ V

Step 4) Calculate R_{th}



$$R_{th} = 4 \| 8 = \frac{4 \times 8}{12} = 2.67\,\Omega$$

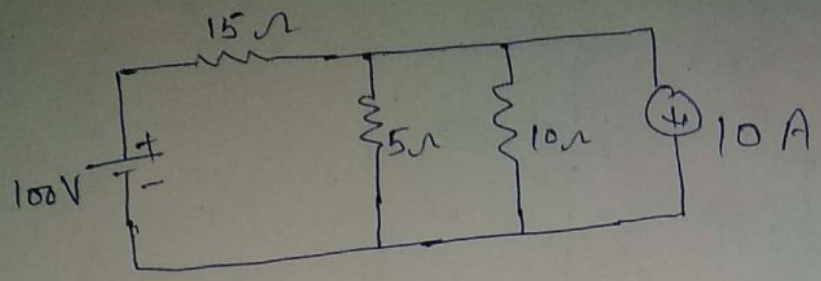
Step 5)



$$I_L = \frac{V_{th}}{R_{th} + R_L} = \frac{26}{2.67 + 2} = 5.57\,A$$

Ans

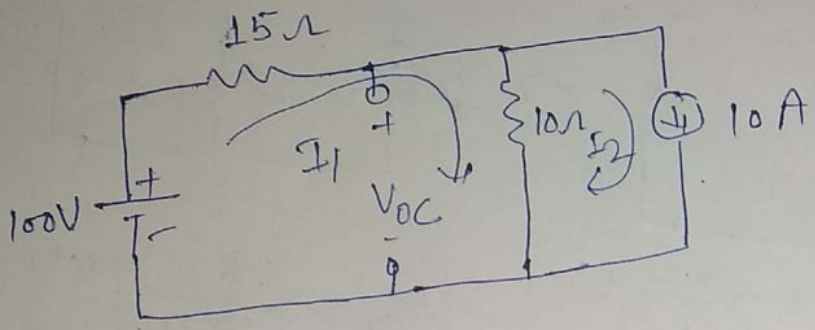
2)



$I_{5\Omega}$ using Thevenin Theorem

Step 1) Load = 5Ω

Step 2) Remove 5Ω



Step 3) Calculate V_{OC}

$I_2 = 10A$

$100 - 15I_1 - 10(I_1 - I_2) = 0$

$25I_1 - 10I_2 = 100$

$25I_1 = 100 + 10I_2$

$= 100 + 10 \times 10 = 200$

$I_1 = 8A$

$100 - 15I_1 - V_{OC} = 0$

$V_{OC} = 100 - 15I_1$

$= 100 - 15 \times 8$

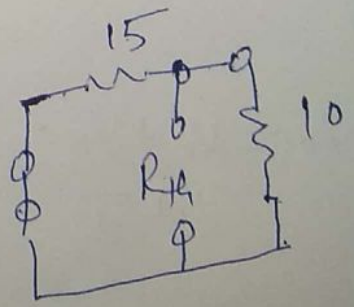
$= -20V$

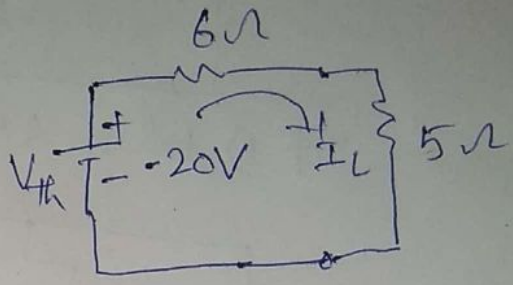
$\boxed{V_{th} = -20V}$

Step 4) Calculate R_{th}

$R_{th} = 15 \parallel 10$

$= \frac{150}{25} = 6\Omega$





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

$= \frac{-20}{6+5}$

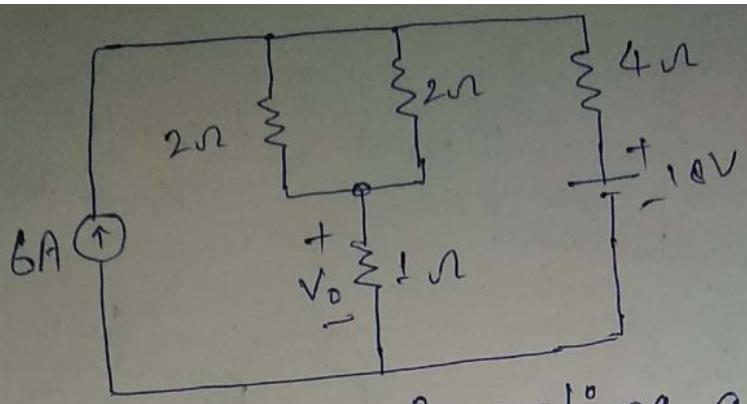
$= \frac{-20}{11}$

$= -1.82A$

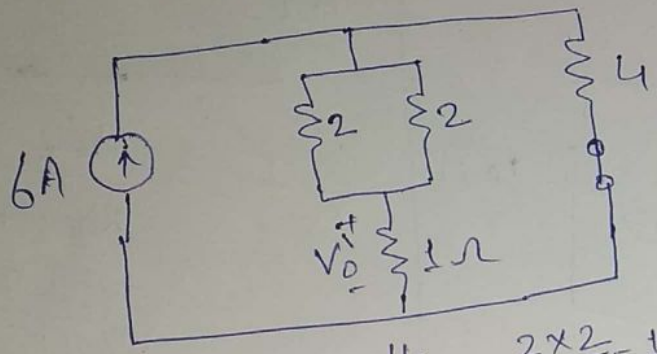
$= 1.82A$ from bottom to top

Ans

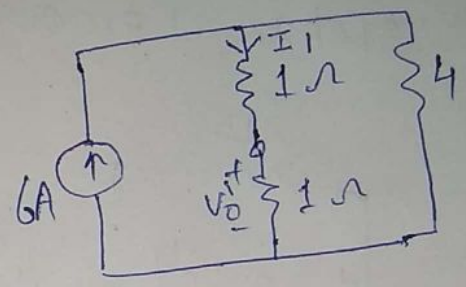
3(b)



Step 1) When 6A is acting alone



$2 \| 2 = \frac{2 \times 2}{2+2} = 1$

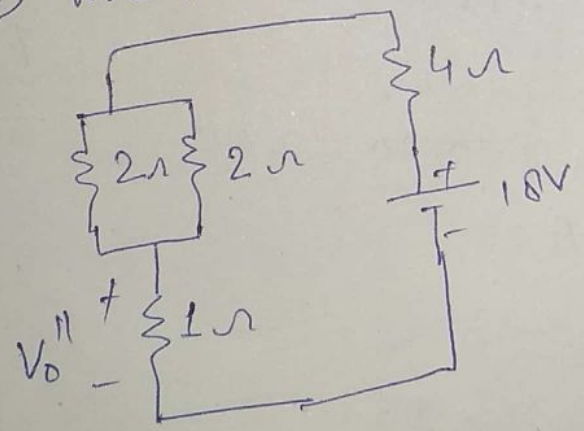


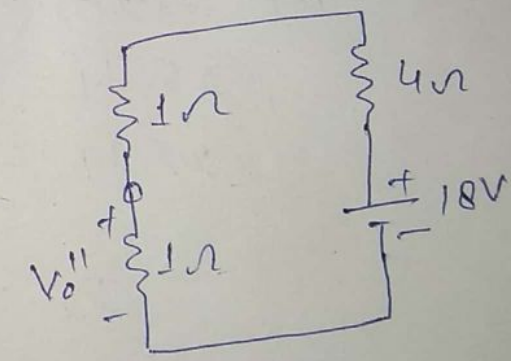
$I_1 = \left[\frac{6}{4+(1+1)}\right] \times 4$

$= \frac{6 \times 4}{6} = 4A$

$V_o' = 4 \times 1 = 4V$ — (1)

Step 2) When 18V is acting alone.





$V_o'' = \left[\frac{18}{4+(1+1)}\right] \times 1$

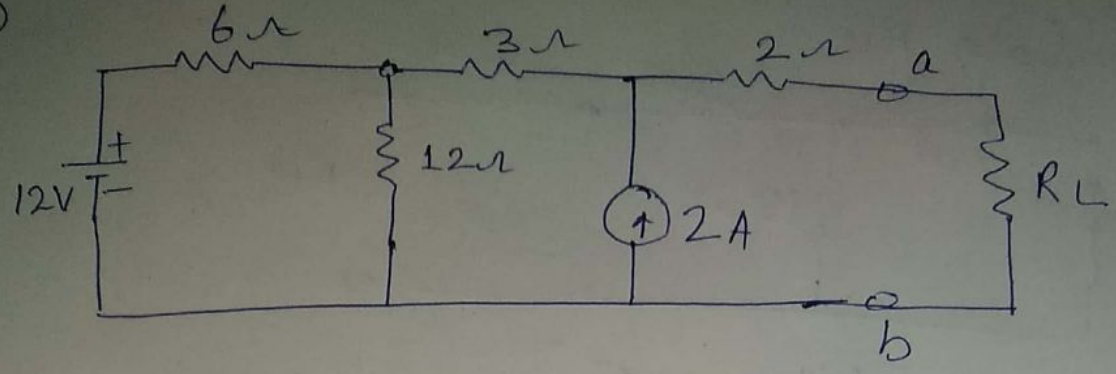
$= \frac{18}{6} = 3V$

Step 3)

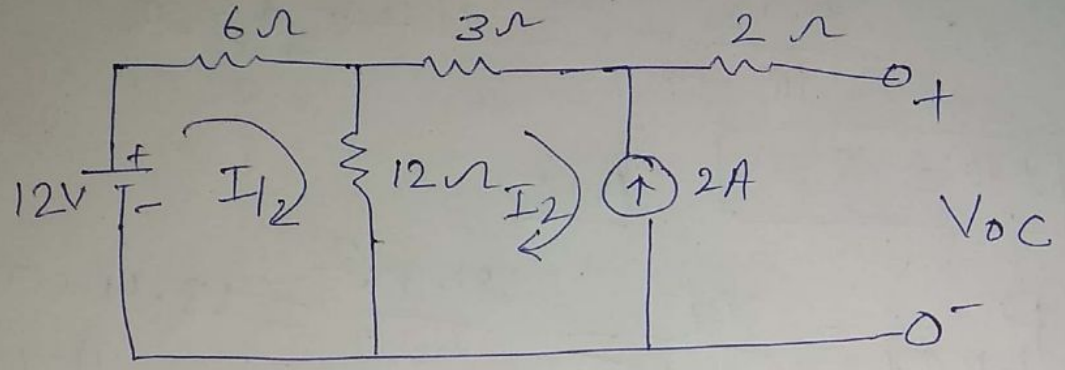
$V_o = V_o' + V_o''$

$= 4 + 3 = 7V$ Ans

4)



Step 1)



Step 2) Calculate Voc

$I_2 = -2A$

KVL in mesh ①

$12 - 6I_1 - 12(I_1 - I_2) = 0$

$18I_1 - 12I_2 = 12$

$18I_1 = 12 + 12I_2$

$= 12 + 12 \times (-2)$

$= 12 - 24 = -12$

$I_1 = \frac{-12}{18} = -0.67\ A$

Apply KVL to get Voc

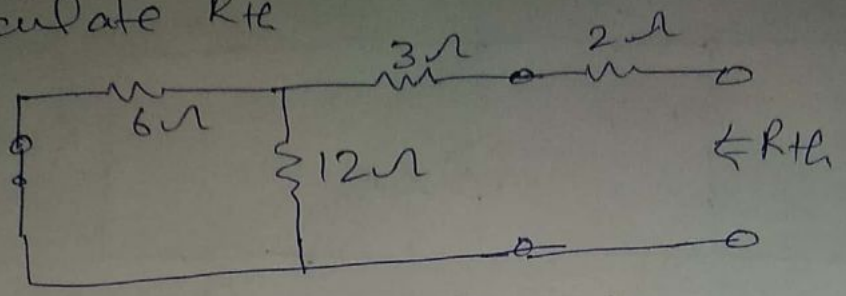
$-3I_2 - 0 \times 2 - Voc - 12(I_2 - I_1) = 0$

$Voc = -3I_2 - 12(I_2 - I_1)$

$= +12I_1 - 15I_2 = 12(-0.67) - 15 \times (-2)$

$= 21.96\ V$

Step 3)
calculate R_{th}



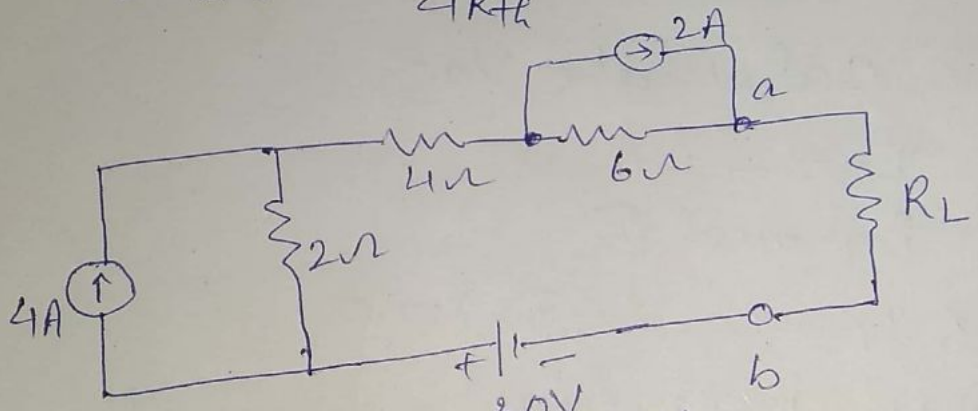
$$R_{th} = 6 \| 12 + 5$$

$$= \frac{6 \times 12}{18} + 5 = 4 + 5 = 9\,\Omega$$

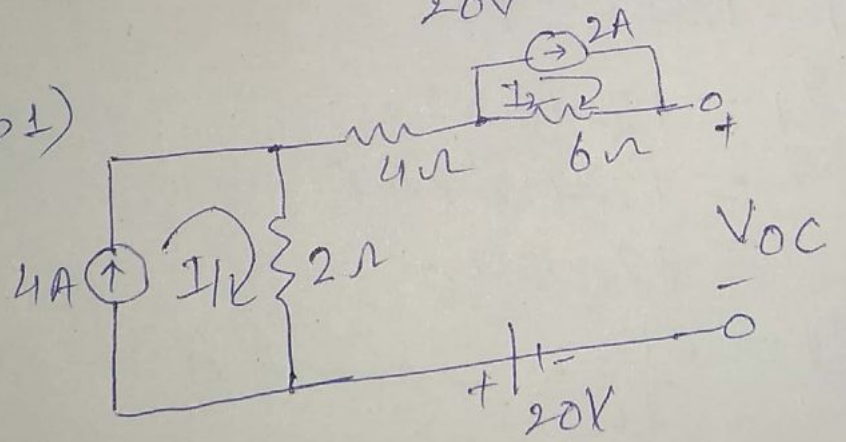
$\boxed{R_{th} = 9\,\Omega}$ Ans

$$P_{L\,max} = \frac{V_{th}^2}{4R_{th}} = \frac{21.96^2}{4 \times 9} = 13.4 \text{ watt}$$ Ans

(5)



Step 1)



$I_1 = 4\,A$

$I_2 = 2\,A$

Apply KVL to get V_{OC}

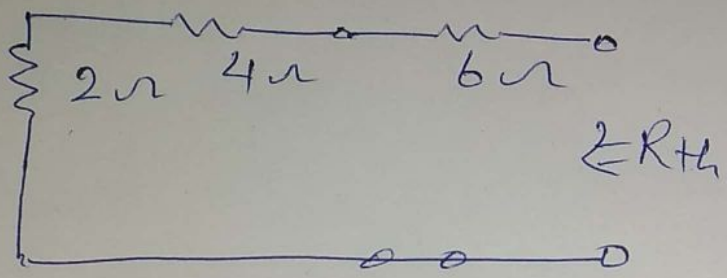
$$-4 \times 0 - 6(-I_2) - V_{OC} + 20 - 2(-I_1) = 0$$

$$6I_2 + 20 + 2I_1 = V_{OC}$$

$$V_{oc} = 20 + 2\times4 + 6\times2$$
$$= 20 + 8 + 12$$
$$= 40V$$

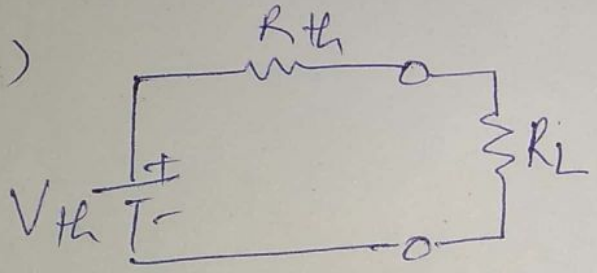
$$\boxed{V_{th} = 40V}$$

Step 2) Calculate R_{th}



$$R_{th} = 2 + 4 + 6 = 12\ \Omega$$

(a)



$$I_L = \frac{V_{th}}{R_{th}+R_L} = \frac{40}{12+8}$$
$$= 2\ A \quad \text{Ans}$$

(b) $R_L = R_{th} = 12\ \Omega$ Ans

(c) $$P_{L(max)} = \frac{V_{th}^2}{4R_{th}} = \frac{40^2}{4\times12} = 33.33 \text{ watt}$$ Ans

(d) $$P_L = I_L^2 R_L = 2^2 \times 8 = 4\times8$$
$$= 32 \text{ watt}$$

Ans