MID SEM EXAM (SET-B)

SOLUTION

SOL(1):

For maximum power transfer from 20V source to the 15Ω load is possible, when the value of resistor R_1 should be minimum & the value of resistor R_2 can take any value ($R_2 \neq 0$).

$\therefore$ Min^m possible value of $R_1 = 0\Omega$ (SC) → [1 POINT]

$\therefore$ Value of R_2 = any value but not short circuit

→ [1 POINT]

SOL (2): For Network N_1/ Network N_2 –

By using KCL (Figure-2), Total incoming current = Total outgoing current

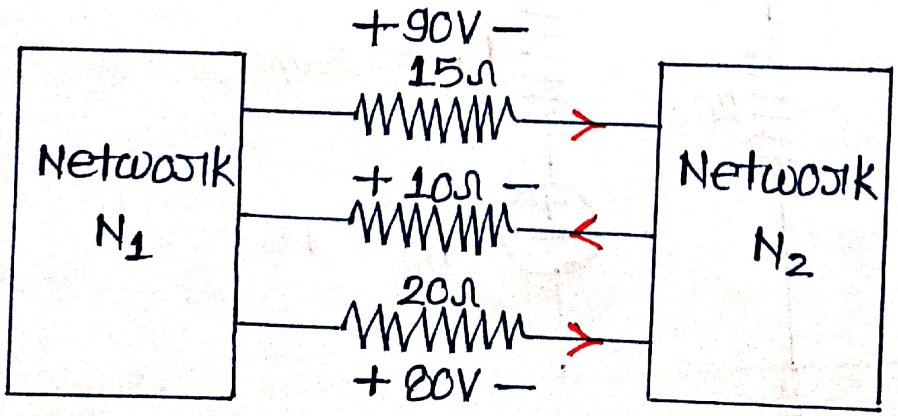
Current through 15 Ω resistor $= \frac{90}{15} = 6A$

Current through 20 Ω resistor $= \frac{80}{20} = 4A$

∴ Current through 10 Ω resistor $= 6+4 = 10A$ [1 POINT]

∴ Voltage across 10 Ω resistor $= (-10)(10)$

$= -100 V$ [1 POINT]



SOL(3):

By Table-1, for Linear Circuit-1 —

OC voltage / Thevenin voltage across A & B = 10 Volt

$V_{th_1} = 10$ Volt [0.5 POINT]

SC current / Norton current across A & B = 5A

$I_{N_1} = 5A$

Thevenin resistance across A & B $= \dfrac{V_{th1}}{I_{N1}} = \dfrac{10}{5}$

$R_{th_1} = 2\,\Omega$ [0.5 POINT]

By Table-2, for Linear Circuit-2 —

OC voltage / Thevenin voltage across C & D = 15 Volt

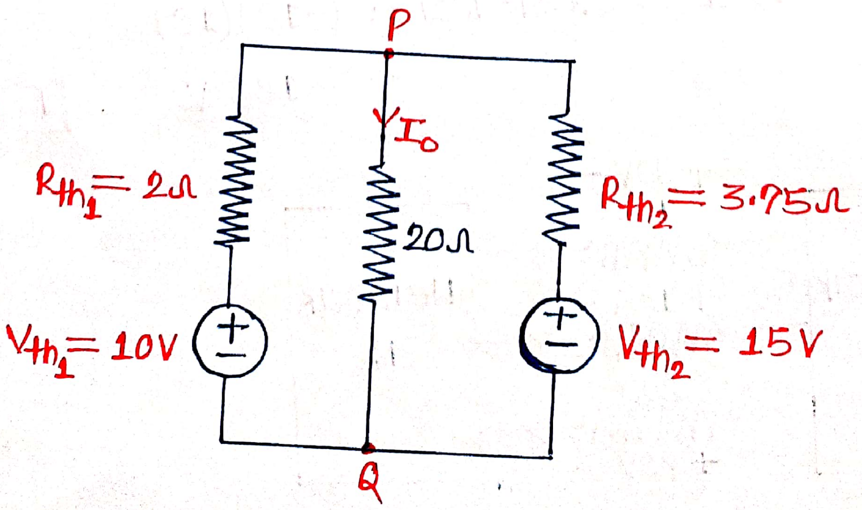
$V_{th_2} = 15$ Volt [0.5 POINT]

SC current / Norton current across C & D = 4A

$I_{N_2} = 4A$

Thevenin resistance across C & D $= \dfrac{V_{th2}}{I_{N2}} = \dfrac{15}{4}$

$R_{th_2} = 3.75\,\Omega$ [0.5 POINT]



By Nodal analysis at Node-P,

$$\frac{V_P}{20} + \frac{V_P - 10}{2} + \frac{V_P - 15}{3.75} = 0$$

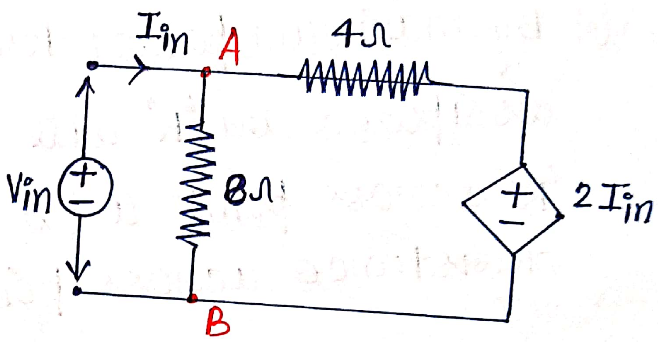
$$\frac{49}{60} V_P = 9$$

$$\therefore V_P = 11.02 \text{ volt}$$

$$\therefore I_o = \frac{V_P}{20} = \frac{11.02}{20} = 0.55 A$$

[1 POINT]

SOL(4):



By Nodal analysis at Node-A,

$$\frac{V_{in}}{8} + \frac{V_{in} - 2I_{in}}{4} = I_{in}$$

$$V_{in} + 2V_{in} - 4I_{in} = 8I_{in}$$

$$3V_{in} = 12\, I_{in}$$

$$\frac{V_{in}}{I_{in}} = 4\ \Omega$$

[3 POINT]

SOL(5):

(a) Thevenin equivalent circuit as viewed by resistor 'R'

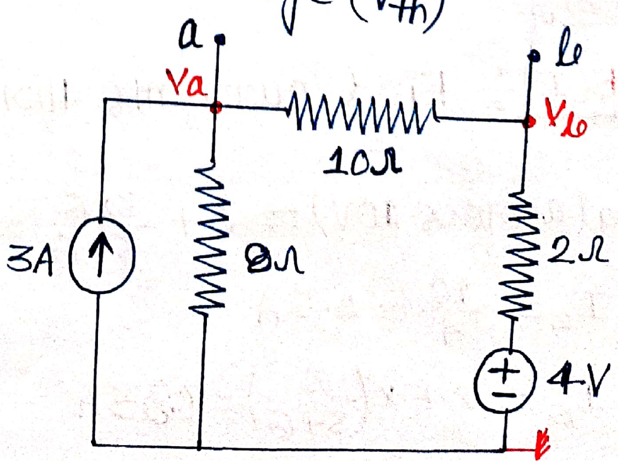
Step(I):- Calculation of Thevenin Voltage (V_{th})

KCL at node-a, we get-

$$3 = \frac{V_a}{8} + \frac{V_a - V_b}{10}$$

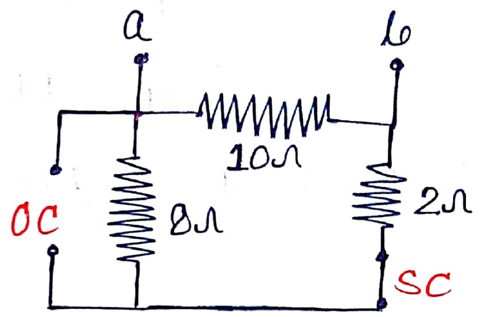
KCL at node-b, we get-

$$\frac{V_b - V_a}{10} + \frac{V_b - 4}{2} = 0$$



$\therefore V_{th} = V_a - V_b = 16 - 6 = 10$ Volt [2 POINT]

Step(II):- Calculation of Thevenin Resistance (R_{th})



$\therefore R_{th} = R_{ab}$

$= 10 \parallel (8+2)$

$= 5\Omega$ [2 POINT]

(b) By maximum power transfer theorem, the power dissipated by 'R' will be maximum, when value of 'R' across point a & b will be equal to the thevenin resistance across point a & b.

$\therefore R = R_{th} = 5\Omega$ [1 POINT]

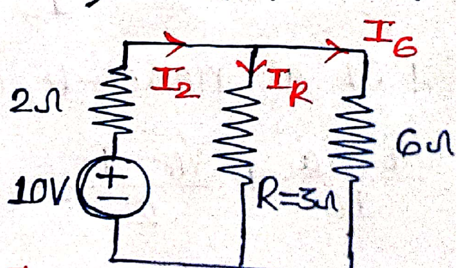
(c) By maximum power transfer theorem,

The maximum power will be equal to $\frac{V_{th}^2}{4R_L} = \frac{V_{th}^2}{4R_{th}}$

$\therefore P_{max} = \frac{V_{th}^2}{4R} = \frac{10^2}{4 \times 5} = 5\,W$ [1 POINT]

SOL(6):

Step(I):- Find currents through 2Ω & 6Ω, when R = 3Ω



Req (across 10V) $= 2 + \frac{3 \times 6}{3+6} = 4\Omega$

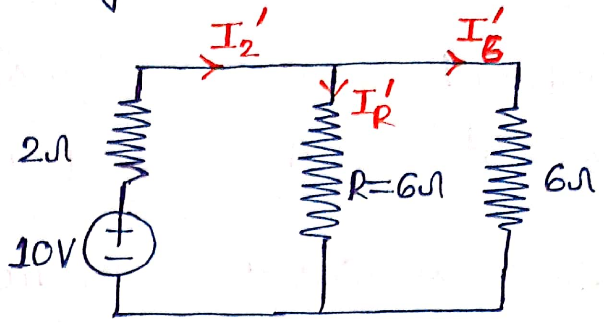
$\therefore I_2 = \frac{10}{4} = 2.5\,A$

$\therefore I_6 = 2.5 \times \left(\frac{3}{3+6}\right) = 0.83\,A$ [2X1 POINT]

Step(II): Find currents through 2Ω & 6Ω, when $R=6\Omega$.

R_{eq} (across 10V)

$$= 2 + \frac{6 \times 6}{6+6} = 5\Omega$$



$$\therefore I_2' = \frac{10}{5} = 2A$$

$$\therefore I_6' = 2 \times \left(\frac{6}{6+6}\right) = 1A$$

[2X1 POINT]

Step(III):

$\therefore$ Difference of value of current in 2Ω $= |I_2 - I_2'|$

$$= |2.5 - 2|$$

$$= 0.5A$$

[1 POINT]

$\therefore$ Difference of value of current in 6Ω $= |I_6 - I_6'|$

$$= |0.83 - 1|$$

$$= 0.17A$$

[1 POINT]

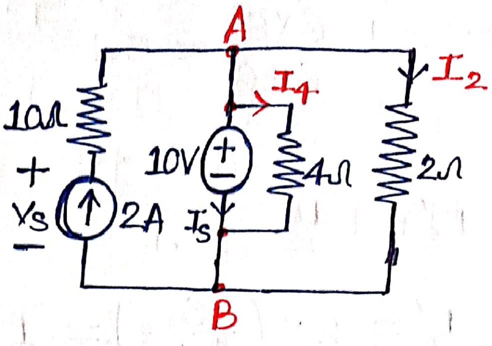
SOL(7):

Same as Set-A.

SOL(8):

Current across 2Ω resistance,

$\therefore I_2 = \frac{10}{2} = 5A$ [2 POINT]



Current across 4Ω resistance,

$I_4 = \frac{10}{4} = 2.5A$

Apply KCL at node-A,

$2 = I_s + I_4 + I_2$

$2 = I_s + 2.5 + 5$

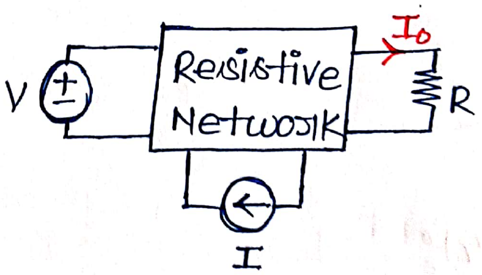
$\therefore I_s = -5.5A$ [2 POINT]

By circuit — $-V_s + 2 \times 10 = -2 \times 5$

$\therefore V_s = +30$ Volt [2 POINT]

SOL(9):

By using superposition theorem,



$I_0 = \pm I_1 \pm I_2$

where,

I_1 = current across resistor R, when voltage source V active alone

I_2 = current across resistor R, when current source I active alone

$$\sqrt{\left(\frac{P_0}{R}\right)} = \pm\sqrt{\left(\frac{P_1}{R}\right)} \pm\sqrt{\left(\frac{P_2}{R}\right)}$$

$$P_0 = \left(\pm\sqrt{P_1} \pm \sqrt{P_2}\right)^2$$

[2 POINT]

$P_o = (\sqrt{9} + \sqrt{16})^2 = (3+4)^2 = 49W$

$P_o = (\sqrt{9} - \sqrt{16})^2 = (3-4)^2 = 1W$

$\therefore$ Power dissipated by resistor R, when both sources are active — $P_o = 49W, 1W$ [4 POINT]