MID SEM EXAM (SET-A)

SOLUTION

SOL(1):

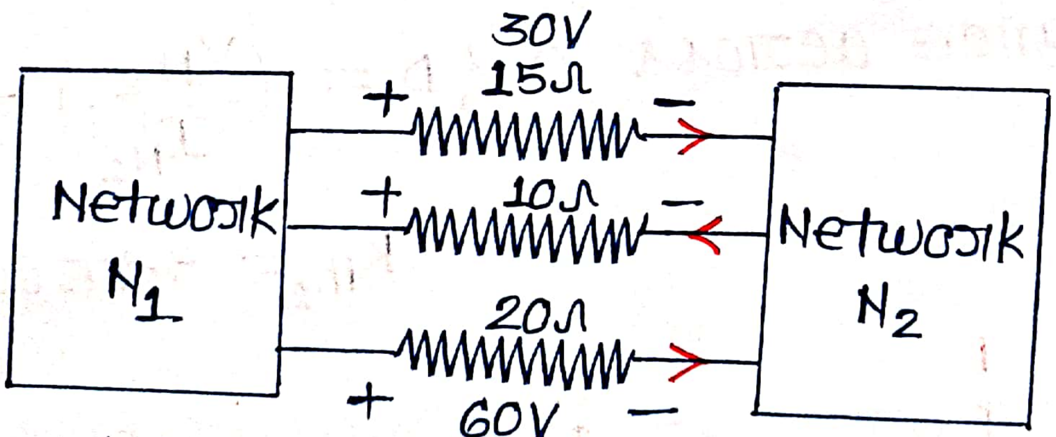
For maximum power transfer from 10 V source to the 5Ω load is possible, when the value of resistor R_1 should be minimum & the value of resistor R_2 can take any value ($R_2 \neq 0$).

∴ Min^m possible value of R_1 = 0Ω (SC) → [1 POINT]

∴ Value of R_2 = any value but not Short Circuit

→ [1 POINT]

SOL.(2):



For Network N_1/ Network N_2 —

By using KCL, Total incoming current = Total outgoing current

Current through 15Ω resistor $= \frac{30}{15} = 2A$

Current through 20Ω resistor $= \frac{60}{20} = 3A$

∴ Current through 10Ω resistor $= 2+3 = 5A$ [1 POINT]

∴ Voltage across 10Ω resistor $= (-5)(10) = -50$ Volt

[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 = $\left(\frac{V_{th_1}}{I_{N_1}}\right) = \left(\frac{10}{5}\right)$

$R_{th_1} = 2\Omega$

[0.5 POINT]

By Table-2, for Linear Circuit-2 —

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

$V_{th_2} = 15$ Volt

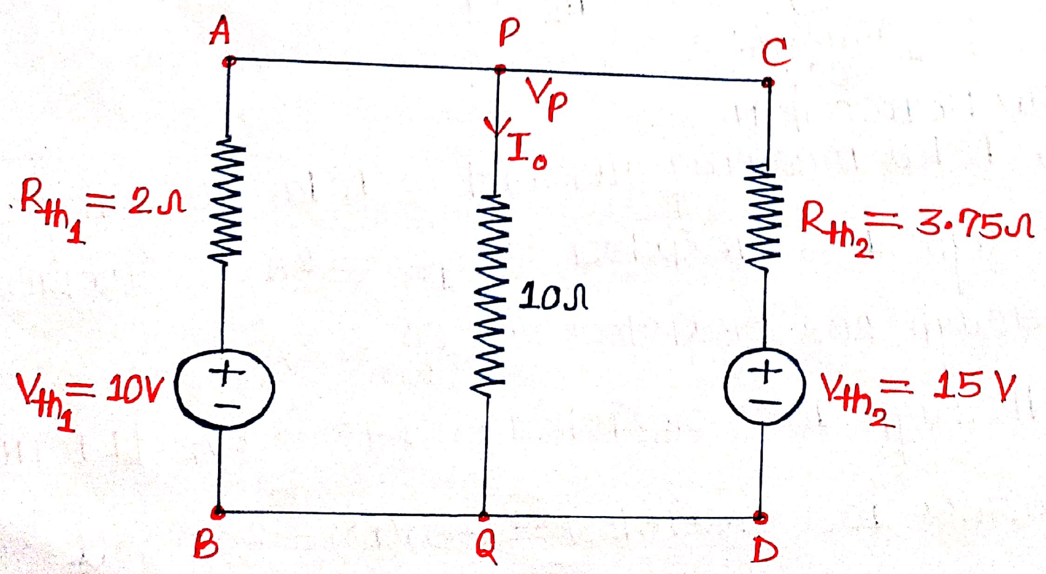
∴ SC current/Norton current across C & D = 4A [0.5 POINT]

$I_{N_2} = 4A$

∴ Thevenin resistance across C & D = $\left(\frac{V_{th_2}}{I_{N_2}}\right) = \left(\frac{15}{4}\right)$

$R_{th_2} = 3.75\Omega$

[0.5 POINT]



By Nodal analysis at Node-P,

$$\frac{V_P}{10} + \frac{V_P - V_{th1}}{R_{th1}} + \frac{V_P - V_{th2}}{R_{th2}} = 0$$

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

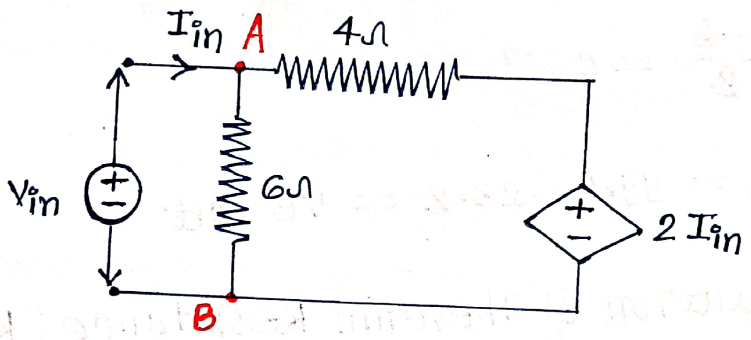
$$\frac{13}{15} V_P = 9$$

$$\therefore V_P = \frac{135}{13} = 10.38 \text{ Volt}$$

$$\therefore I_o = \frac{V_P}{10} = \frac{10.38}{10} = 1.04\,A$$

[1 POINT]

SOL(4):



By Nodal analysis at Node-A,

$$\frac{V_{in}}{6} + \frac{V_{in} - 2I_{in}}{4} = I_{in}$$

$$10\,V_{in} - 12\,I_{in} = 24\,I_{in}$$

$$\frac{V_{in}}{I_{in}} = \frac{36}{10} = 3.6\,\Omega$$

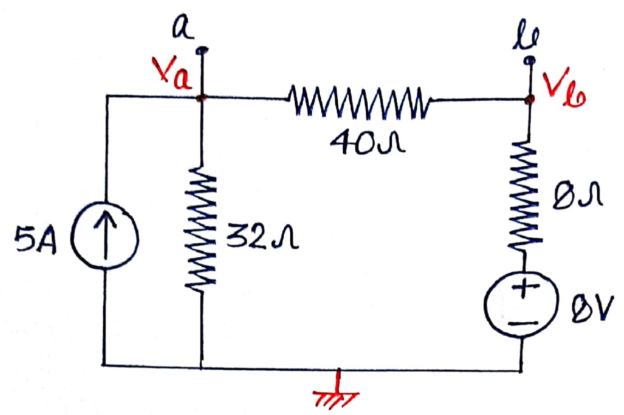
[3 POINT]

SOL(5):

(b)

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

Step(I): Calculation of Theverin voltage (V_{th})



KCL at node-a, we get-

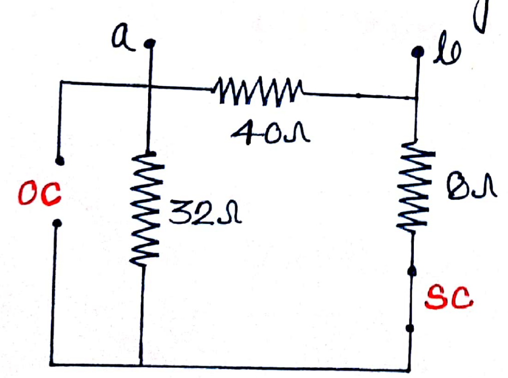
$$5 = \frac{V_a}{32} + \frac{V_a - V_b}{40}$$

KCL at node-b, we get-

$$\frac{V_b - V_a}{40} + \frac{V_b - 8}{8} = 0$$

$\therefore V_{th} = V_a - V_b = 99.2 - 23.2 = 76$ Volt [2 POINT]

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



$\therefore R_{th} = R_{ab} = 40 \parallel (32+8) = 40 \parallel 40 = 20\Omega$ [2 POINT]

Q. (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.

$\therefore R = R_{th} = 20\Omega$ [1 POINT]

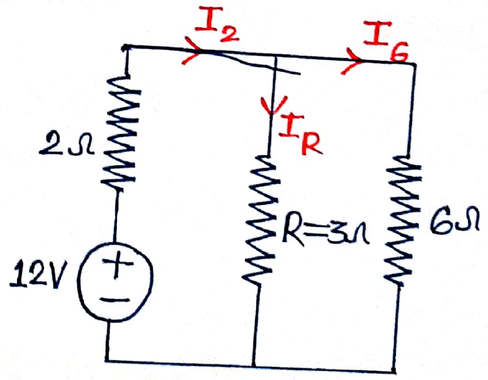
(C) By maximum power transfer theorem,

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

$\therefore P_{max} = \frac{V_{th}^2}{4R} = \frac{76^2}{4\times 20} = 72.2$ Watt [1 POINT]

SOL(6):

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



R_{eq} (across 12 V) $= 2 + \frac{3\times 6}{3+6}$

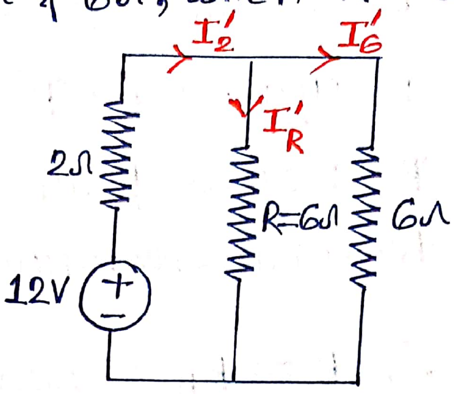
$= 4\Omega$

$\therefore I_2 = \frac{12}{4} = 3A$

$\therefore I_6 = 3\times\left(\frac{3}{3+6}\right) = 1\ A$

[2X1 POINT]

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



$$R_{eq}\text{(across 12V)} = 2 + \frac{6\times6}{6+6}$$
$$= 5\Omega$$

$$\therefore I_2' = \frac{12}{5} = 2.4\,A$$

$$\therefore I_6' = 2.4\times\left(\frac{6}{6+6}\right) = 1.2\,A$$

[2X1 POINT]

Step(III):

$\therefore$ Difference of value of current in 2Ω $= |I_2 - I_2'|$
$$= |3-2.4|$$
$$= 0.6\,A$$

[1 POINT]

$\therefore$ Difference of value of current in 6Ω $= |I_6 - I_6'|$
$$= |1-1.2|$$
$$= 0.2\,A$$

[1 POINT]

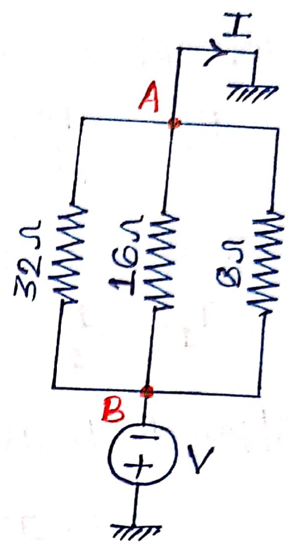
Ans(7):

From Figure-7,

Equivalent resistance across A & B,

$$R'_{eq} = \frac{1}{\left(\frac{1}{32}+\frac{1}{16}+\frac{1}{8}\right)} = \frac{32}{7}\,\Omega$$

[2 POINT]

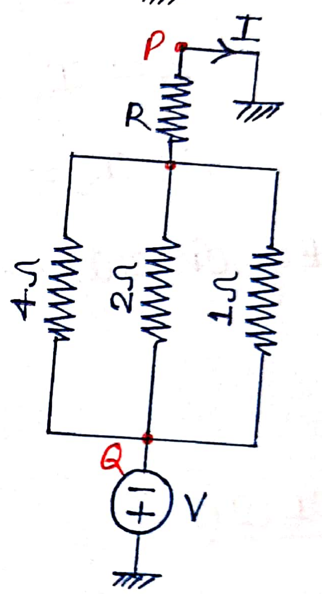


From Figure-8,

Equivalent resistance across P & Q,

$$R''_{eq} = \frac{1}{\left(\frac{1}{4}+\frac{1}{2}+\frac{1}{1}\right)} = \frac{4}{7}\,\Omega$$

[2 POINT]



The value of current 'I' remain same (Given), Hence—

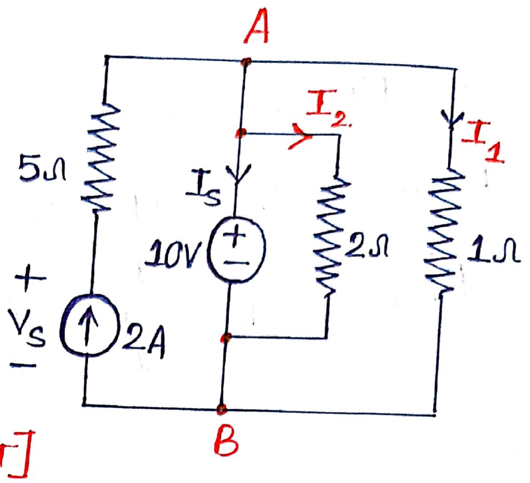
$$R'_{eq} = R''_{eq} + R$$

$$\frac{32}{7} = \frac{4}{7} + R$$

$$\therefore R = \frac{28}{7} = 4\,\Omega$$

[2 POINT]

SOL(8):



Current across 2Ω resistance,

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

Current across 1Ω resistance,

$$\therefore I_1 = \frac{10}{1} = 10\,A$$

[2 POINT]

Apply KCL at node-A,

$$2 = I_s + I_2 + I_1$$

$$2 = I_s + 5 + 10$$

$$\therefore I_s = -13\,A$$

[2 POINT]

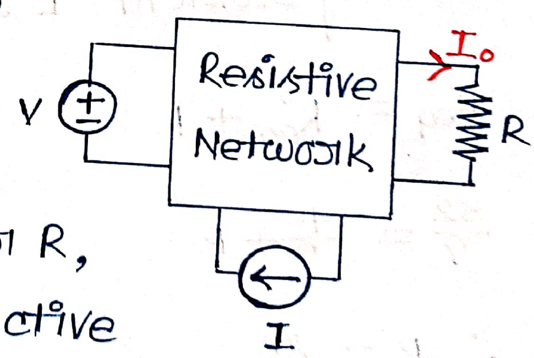
By circuit— $-V_s + 2 \times 5 + 10 = 0$

$$\therefore V_s = 20 \text{ Volt}$$

[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

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

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

[2 POINT]

$P_o = (\sqrt{4} + \sqrt{9})^2 = (2+3)^2 = 25\ W$

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

$\therefore$ Power dissipated by resistor R, when both sources are active— $P_o = 25\ W, 1\ W$ [4 POINT]