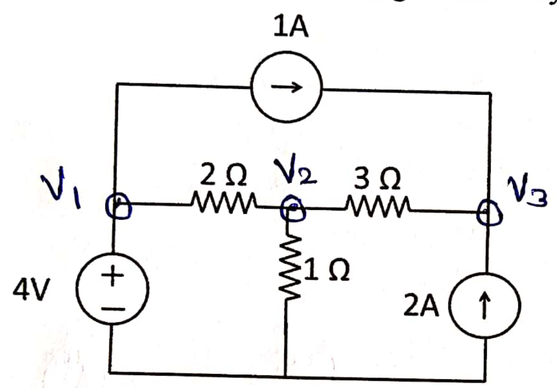
K. J. Somaiya College of Engineering, Mumbai-77
(Autonomous College Affiliated to University of Mumbai)
Semester: Jan – April 2020
Test -1

Solution

Max. Marks: 40 **Duration: 1hr.30 min**
Class: FY B.Tech **Semester:** I
Branch: ETRX/EXTC/MECH-DIV-J
Name of the Course: Elements of Electrical and Electronics Engineering

Ques. No.		Mark
Q. 1	**Solve Any two of the following**	
	(a) Find the current in 1 Ω resistor using nodal analysis.	



⇒ Using Nodal Analysis

$V_1 = 4V$ —— ① .... (2)

KCL at node ②

$$\frac{V_2 - V_1}{2} + \frac{V_2}{1} + \frac{V_2 - V_3}{3} = 0$$

$$-3V_1 + 11V_2 - 2V_3 = 0$$

$$11V_2 - 2V_3 = 12 \text{ ---- (A)}$$ ---- (3)

KCL at node ③

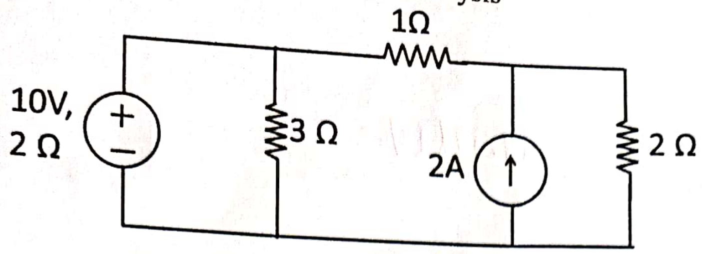
$$\frac{V_3 - V_2}{3} = 2 + 1$$

$$-V_2 + V_3 = 9 \text{ ---- (B)}$$ ---- (3)

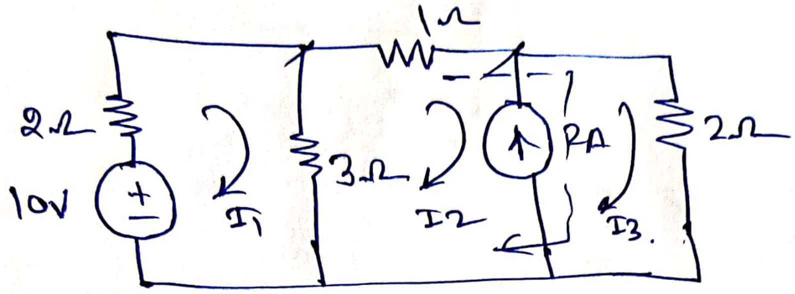
Solving (A) & (B) $V_2 = \frac{30}{9} = 3.33V$

$$\boxed{I_{1\Omega} = \frac{V2}{1} = \frac{3.33}{1} = 3.33A}$$ — (2)

(b) Find current in 2 Ω resistor using mesh analysis



⇒



⇒ KVL to mesh (I)

$$10 - 2I_1 - 3(I_1 - I_2) = 0$$

$$5I_1 - 3I_2 = 10 \;\text{---}\; (i) \qquad \text{--} (2)$$

2A current source on common branch of mesh (I) + (II) so super mesh.

$$I_2 + 2 = I_3 \;\text{--}$$

$$I_2 - I_3 = -2 \;\text{--}\; (ii) \quad (2)$$

KVL to supermesh

$$-3(I_2 - I_1) - I_2 - 2I_3 = 0$$

$$-3I_2 + 3I_1 - I_2 - 2I_3 = 0$$

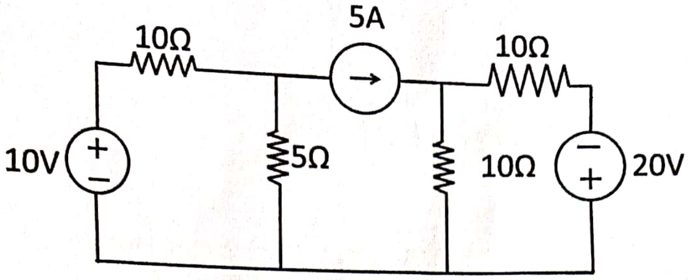
$$\cancel{2I_1 - 3I_2}$$

$$+3I_1 - 4I_2 - 2I_3 = 0 \;\text{---}\; (iii) \quad \text{--} (3)$$

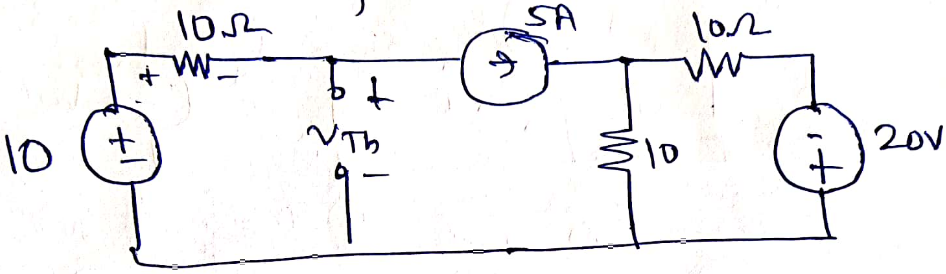
Solving (i) (ii) & (iii) $I_1 = \frac{16}{7}$, $I_2 = \frac{10}{7}$

$$\boxed{I_3 = 2.476A} \;\text{----}\; (3)$$

(c) Find voltage across 5 Ω resistor using Thevenin's theorem.



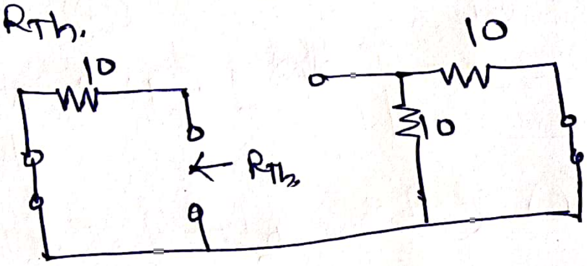
⇒ Remove load & find V_{Th}.



$V_{10\Omega} = 10 \times 5 = 50V$ ---- (4)

$V_{Th} = -50 + 10 = -40V.$

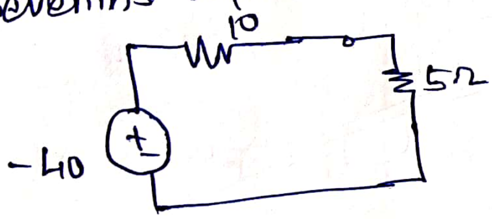
⇒ To find R_{Th}.



---- (3)

$\underline{\underline{R_{Th} = 10\Omega}}$

⇒ Thevenin's Equivalent Circuit.



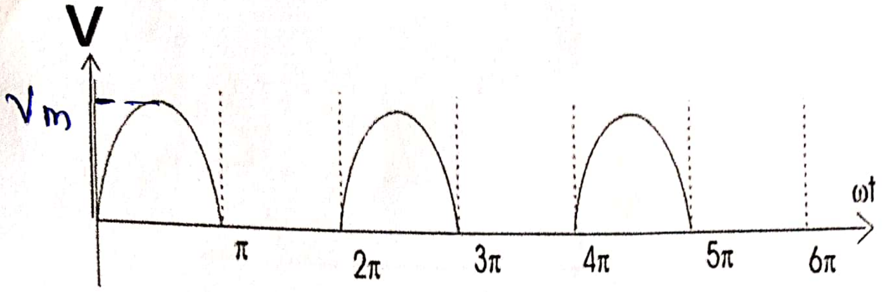
$V_{5\Omega} = \dfrac{-40 \times 5}{15}$

$V_{5\Omega} = \dfrac{-40}{3}.$

---- (3)

$\boxed{V_{5\Omega} = -13.33V}$

Q. 2 (a) Find RMS value of the following waveform.



$$\Rightarrow V_{rms} = \left[\frac{1}{2\pi}\int_0^{\pi} (V_m \sin\omega t)^2 \, d\omega t\right]^{1/2} \quad \text{---- (2)}$$

$$= \left[\frac{1}{2\pi}\int_0^{\pi} V_m^2 \sin^2\omega t \, d\omega t\right]^{1/2}$$

$$= \left[\frac{1}{2\pi} V_m^2 \int_0^{\pi} \left(\frac{1-\cos 2\omega t}{2}\right) d\omega t\right]^{1/2}$$

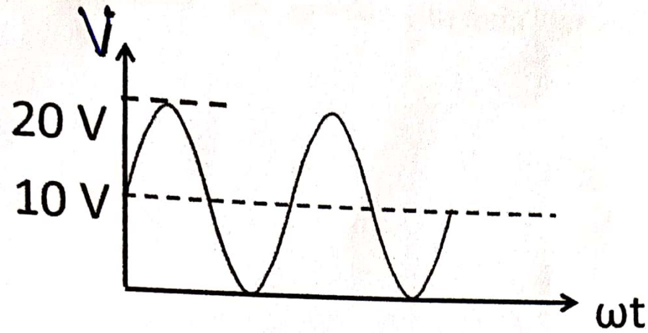
$$= \left[\frac{V_m^2}{2\pi}\cdot\frac{1}{2}\left[\omega t - \frac{\sin 2\omega t}{2}\right]_0^{\pi}\right]^{1/2}$$

$$= \left[\frac{V_m^2}{4\pi}\left[\pi - \frac{\sin 2\pi}{2} - 0 + \sin 0\right]\right]^{1/2}$$

$$= \left[\frac{V_m^2}{4\cancel{\pi}}(\cancel{\pi})\right]^{1/2}$$

$$\boxed{V_{rms} = \left[\frac{V_m}{2}\right]} \quad \text{---- (4)}$$

Find average value of the following waveform.



$v = 10 + 10\sin\omega t$ ---------- (2)

$$V_{av} = \frac{1}{2\pi}\int_0^{2\pi}(10 + 10\sin\omega t)\,d\omega t$$

$$= \frac{1}{2\pi}\left[10\omega t - 10\cos\omega t\right]_0^{2\pi}$$

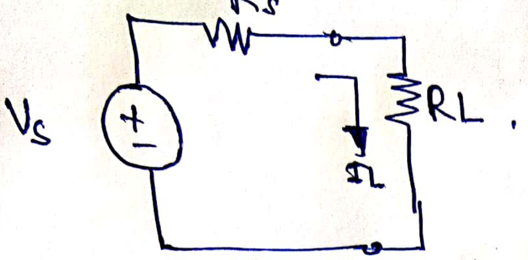
$$= \frac{1}{2\pi}\left[10\times 2\pi - 10\cos 2\pi - 0 + 10\cos 0\right]$$

$$= \frac{1}{2\pi}\left[2\pi\times 10 - 1 + 1\right]$$

$\boxed{V_{av} = 10V.}$ ---------- (4)

Q. 3 **Solve any two of the following** 10

(a) State and prove maximum power transfer theorem.



statement —— (1)

—— (1)

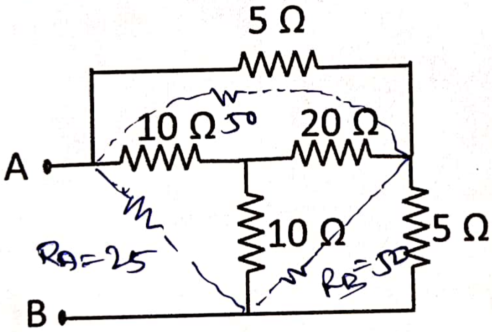
$I_L = \frac{V_s}{(R_s+R_L)}$ $\quad P = I_L^2 \cdot R_L = \left(\frac{V_s^2}{(R_s+R_L)^2}\right)\cdot R_L$ —— (1)

$\frac{dp}{dR_L} = 0$ $\quad \frac{dp}{dR_L} = \frac{d}{dR_L}\frac{V_s^2 R_L}{(R_s+R_L)^2}$ solving —— (1)

$\boxed{R_S = R_L}$ —— (1)

$P_{max} = \frac{V_s^2}{4R_L}$.

(b) Find resistance between terminals A and B.



$\Sigma R = 10\times20+20\times10+10\times10$

$\Sigma R = 200+200+100,$

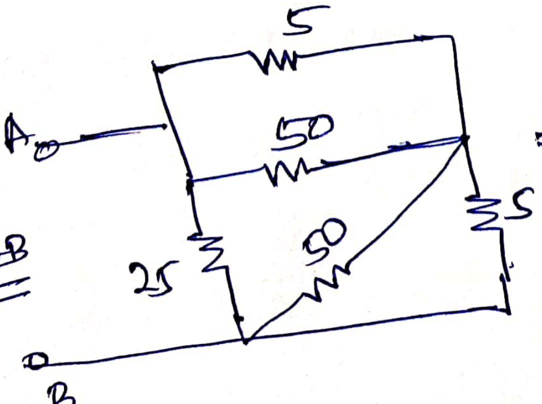
$\Sigma R = 500$

$R_B = \frac{500}{10} = 50\Omega$ —— (2)

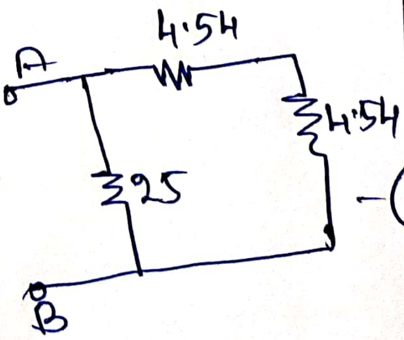
$R_A = \frac{500}{20} = 25$

$R_C = \frac{500}{10} = 50\Omega$

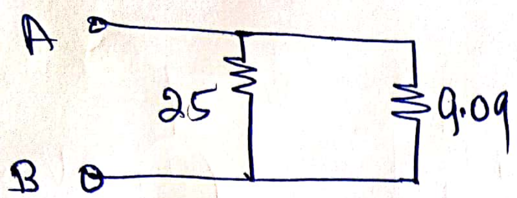
$\underline{\underline{R_{AB}}}$



$\Rightarrow$

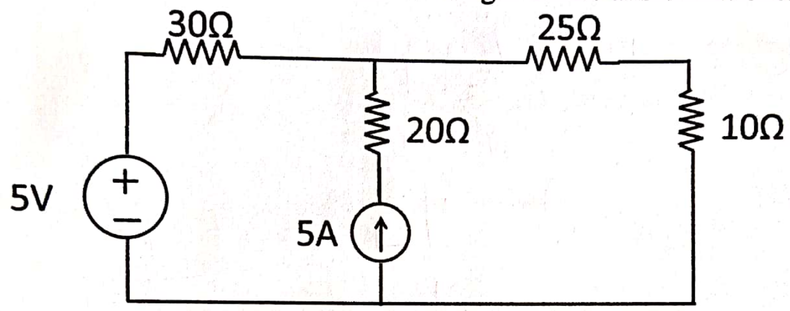


—— (2)

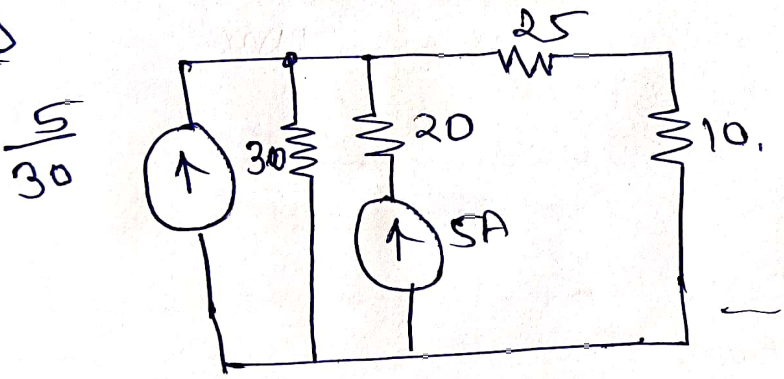


$\boxed{R_{AB} = 6.66\,\Omega}$ (1)

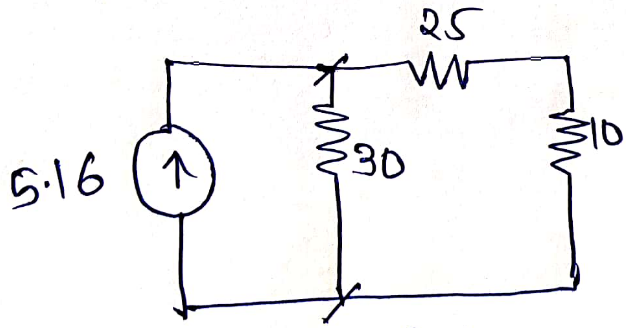
(c) Find the current in 10 Ω resistor using source transformations.



$\Rightarrow$



(2)



(2)

Using Current Division Rule

$$I_{10\Omega} = \frac{5.16 \times 30}{30 + 25 + 10} = \frac{155}{65}$$

$\boxed{I_{10\Omega} = 2.384\,A}$ (1)