ST. FRANCIS INSTIYUTE OF TECHNOLOGY

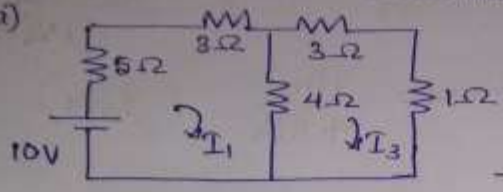
BASIC SCIENCE & HUMANITIES DEPARTMENT

BASIC ELECTRICAL ENGINEERING

IAT 1 SOLUTION

B.E.E IATI 2018
SOLUTION & MARKING SCHEME

1 a)



$-3I_1 - 4(I_1 - I_2) + 10 - 5I_1 = 0$

$-12I_1 + 4I_2 = -10$ ——— (1) (1M)

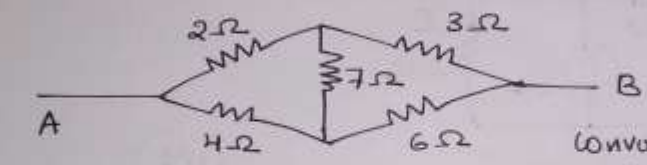
$-3I_2 - I_2 - 4(I_2 - I_1) = 0$

$4I_1 - 8I_2 = 0$ ——— (2) (1M)

$I_1 = 1A \quad I_2 = 0.5A$

$I_{1\Omega} = 0.5A$

1b)

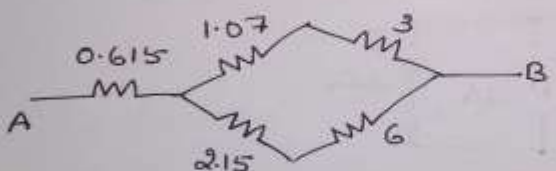


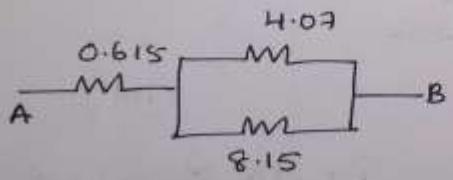
converting 2Ω, 4Ω, 7Ω delta to star

$R_1 = \frac{4 \times 2}{4+2+7} = 0.615\Omega$

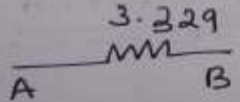
$R_2 = \frac{7 \times 2}{4+2+7} = 1.07\Omega$

$R_3 = \frac{4 \times 7}{4+2+7} = 2.15\Omega$ (1M)





(1M)



$R_{AB} = 3.329\Omega$

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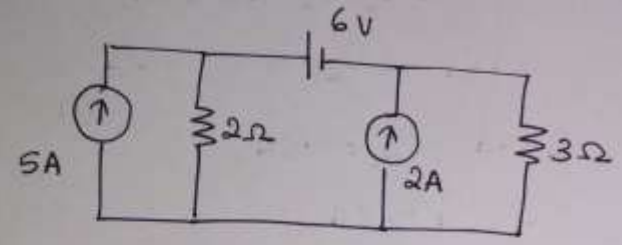
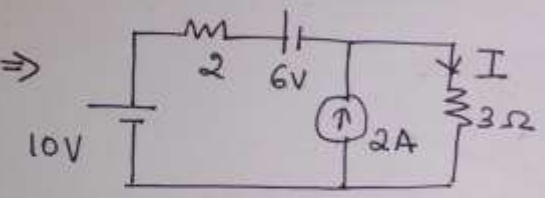
c.) Complete derivation and proof for $R_L = R_{th}$ (1½M)

Pmax equation $P_{max} = \frac{V_{th}^2}{4R_{th}}$ (½M)

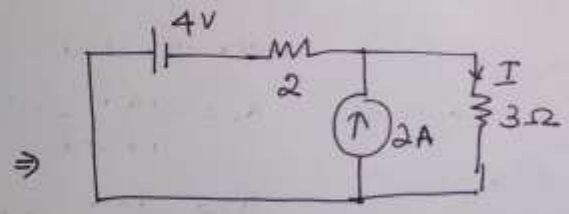
d)



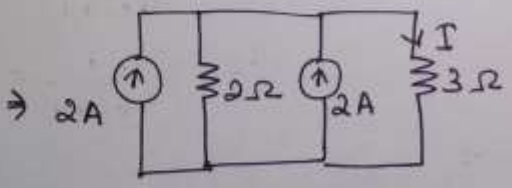
⇒



(1M)

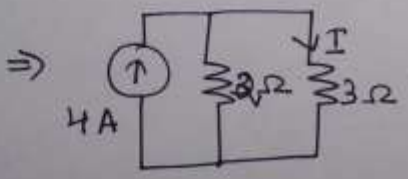


⇒



(1M)

⇒



$I = 4 \times \frac{2}{2+3} = 1.6A$

e) given $i(t) = 141.4 \sin(314t)$

general equation $i(t) = I_m \sin \omega t$

On comparing; 1. peak value $\underline{I_m = 141.4\ A}$ (½M)

2. $\omega t = 314t$

$2\pi f = 314 \Rightarrow f = \frac{314}{2\pi} = 49.99\ Hz$ (½M)

3. Time period $T = \frac{1}{f} = \frac{1}{50} = 0.02\ sec$ (½M)

4. $i_{(t=3msec)} = 141.4 \sin(314 \times 3 \times 10^{-3})$

$\underline{i = 114.35\ A}$ (½M).

f). $V = V_m \sin\theta \quad 0 < \theta < \pi$

$V = 0 \quad \pi < \theta < 2\pi$

$$V_{avg} = \frac{1}{2\pi}\left[\int_0^{2\pi} V\, d\theta\right]$$

$$= \frac{1}{2\pi}\left\{\int_0^{\pi} V_m \sin\theta\, d\theta + \int_{\pi}^{2\pi} 0\, d\theta\right\}$$

$$= \frac{V_m}{2\pi}\int_0^{\pi} \sin\theta\, d\theta$$

$$= \frac{V_m}{2\pi}\left[-\cos\theta\right]_0^{\pi}$$

$$= \frac{V_m}{2\pi}\left[-(-1-1)\right] = \frac{V_m}{2\pi} \times 2$$

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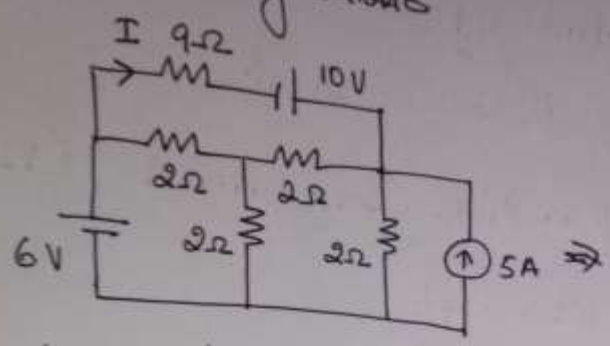
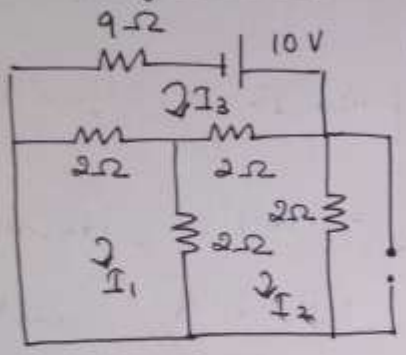
acting alone



(1½M)

10V acting alone



mesh ① ⇒ $4I_1 - 2I_2 - 2I_3 = 0$ — ①

mesh ② ⇒ $6I_2 - 2I_1 - 2I_3 = 0$ — ②

mesh ③ ⇒ $-2I_1 - 2I_2 - 13I_3 = 10$ — ③

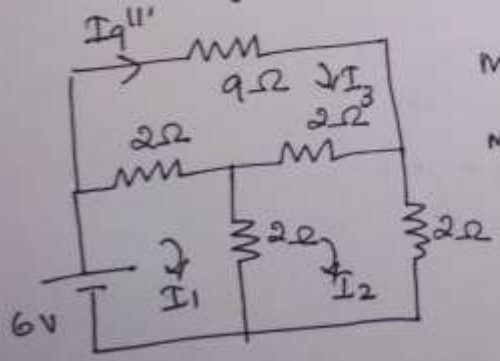
$I_1 = 0.784\,A$

$I_2 = 0.588\,A$

$I_3 = 0.980\,A$

$I_9' = I_3 = 0.98\,A (\rightarrow)$

6V acting alone



mesh ① $4I_1 - 2I_2 - 2I_3 = 6$ — ①

mesh ② $-2I_1 + 6I_2 - 2I_3 = 0$ — ②

mesh ③ $13I - 2I_1 - 2I_2 + 13I_3 = 0$ — ③

$I_1 = 2.176\,A$

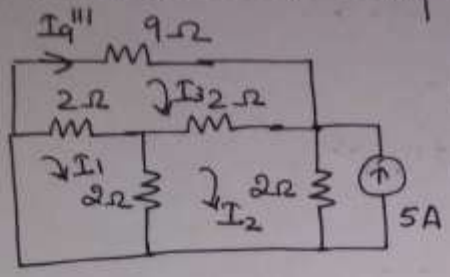
$I_2 = 0.882\,A$

$I_3 = 0.470\,A$

(1½ M)

$I_9'' = 0.470\,A (\rightarrow)$

5A current source acting alone.



mesh ① $4I_1 - 2I_2 - 2I_3 = 0$ — ①

mesh ② $-2I_1 + 6I_2 - 2I_3 = -10$ — ②

mesh ③ $-2I_1 - 2I_2 + 13I_3 = 0$ — ③

$I_1 = -1.470A$

$I_2 = -2.352A$

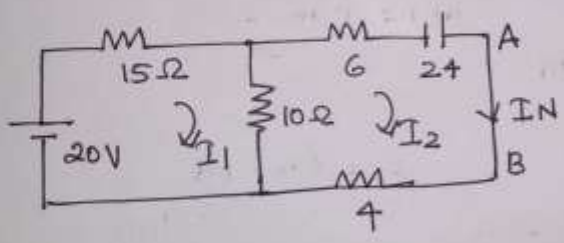
$I_3 = -0.588A$

$I_q''' = 0.588A (\leftarrow)$

$\therefore I_q = I_q' + I_q'' + I_q''' = 0.980 + .470 - 0.588$

$I_q = 0.862A (\rightarrow)$ (2M)

2b) Calculation of I_N.



mesh ①

$-25I_1 + 10I_2 = -20$ — ①

mesh ②

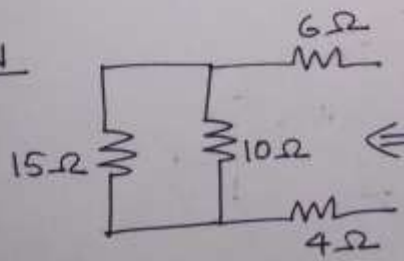
$10I_1 - 20I_2 = -24$ — ②

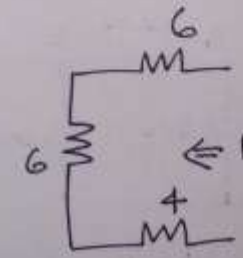
$I_1 = 1.6A$

$I_2 = 2A$ (2M)

$\therefore I_N = 2A$

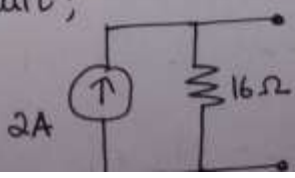
RN





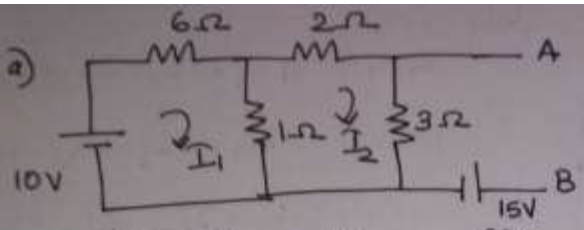
$R_N = 16\Omega$ (2M)

Norton's equivalent circuit;



(1M)

3 a)



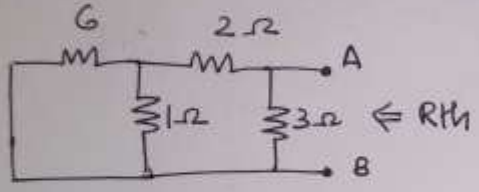
$-7I_1 + I_2 = -10$ —— ①

$I_1 - 6I_2 = 0$ —— ②

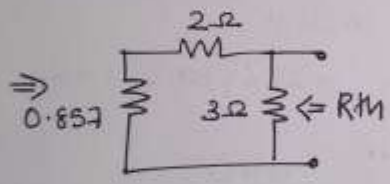
$I_1 = 1.463A$ (2M)

$I_2 = 0.2439A$

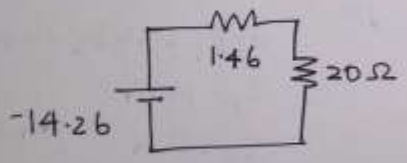
$V_{th} = -15 + 3I_2 = -14.26V$



(2M)

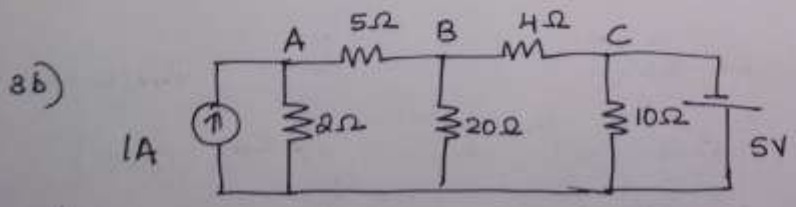


$R_{th} = 1.46\Omega$



$I_L = 0.664A$ (1M)

3 b)



Node A $\quad \frac{V_A}{2} + \frac{V_A - V_B}{5} - 1 = 0$ (1½M)

$V_A\left(\frac{1}{2} + \frac{1}{5}\right) - \frac{V_B}{5} = 1$

$0.7V_A - 0.2V_B = 1$ —— ①

node B $\frac{V_B}{20} + \frac{V_B - V_C}{4} + \frac{V_B - V_A}{5} = 0$ (1½M)

node C
$V_C = -5V$ (1M)

$-0.2V_A + \left(\frac{1}{20} + \frac{1}{4} + \frac{1}{5}\right)V_B + \frac{5}{4} = 0.$

$-0.2V_A + 0.5V_B = -1.25$ —— ②

$V_A = 0.806V$

$V_B = -2.177V$ (1M)

$V_C = -5V$