End Semester Examination (R-24) SH 2025

Branch : All
Course : BEEE

Year | Semester : FE | I
Course code : FEC 103

Marks : 60

Time : 2 Hrs.

Solution | Marking scheme for QP. 4

Q.1 a) Losses in Transformer

Types - 2 Marks

Definition | Explanation - 3 Marks

b) Application of BJT as an amplifier

Diagram - 2 Marks

Explanation - 3 Marks

c) Three phase induction motors are of self starting type.

Figure - 2 Marks

Explanation | Justification - 3 Marks

d) Sol^n :-

i) $i = I_m \sin \omega t = 10 \sin 2\pi \times 50 t = 10 \sin 314 t$. (1M)

ii) Value of current after $\frac{1}{360}$ second,

$$i = 10 \sin 314 t$$

$$= 10 \sin 314 \left(\frac{1}{360}\right)$$

$$= 10 \sin \left(0.873 \times \frac{180^\circ}{\pi}\right)$$

$$= 10 \sin 50^\circ$$

$$i = 7.67\ A \quad (2\ M)$$

iii) Time taken to reach 9.6 A for the first time

$$i = I_m \sin 314 t$$

$$7.67 = 10 \sin 314 t$$

$$\sin 314 t = 0.767$$

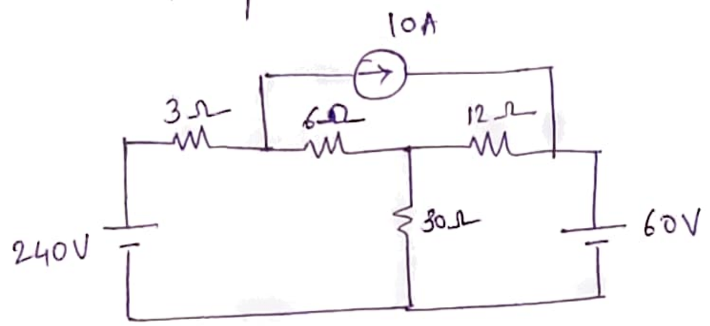
$$\sin\left(314t \times \frac{180}{\pi}\right)^\circ = 0.767$$

$$314t \times \frac{180}{\pi} = \sin^{-1} 0.767$$

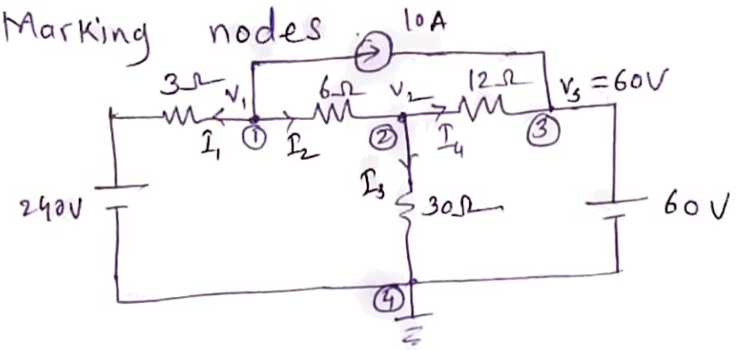
$$= 50.08$$

$$\boxed{t = 2.78\ ms} \quad (2M)$$

Q. 2 A) Find current through 6 Ω resistance using Nodal Analysis.



Marking nodes



(2 M)

KCL at node 1,

$$I_1 + I_2 + 10 = 0$$

$$\frac{V_1 - 240}{3} + \frac{V_1 - V_2}{6} + 10 = 0$$

$$3V_1 - V_2 = 420 \quad — ①$$

(2 M)

KCL at node 2,

$$I_2 = I_3 + I_4$$

$$\frac{V_1 - V_2}{6} = \frac{V_2 - 0}{30} + \frac{V_2 - 60}{12}$$

$$60V_1 - 102V_2 = -1800 \quad — ②$$

(2 M)

solving eqn ① & ②

$V_1 = 181.46$ V

$V_2 = 124.39$ V

(2 M)

$$\therefore \quad I_{6\Omega} = \frac{V_1 - V_2}{6} = \frac{181.46 - 124.39}{6} = 9.51 \text{ A.}$$

(2 M)

Q. 2 B) solution :-

a) Star connection :

Let impedance of each coil is Z_{ph},

Resistance of each coil, $R_{ph} = 20\Omega$

Inductance of each coil ; $L = 0.5H$

Reactance of each coil, $X_L = 2\pi f L = 2\pi \times 50 \times 0.5$

$= 157\ \Omega$ (1M)

Rectangular form of Z_{ph}, $\bar{Z}_{ph} = (20 + j157)\ \Omega$ (1M)

Polar form of Z_{ph}, $\bar{Z}_{ph} = (158.27 \angle 82.74)\ \Omega$

$\therefore Z_{ph} = 158.27\ \Omega$ & $\phi = 82.74°$ (1M)

Phase voltage, $V_{ph} = \frac{V_L}{\sqrt{3}} = \frac{400}{\sqrt{3}} = 230.94\ V$ (1M)

Phase current, $I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{230.94}{158.27} = 1.46\ A$ (1M)

$I_L = I_{ph}$

$\therefore I_L = 1.46\ A$. (1M)

Total power absorbed, $P = \sqrt{3}\ V_L \times I_L \cos\phi$

$= \sqrt{3} \times 400 \times 1.46 \times \cos 82.74°$

$= 127.83\ W$. (1M)

b) Delta connection :

$\bar{Z}_{ph} = (158.27 \angle 82.74)\ \Omega$

$V_L = V_{ph} = 400\ V$

$I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{400}{158.27} = 2.53\ A$. (1M)

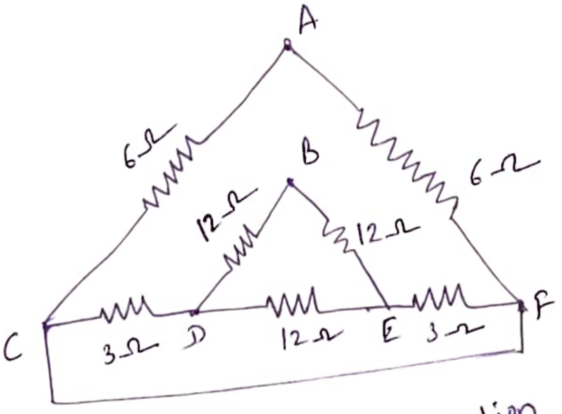
$I_L = \sqrt{3}\ I_{ph} = \sqrt{3} \times 2.53 = 4.38\ A$. (1M)

Total power absorbed, $P = \sqrt{3}\, V_L I_L \cos\phi$

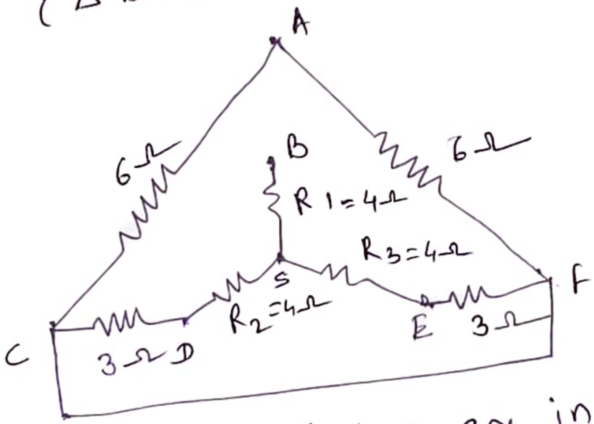
$= \sqrt{3} \times 400 \times 4.38 \times \cos 82.74^\circ$

$P = 383.48$ W (1m)

Q. 2 c)



Soln:- Converting delta connection formed by three 12 Ω resistors (Δ BDE) into eqt star connection.



$R_1 = R_2 = R_3 = \dfrac{12 \times 12}{12+12+12}$

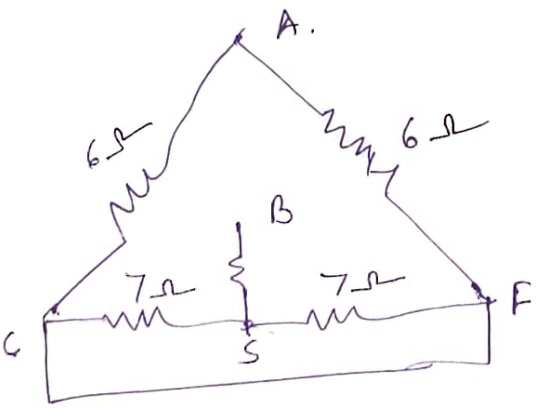
$= 4\,\Omega$.

(2m)

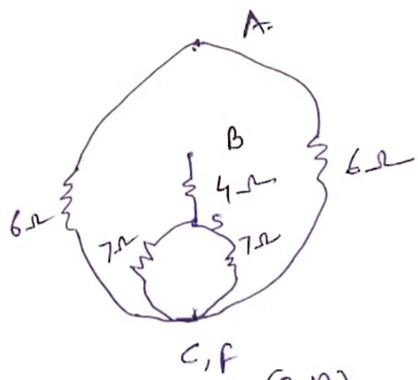
In branch CDS, 3 & 4 Ω are in series. Also in branch SEF, 4 & 3 Ω are in series.

Nodes C & F are same.

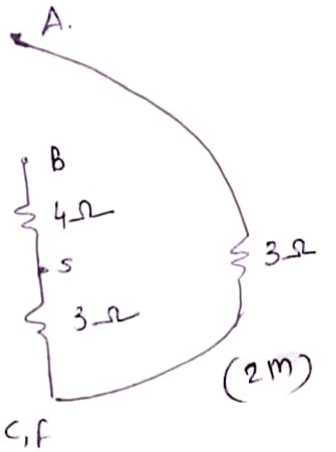
∴ Joining them.



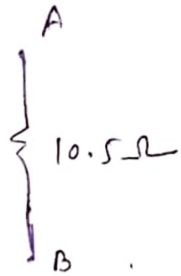
(2m)



(2m)



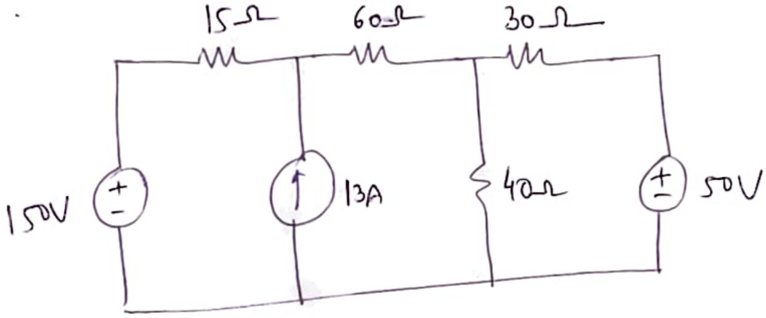
(2m)



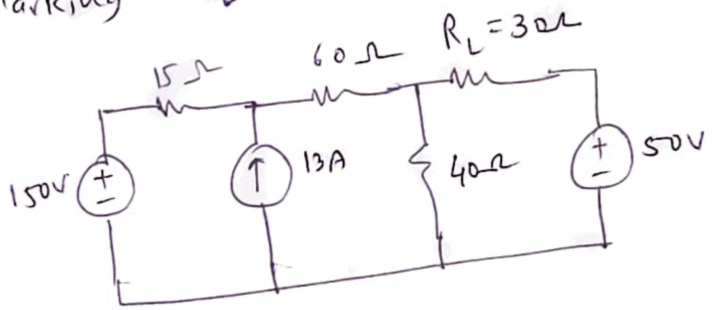
(2 m)

$\therefore \; R_{eq} = R_{AB} = 10.5\,\Omega$

Q.2 D).

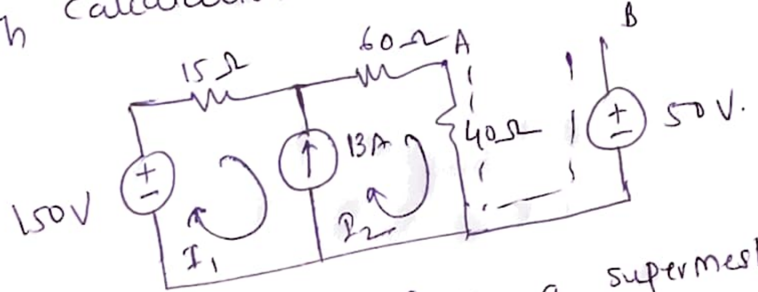


Marking R_L



(1m)

V_{Th} calculation:-



(2m)

Mesh 1 & 2 forms a supermesh

$I_2 - I_1 = 13 \quad -(1)$

$-15 I_1 - 60 I_2 - 40 I_2 + 150 = 0$

$-15 I_1 - 100 I_2 = -150 \quad -(2)$

(2m)

solving eq^n (i) & (ii)

$I_2 = 3A$

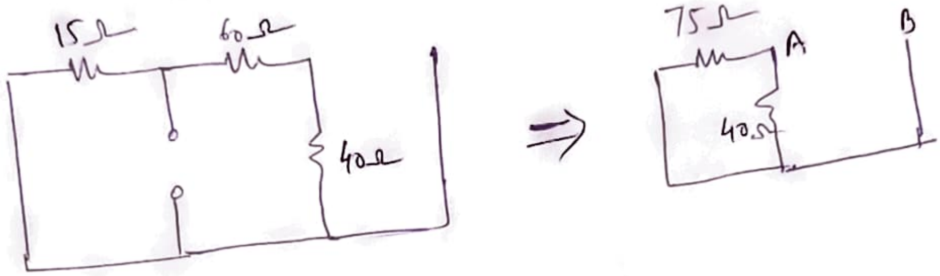
$\therefore V_{Th} = V_{AB}$

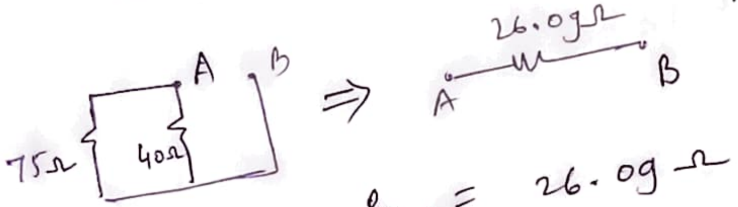
$= -50 + 40 I_2$

$= -50 + 40 \times 3$

$= 70V.$ (1M)

2) R_{Th} calculation:





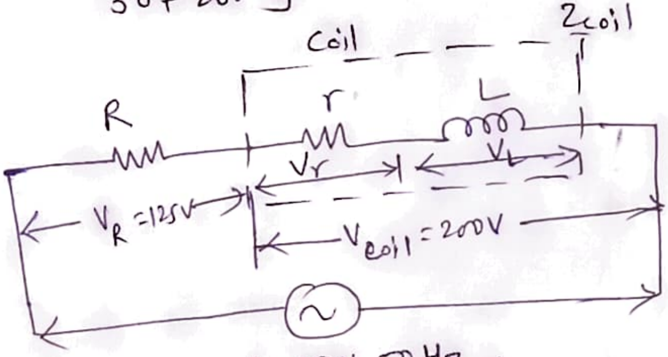
$R_{AB} = 26.09\,\Omega$ (2M)

$\therefore R_{Th} =$

3) $I_L = \dfrac{V_{Th}}{R_L + R_{Th}}$

$I_L = I_{30\Omega} = \dfrac{70}{30 + 26.09} = \underline{1.248\,A\ (\rightarrow)}$ (2M)

Q.2 E)



$V = 250V, 50Hz.$

i) Resistance $R = \dfrac{V_R}{I} = \dfrac{125}{5} = 25\,\Omega$ (1M)

Impedance of the coil, $Z_{coil} = \dfrac{V_{coil}}{I} = \dfrac{200}{5} = 40\Omega$ (1M)

Total impedance of the circuit, $Z = \dfrac{V}{I} = \dfrac{250}{5} = 50\Omega$ (1M)

$$Z_{coil} = \sqrt{r^2 + X_L^2}$$

$$Z_{coil}^2 = r^2 + X_L^2$$

$$(40)^2 = r^2 + X_L^2 \quad - (1)$$

Also, $$Z = \sqrt{(R+r)^2 + X_L^2}$$

$$Z^2 = (R+r)^2 + X_L^2$$

$$(50)^2 = (25+r)^2 + X_L^2 \quad - (2)$$

(2 m)

from eq^n (1) & (2)

$$r = 5.5\ \Omega$$

(1 m)

$$X_L = 39.62\ \Omega$$

ii) Power absorbed $P_{coil} = I^2 r = (5)^2 \times 5.5 = 137.5\ W$

(1 M)

iii) $(Pf)_{coil} = \dfrac{r}{Z_{coil}} = \dfrac{5.5}{40} = 0.137$ lagging.

(1 m)

iv) Phasor diagram,

Take 'I' as reference phasor,

eq^n $\bar{V} = \bar{V}_R + \bar{V}_{coil}$

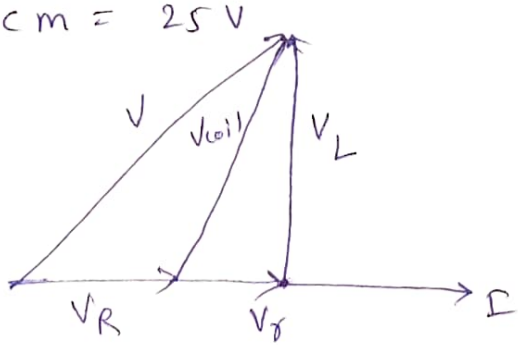
$$\bar{V} = \bar{V}_R + \bar{V}_r + \bar{V}_L$$

$$V_R = 125\ V$$

$$V_r = I \times r = 27.5\ V.$$

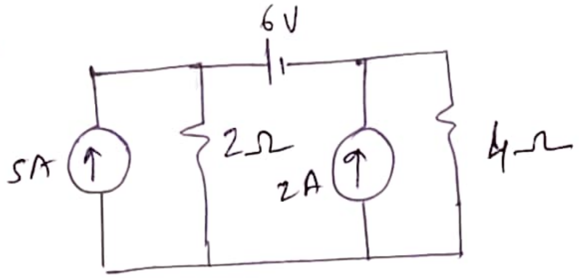
$$V_L = I X_L = 198.1\ V.$$

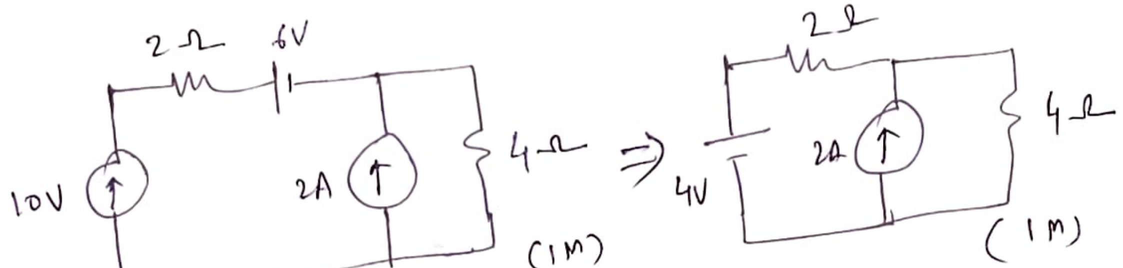
Scale 1 cm = 25 V

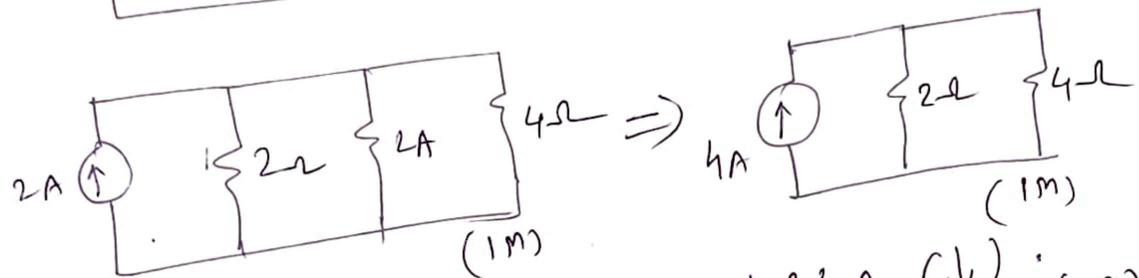


(2 M)

Q. 3 A)







$$I_{4\Omega} = 4 \times \frac{2}{2+4} = 1.33\ A\ (\downarrow) \quad (1M)$$

Q. 3 B) Zener diode as voltage regulator

figure — 2 Marks

Explanation — 3 Marks

c) core Type & shell Type Transformer comparison.

5 valid pts — 5 M

(figures compulsory)

D) $V_1 = 25 \sin \omega t$

$V_2 = 10 \sin(\omega t + \pi/6)$

$V_3 = 30 \cos \omega t \Rightarrow 30 \sin(\omega t + \pi/2)$

$V_4 = 20 \sin(\omega t - \pi/4)$

(1M)

converting into polar forms,

$\bar{V}_1 = (17.68 \angle 0)\,V$

$\bar{V}_2 = (7.07 \angle 30)\,V$

$\bar{V}_3 = (21.21 \angle 90)\,V$

$\bar{V}_4 = (14.14 \angle -45)\,V$. (1M)

polar to rectangular conversion,

$\bar{V}_1 = (17.68 + j0)\,V$

$\bar{V}_2 = (6.12 + j3.54)\,V$

$\bar{V}_3 = (0 + j21.21)\,V$

$\bar{V}_4 = (10 - j10)\,V$ (1M)

$\bar{V} = \bar{V}_1 + \bar{V}_2 + \bar{V}_3 + \bar{V}_4$

$= (17.68 + j0) + (6.12 + j3.54) + (0 + j21.21) + (10 - j10)$

$= 33.8 + j14.75)\,V$ (1M)

converting into polar form,

$\bar{V} = (36.88 \angle 23.58)\,V$.

std. sinusoidal form,

$v = 52.16 \sin(\omega t + 23.58)$. (1M)