Autumn - End Semester Examination, 2022

1st semester B. Tech.

BEE (EE10002)

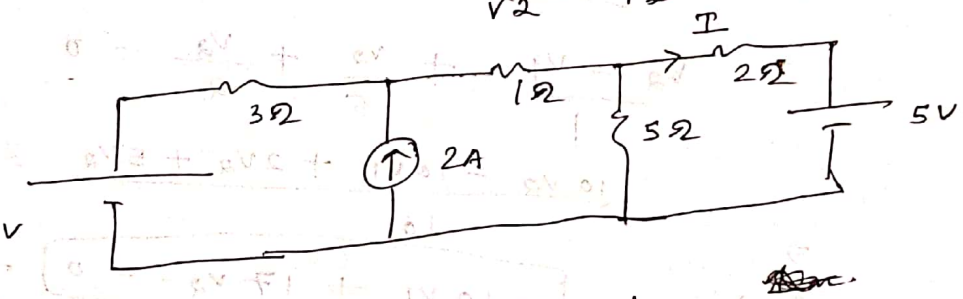
Scheme of Evaluation

1) g) Pactive = $V_{rms} I_{rms} \cos(\theta - \phi)$

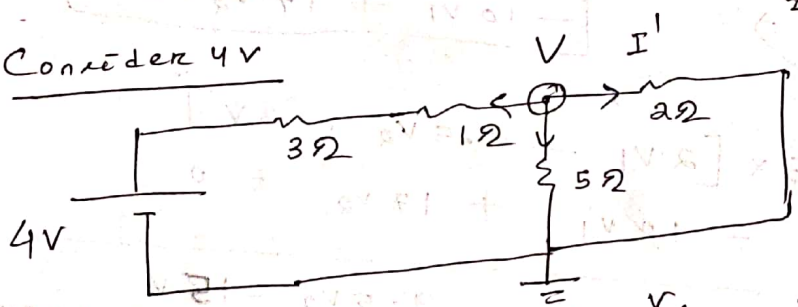
$= \frac{230}{\sqrt{2}} \times \frac{5}{\sqrt{2}} \cos\left(\frac{\pi}{4} + \frac{\pi}{4}\right)$

$= \frac{230}{\sqrt{2}} \times \frac{5}{\sqrt{2}} \cos\frac{\pi}{2} = 0$

4 (a)



Consider 4V



Applying nodal: $\frac{V-4}{4} + \frac{V}{5} + \frac{V}{2} = 0$

$5V - 20 + 4V + 10V = 0$

20

$19V = 20$

$V = \frac{20}{19}$

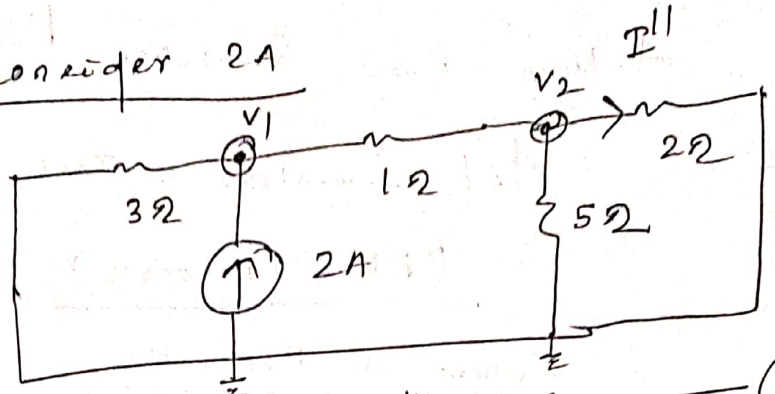
$I' = \frac{V}{2} = \frac{20}{38} = 0.526$

1 mark

4, 5, 2

2, 5, 1

Consider 2A



$$\frac{V_1}{3} - 2 + \frac{V_1 - V_2}{1} = 0 \quad \text{---(1)}$$

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

$$\Rightarrow \boxed{4V_1 - 3V_2 = 6V} \quad \text{---(2)}$$

$$\frac{V_2 - V_1}{1} + \frac{V_2}{5} + \frac{V_2}{2} = 0$$

$$\frac{10V_2 - 10V_1 + 2V_2 + 5V_2}{10} = 0$$

$$\Rightarrow \boxed{-10V_1 + 17V_2 = 0} \quad \text{---(3)}$$

$$5 \times [2V_1 - 1.5V_2 = 3V]$$

$$-10V_1 + 17V_2 = 0$$

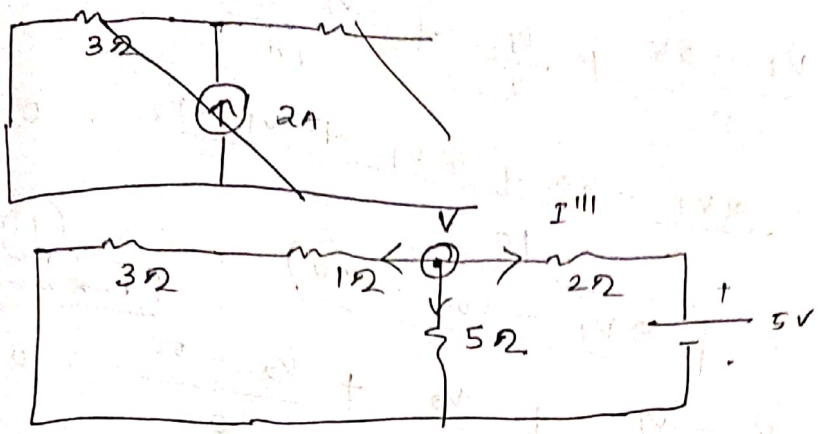
$$9.5V_2 = 15V$$

$$\boxed{V_2 = 1.578V}$$

$$I'' = \frac{V_2}{2} = \frac{1.578}{2}$$

$$\boxed{I'' = 0.789A} \quad \text{1 mark}$$

Consider 5V



$$\frac{V}{4} + \frac{V}{5} + \frac{V-5}{2} = 0$$

2 | 4, 5, 2
2, 5, 1

$$\Rightarrow \frac{5V + 4V + 10(V-5)}{20} = 0$$

$$\Rightarrow 19V - 50 = 0$$

$$\Rightarrow V = \frac{50}{19} = 2.631V$$

$$\Rightarrow I''' = \frac{V-5}{2} = -1.1845A$$

1 mark

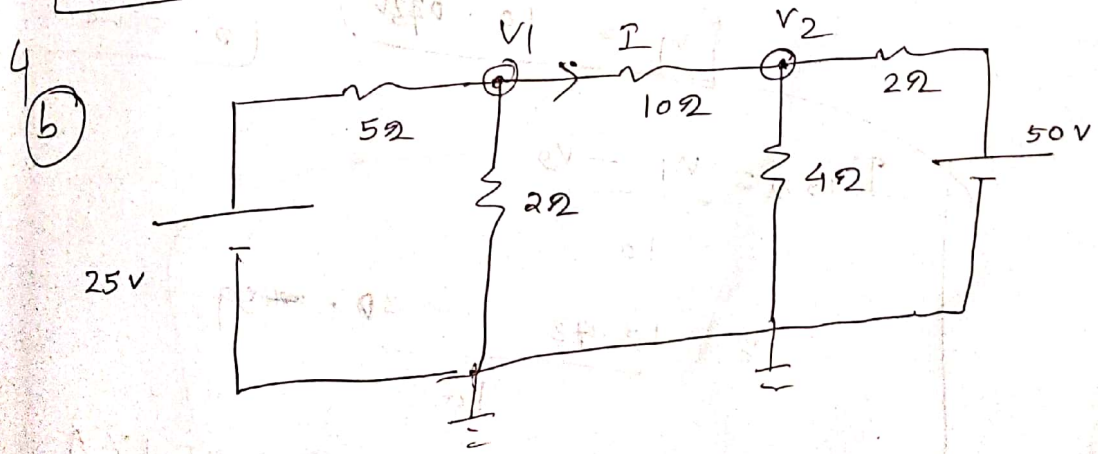
$$I = I' + I'' + I'''$$

$$= 0.526A + 0.789A - 1.1845A$$

$$I = 0.1305A$$

1 mark

4 (b)



$$\frac{V_1 - 25}{5} + \frac{V_1}{2} + \frac{V_1 - V_2}{10} = 0$$

$$\Rightarrow \frac{2V_1 - 50 + 5V_1 + V_1 - V_2}{10} = 0$$

$$\Rightarrow \boxed{8V_1 - V_2 = 50} \quad \text{---(1)}$$

1 mark

$$\frac{V_2 - V_1}{10} + \frac{V_2}{4} + \frac{V_2 - 50}{2} = 0$$

$$\Rightarrow \frac{2[V_2 - V_1] + 5V_2 + 10V_2 - 500}{20} = 0 \qquad 2\left(\frac{10,4,2}{5,2,1}\right)$$

$$\Rightarrow \boxed{-2V_1 + 17V_2 = 500}$$

1 mark

$$8V_1 - V_2 = 50$$

eqn^{n} $\times 2 \times 4$ $\left[-8V_1 + 68V_2 = 2000\right]$ $\quad \frac{17}{8}$

$$69V_2 = 2050$$

$$\boxed{V_2 = 30.59\ V}$$

0.5 mark

$$8V_1 - 30.59 = 50$$

$$\boxed{V_1 = 10.073 V}$$

0.5 mark

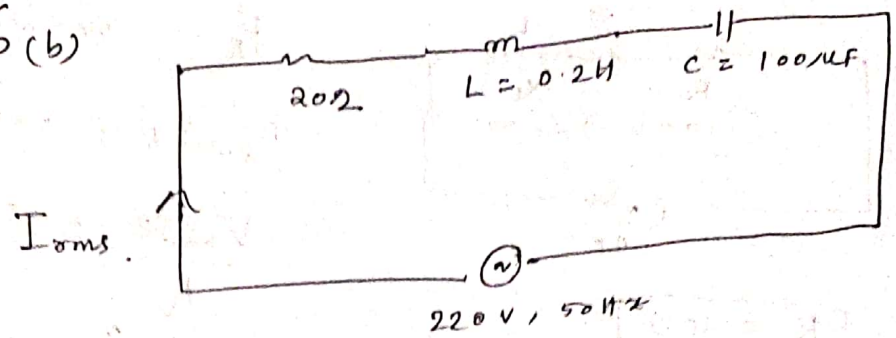
$$I_{10\Omega} = \frac{V_1 - V_2}{10}$$

$$= \frac{10.073 - 30.59}{10}$$

$$= -2.0517\ A$$

1 mark

6(b)



(i) $Z = R + j(X_L - X_C)$

$= 20 + j\left(2 \times 3.142 \times 50 \times 0.2 - \frac{1}{2\pi \times 50 \times 100 \times 10^{-6}}\right)$

$= 20 + j(62.84 - 31.82)$

$= 20 + j\,31.01$

$= 36.90 \angle 57.17^\circ$ (1 mark)

(ii) $I_{rms} = \frac{220 \angle 0^\circ}{36.90 \angle 57.17^\circ} = 5.962 \angle -57.17^\circ$ (1 mark)

(iii) $V_R = I_{rms} R = 5.962 \times 20 = 119.24\ V$

$V_L = I_{rms} X_L = 379.65\ V$

$V_C = I_{rms} X_C = 189.71\ V$ (1 mark)

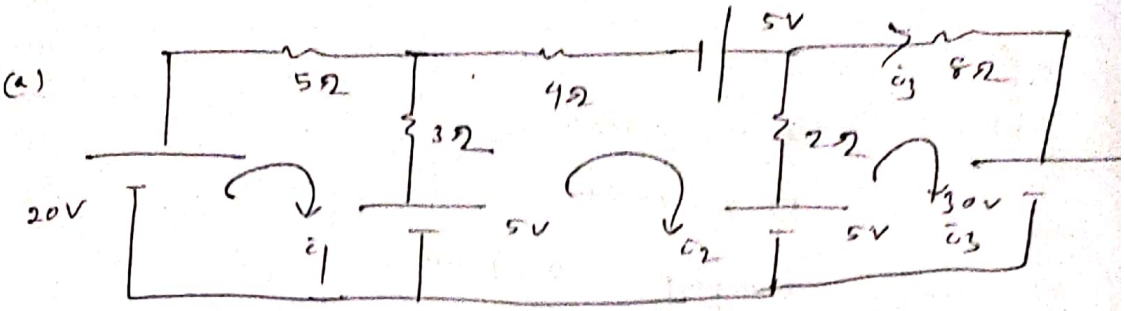
(iv) $P_{consumed} = V_{rms} I_{rms} \cos\phi$

$= 220 \times 5.962 \cos 57.17^\circ$

$= 711.100$

1 mark

7(a)



Mesh 1

$$20 - 5i_1 - 3(i_1 - i_2) - 5 = 0$$

$$20 - 8i_1 + 3i_2 - 5 = 0$$

$$15 = 8i_1 - 3i_2 \quad \text{——— (1)}$$

1 mark

Mesh 2

$$5 - 3(i_2 - i_1) - 4i_2 + 5V$$

$$- 2(i_2 - i_3) - 5 = 0$$

$$5 - 3i_2 + 3i_1 - 4i_2 + 5$$

$$- 2i_2 + 2i_3 - 5 = 0$$

$$5 + 3i_1 - 9i_2 + 2i_3 = 0$$

$$3i_1 - 9i_2 + 2i_3 = -5 \quad \text{——— (2)}$$

1 mark

Mesh 3

$$5 - 2(i_3 - i_2) - 8i_3 - 30 = 0$$

$$2i_2 - 10i_3 - 25 = 0$$

$$2i_2 - 10i_3 = 25 \quad \text{——— (3)}$$

1 mark

1 mark

$i_{3(8\Omega)} = -2.349\ A$

$i_1 = 2.157\ A$

$i_2 = 0.752\ A$

$i_3 = -2.349\ A$

7.

(b)

$a = 3\ cm^2$

$D = 25\ cm$

airgap $= 0.4\ mm$.

$N = 200$ turns

$I = 2A$

$\phi_{total} = 0.24\ mWb$.

Total mmf $= NI$

$= 200 \times 2$

$= 400\ AT$.

~~Total mmf~~ $= H = \frac{NI}{l_i} = \frac{mmf}{l_i}$,

Total mmf $= NI = H_i \times l_i + H_{ag} \times l_{ag}$

$= \left[400 = \frac{B}{\mu_0 \mu_r} \times l_i + \frac{B}{\mu_0} \times l_{ag} \right]$ — (1)

1 mark

$B = \frac{\phi}{a} = \frac{0.24 \times 10^{-3}}{3 \times 10^{-4}}$

$= \frac{0.24 \times 10}{3}$

$= \frac{2.4}{3} = 0.8\ \frac{Wb}{m^2}$ — 1 mark

$400 = \frac{0.8}{4\pi \times 10^{-7} \times \mu_r} \times \pi \times 25 \times 10^{-2}$

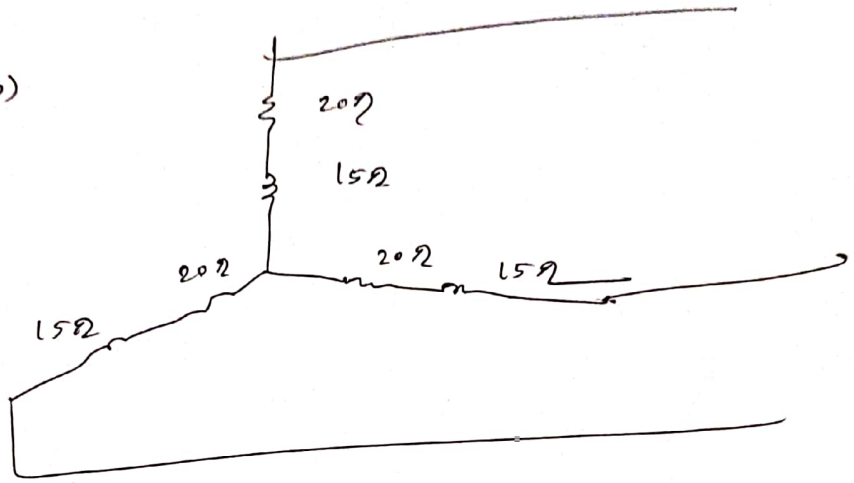
$+ \frac{0.8}{4\pi \times 10^{-7}} \times 0.4 \times 10^{-3}$

$$400 = 2 \times \frac{250/1000}{\mu_0} + 254.614$$

$$\mu_0 = \frac{2 \times 250/1000}{145.386} = 1719.56 \times 2 = 3439.12$$

1 mark

8 (b)



Y Connection

$V_L = 400\ V$

$V_{ph} = \frac{V_L}{\sqrt{3}} = \frac{400}{\sqrt{3}} = 230.94\ V$

2 marks

$Z_{ph} = \sqrt{R^2 + X_L^2}$

$= \sqrt{(20)^2 + (15)^2}$

$= \sqrt{625} = 25\Omega$ 2 marks

(i) $I_L = I_{ph} = \frac{V_{ph}}{Z_{ph}}$

$= \frac{230.94}{25} = 9.23A$

(ii) $pf = \frac{R_{ph}}{Z_{ph}} = \frac{20}{25} = 0.8$

(iii) $P_{kW} = \sqrt{3} \times 400 \times 9.23 \times 0.8$

$= 5115.63W$

Δ Connection

$V_L = 400\ V$

$V_{ph} = 400\ V$

(i) $I_L = \sqrt{3} I_{ph}$

$= \sqrt{3} \frac{V_{ph}}{Z_{ph}}$

$= \frac{\sqrt{3} \times 400}{25}$ 2 marks

$= 16\sqrt{3}\ A$

$= 27.71\ A$

(ii) $\cos\phi = \frac{R_{ph}}{Z_{ph}}$

$= 0.8$

(iii) $P = \sqrt{3} \times 400 \times 27.71 \times 0.8$

$= 15357W$

6(a)

$X_L = 9.168\,\Omega$ | 1 mark

$R_{coil} = 4\,\Omega$ | 1 mark

$V = 128.5\,V$ | 2 mark

8(a) $R = 480\,\Omega$ | 1 mark

$C = 6.36\,\mu F$ | 1 mark

$L = 1.59\,H$ | 2 mark

$$R = \frac{V}{I_0} = \frac{240\,V}{0.5\,A} = 480\,\Omega$$

At Resonance condition

$X_{L0} = X_{C0}$

$$X_{C0} = \frac{V_{C0}}{I_0} = \frac{250}{0.5} = 500$$

$$500 = \frac{1}{2\pi \times 50 \times C}$$

$$C = 6.36\,\mu F$$

$$X_{L0} = \frac{V_{L0}}{I_0} = \frac{250}{0.5} = 500$$

$$500 = 2\pi \times 50 \times L$$

$$L = 1.59\,H$$