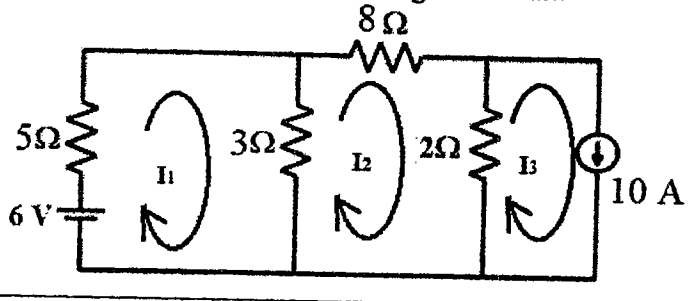
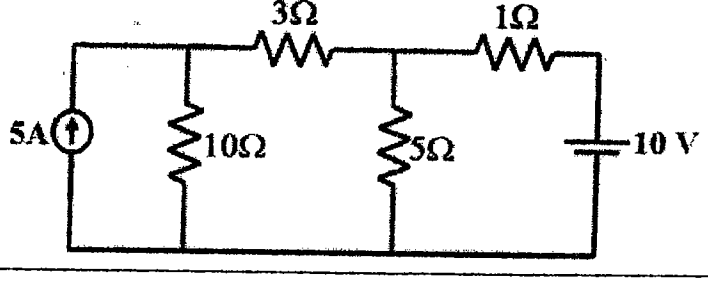
210491

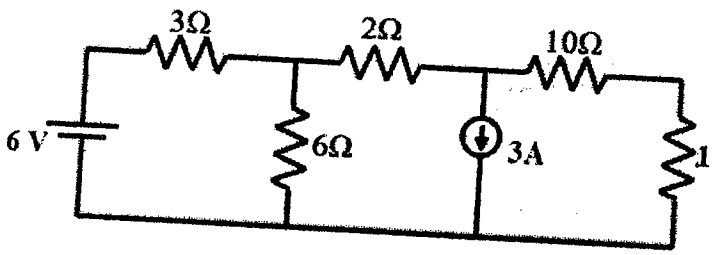
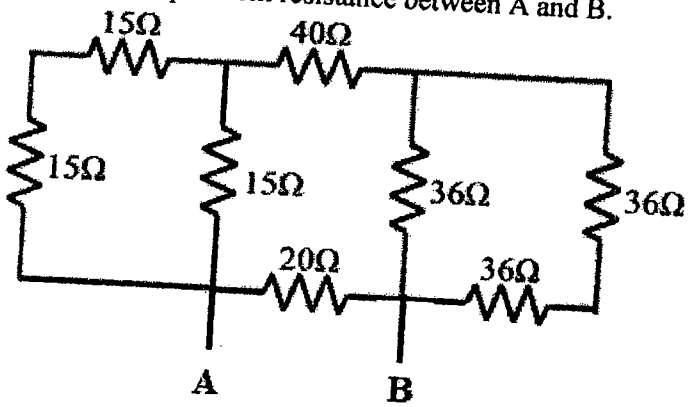
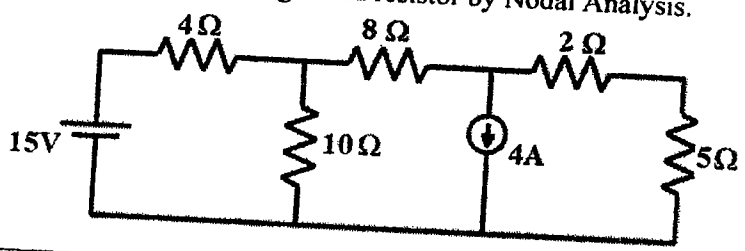
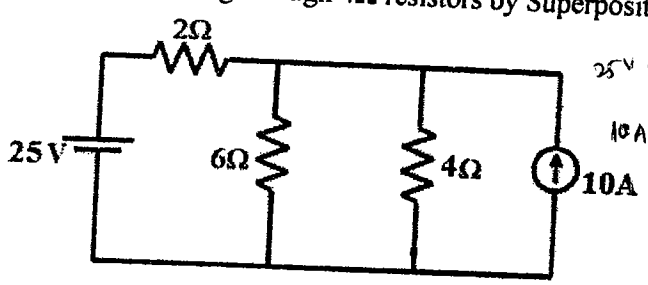
# PILLAI COLLEGE OF ENGINEERING, NEW PANVEL
## (Autonomous) (Accredited 'A+' by NAAC)
## END SEMESTER EXAMINATION
## SECOND HALF 2021

**BRANCH: FE ( ECS /EXTC )**

**Subject: Basic Electrical Engineering**
**Max. Marks: 60**
**N.B 1. Q.1 is compulsory**
**2. Attempt any two from the remaining three questions**

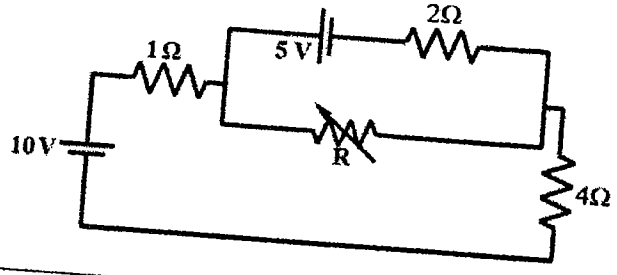
**Time: 02.00 Hours**
**Date: 13-04-2022**

| Q.1. | **Attempt all** | M | BT | CO |
|---|---|---|---|---|
| a) | Calculate the mesh currents in the given circuit.   $I_1 = 1.45A$ $I_2 = 1.873A$ $I_3 = 10A$ | 5 | 4 | 1 |
| b) | Derive average and RMS values of an alternating voltage in terms of maximum value. | 5 | 1 | 3 |
| c) | A balanced load of phase impedance 100Ω and power factor of 0.5(lag) is connected in delta to a 415V, 3-phase supply. Calculate Phase voltage, Line voltage, Phase current, line current and power consumed. $V_{ph} = V_L = 415V$ $Z_{ph} = 100$ $I_{ph} = 4.15$, $I_L = 7.19$ | 5 | 4 | 5 |
| d) | Draw a series R-L-C circuit and derive the equation of Resonant Frequency. $P = 2580.1$ | 5 | 1 | 4 |
| **Q.2.** | **Attempt all** | | | |
| a) | Using Thevenin's Theorem, compute the current through 1 ohm resistor.   $I_2 = 2.778A$ $V_{TH} = 3.85V$ $R_{TH} = 3.61$ $I_L = 0.835A$ | 4 | 3 | 2 |
| b) | For a three phase star connection prove that line voltage is √3 times phase voltage. | 4 | 1 | 5 |
| c) | Two impedances A and B are connected in series to an alternating voltage, V=230∠0 Volts. The impedance of A is 25+j10 and B is 35-j10. Calculate the power factor and total power dissipated in the circuit. $pf = 1$ $P = 881.667 W$ $Z = 60\Omega$ | 6 | 4 | 4 |
| | $T = 3.833$ ; $P = 881.66$ | P. | T. | O. |

| | | | | |
|---|---|---|---|---|
| d) | Calculate the current flowing through 15Ω resistor using Norton's theorem<br>  <br>$I_1 = 2.285$<br>$I_2 = 2.428$<br>$I_N = I_3 = -0.571$<br>$R_N = 14$<br>$I_{15} = 0.2758$ | 6 | 4 | 2 |
| Q.3. | **Attempt all** | | | |
| a) | Compute the equivalent resistance between A and B.<br>  <br>$R_{AB} = 15.74\ \Omega$ | 4 | 3 | 1 |
| b) | Find the value of current flowing through a 21mH inductor when connected to 230V, 50 Hz, 1-ϕ AC Supply. $X_L = 6.59$ $I = 34.84\ A$ | 4 | 3 | 4 |
| c) | Find current flowing through 10Ω resistor by Nodal Analysis.<br>  <br>$V_A = 4.52\ V$<br>$V_B = -12.824$<br>$I_{10} = 0.4524\ A$ | 6 | 3 | 1 |
| d) | Three identical coils having reactance of 15Ω and resistance of 10Ω are connected in star across a 400V three phase line. Calculate:<br>(i) Line current and phase current. $Z_{ph} = 18.03\angle 56.3$ $V_L = 400$ ; $V_{ph} = 230.9$ $I_L = I_{ph} = 12.8151$<br>(ii) Reading of each Wattmeter connected to measure power. $W_1 = 4.593\ kW$ $W_2 = 329.8\ G$ | 6 | 4 | 5 |
| Q.4. | **Attempt all** | | | |
| a) | Find the current flowing through 4Ω resistors by Superposition theorem.<br>  <br>25V → $I'_{4\Omega} = 3.4\ A$<br>10A → $I''_{4\Omega} = 2.73$<br>$I_4 = 6.15$ | 4 | 3 | 2 |
| b) | An alternating voltage is represented by v=141.4sin(377t+0)Volts. Find ( i) Max Voltage (ii) RMS value (iii)frequency and (iv)Time period. $T = 0.016$<br>100 60 Hz | 4 | 3 | 3 |

$f_0 = 21.17$ Hz  $Z_D = 53.33\ \Omega$  $I = 4.3125$A



| | | | | |
|---|---|---|---|---|
| c) | A circuit has L=0.2H and inductive resistance 25Ω is connected in parallel with 150μF capacitor with variable frequency, 230V supply. Find the resonant frequency and impedance at which the total current taken from the supply is in phase with supply voltage. Also find the value of the supply current and impedance at resonance. | 6 | 3 | 4 |
| d) | Evaluate the value of R for maximum power transfer and also calculate the maximum power in the load resistor.   $I = 0.71$ $V_{TH} = 6.428$ $R_{TH} = 1.428$ $P_{max} = 7.233$W | 6 | 6 | 2 |

CO1-Apply basic concepts to analyse D.C circuits.

CO2-Apply various D.C network theorems to determine the circuit response/ behaviour.

CO3-Apply basic concepts to analyse A.C waveforms.

CO4-Evaluate and analyse single phase A.C circuits.

CO5-Evaluate and analyse three phase A.C circuits.

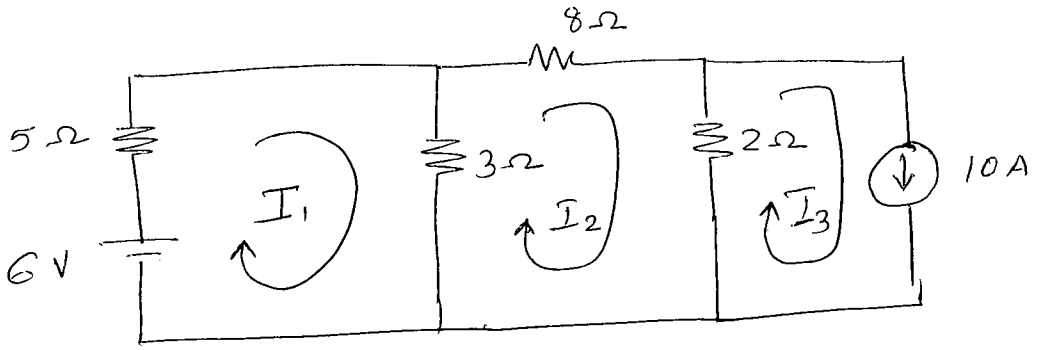
CO6-Understand the constructional features and operation of electrical machines.

**BT Levels:** - 1 Remembering ,2 Understanding, 3 Applying,4 Analyzing, 5 Evaluating, 6 Creating.

**M-Marks, BT**- Bloom's Taxonomy, **CO**-Course Outcomes.

13/04/22

Q1 a




$$6 - 5I_1 - 3(I_1 - I_2) = 0$$

$$-8I_1 + 3I_2 = -6 \quad \text{—(1)}$$

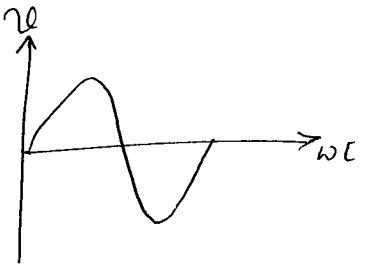
$$-3(I_2 - I_1) - 8I_2 - 2(I_2 - 10) = 0$$

$$3I_1 - 13I_2 = -20 \quad \text{—(2)}$$

$$\boxed{I_1 = 1.45\,A, \quad I_2 = 1.873\,A \quad I_3 = 10\,A}$$

Q1 b

$v = V_m \sin\omega t$




$$V_{rms} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} v^2(\theta)\,d\theta}$$

$$= \sqrt{\frac{1}{2\pi}\int_0^{2\pi} V_m^2 \sin^2\theta\,d\theta}$$

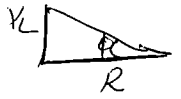
$$= \sqrt{\frac{V_m^2}{2\pi}\int_0^{2\pi}\left[\frac{1-\cos 2\theta}{2}\right]}$$

$$= \sqrt{\frac{V_m^2}{2}} = \frac{V_m}{\sqrt{2}}$$

$$\boxed{V_{rms} = \frac{V_m}{\sqrt{2}}}$$

Q1

c) $R = 100\ \Omega$




$\cos\phi = 0.5$

$\phi = 60$

$Z_{ph} = 100 \angle 60$

$= 50 + 86.6j$

$\tan 60 = \frac{X_L}{R}$

$X_L = 100 \times \tan 60$

$= 173.20\ \Omega$

$Z = 100 + 173.20j$

$Z_{ph} = 200 \angle 60\ \Omega$

$V_L = V_{ph} = 415\ V$

$I_{ph} = \frac{415}{200} = 2.075$ $\quad I_{ph} = 4.15\ A$

$I_L = \sqrt{3}\ I_{ph}$ $\quad I_L = 7.18\ A$

$I_L = 3.594\ A$

$P = \sqrt{3}\ V_L\ I_L \cos\phi$

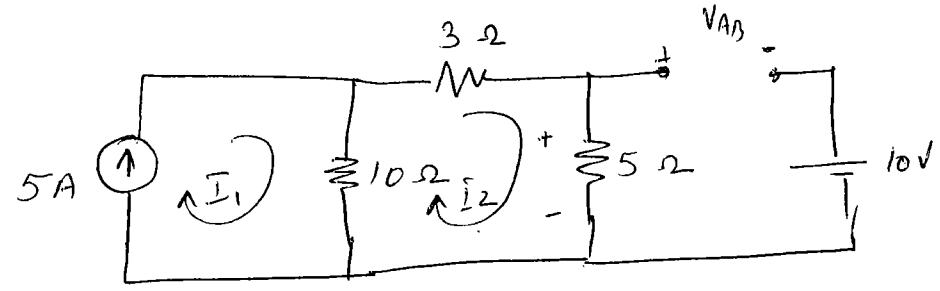
$= \sqrt{3} \times 415 \times 3.594 \times \cos 60$

$= 1291.6\ W$

$P = 1.292\ kW$ $\quad 2580.5\ W$

Q2

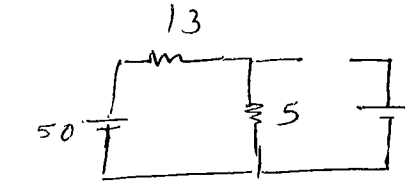
a.

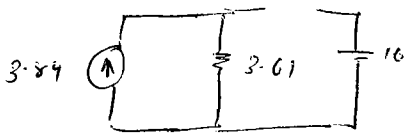



$$-3I_2 - 5I_2 - 10(I_2 - 5) = 0$$

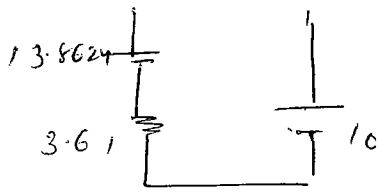
$$-18I_2 = -50$$

$$\boxed{I_2 = 2.778\ A}$$



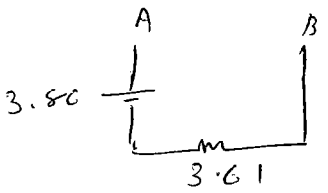




$$V_{AB} - 5 \times 2.778 + 10 = 0$$



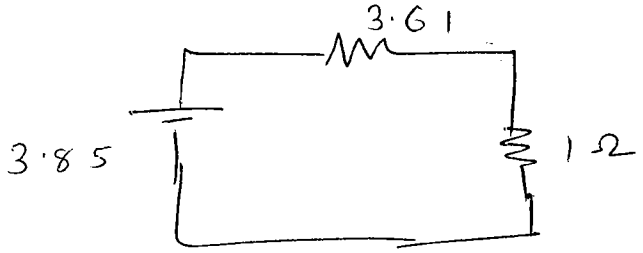

$$V_{AB} = 13.85 - 10$$

$$= 3.85\ V$$



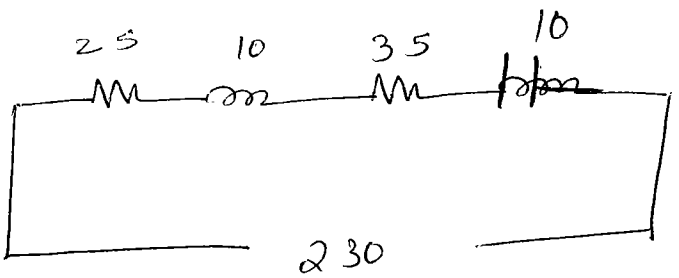

$$\boxed{V_{TH} = 3.85\ V}$$

$$\boxed{R_{TH} = 3.61\ \Omega}$$




$$I_{1\Omega} = 0.8351\ A$$

c.




$$Z = 25 + j10 + 35 - j10$$

$$= 60\ \Omega$$

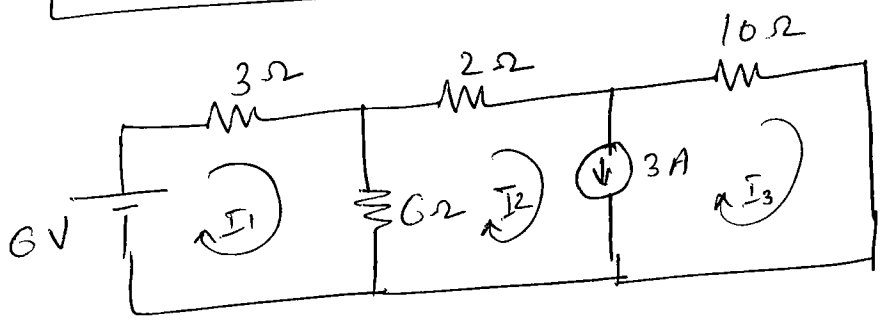
$$pf = \cos\phi$$

$$= 1$$

$$P = 230 \times 3.833 \times \cos 0$$

$$\boxed{P = 881.667\ W}$$

Q2 d




$$I_2 - I_3 = 3 \quad \text{—(1)}$$

$$6 - 3I_1 - 6(I_1 - I_2) = 0$$

$$-9I_1 + 6I_2 = -6 \quad \text{—(2)}$$

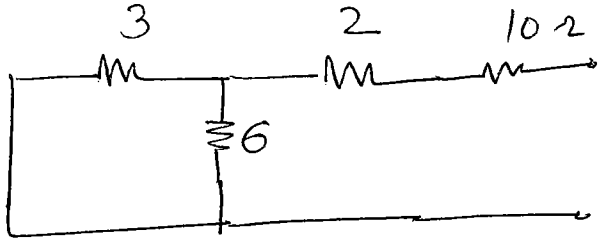
$$-2I_2 - 10I_3 - 6(I_2 - I_1) = 0$$

$$6I_1 - 8I_2 - 10I_3 = 0 \quad \text{—(3)}$$

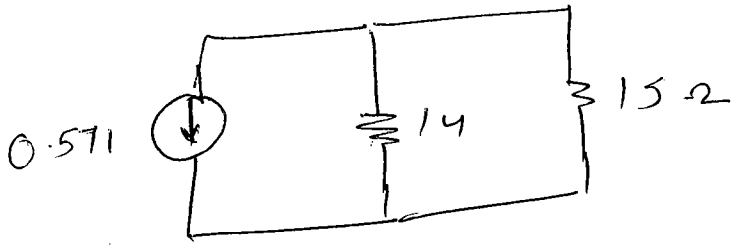
$$I_1 = 2.285 \quad I_2 = 2.428 \quad I_3 = -0.571$$

$$I_N = -0.571 \text{ A}$$

$R_N$ :-

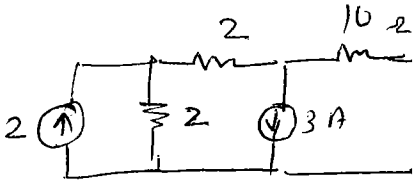


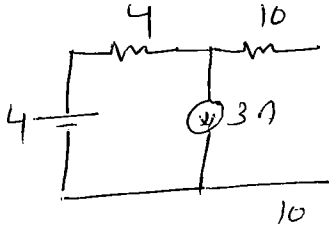

$$R_N = 14\ \Omega$$

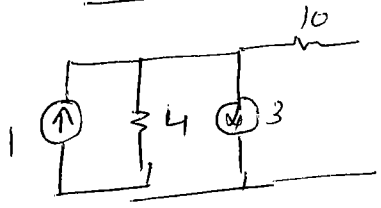


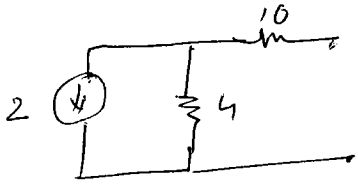

$$I_{15\Omega} = \frac{0.571 \times 14}{14+15}$$

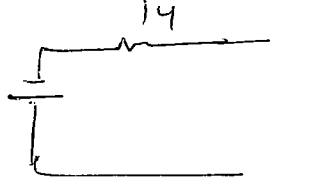
$$I_{15\Omega} = 0.2756 \text{ A}$$

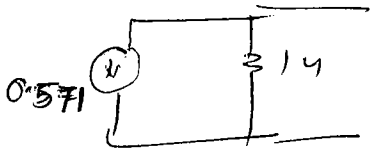


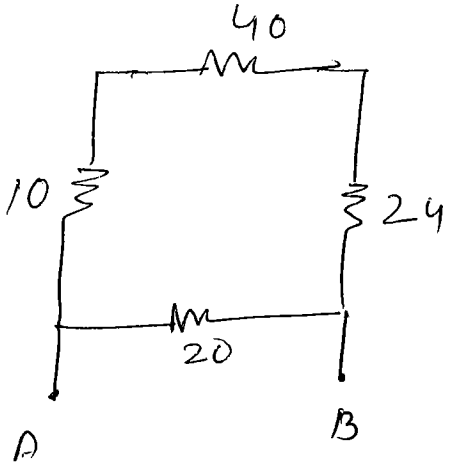



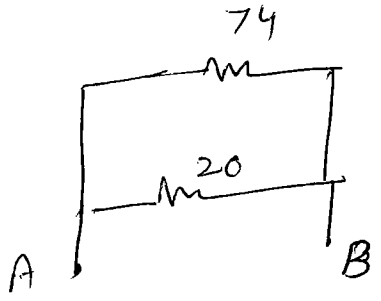



Q3 a




$R_{AB} = 15.7446\ \Omega$

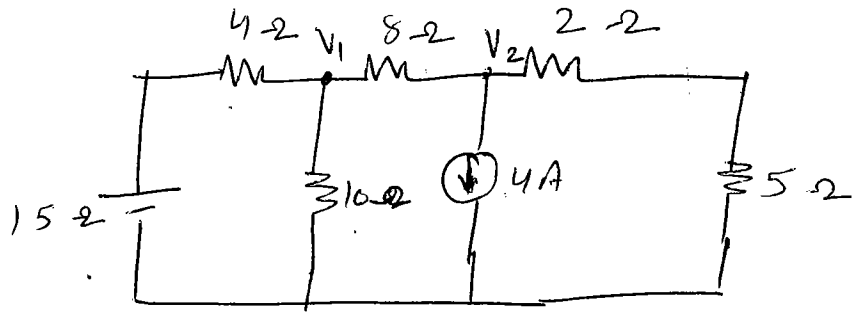
Q3 b)

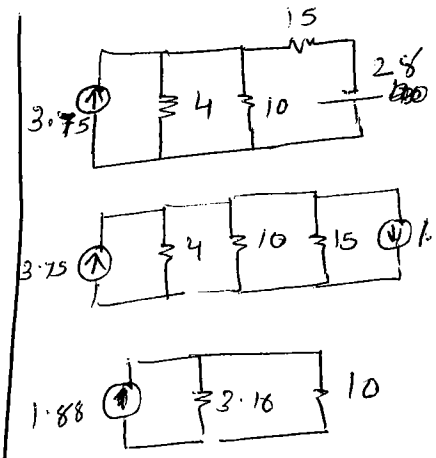
$X_L = 2\pi \times 50 \times 21\,m$

$= 6.597\ \Omega$

$I = \frac{230}{6.597} = 34.84\ A$

Q3. C




$$\frac{V_1 - 15}{4} + \frac{V_1}{10} + \frac{V_1 - V_2}{8} = 0$$

$$V_1\left[\frac{1}{4} + \frac{1}{10} + \frac{1}{8}\right] + V_2\left[\frac{-1}{8}\right] = \frac{15}{4} \quad -(1)$$

$$\frac{V_2 - V_1}{8} + 4 + \frac{V_2 - 0}{7} = 0$$

$$V_1\left[\frac{-1}{8}\right] + V_2\left[\frac{1}{8} + \frac{1}{7}\right] = -4 \quad -(2)$$

$V_1 = 4.52\ V$ ~~5.576 V~~ $\quad V_2 = -12.824$ ~~-8.8076 V~~

$I_{10\Omega} = \frac{4.52}{10} = 0.452\ A$ ~~$\frac{5.576}{10} = 0.5576$ A~~

Q3 d $Z_{ph} = 10 + j15$

$= 18.02 \angle 33.69 \; 56.30$

$V_L = 400V$

$V_{ph} = 230.9 \; V$

$I_{ph} = 12.815 \; A$

$I_L = 12.815$

$W_1 = V_L I_L \cos(30 - \phi)$

$= 400 \times 12.815 \cdot \cos 3.69$

$= 5115.37 \; W$

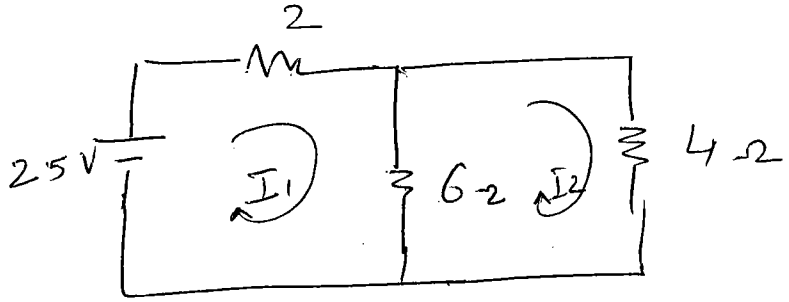
$W_2 = V_L I_L \cos(30 + \phi)$

$= 400 \times 12.815 \times \cos 63.69$

$= 2271.98 \; W$

Q4

a)




$$25 - 2I_1 - 6(I_1 - I_2) = 0$$

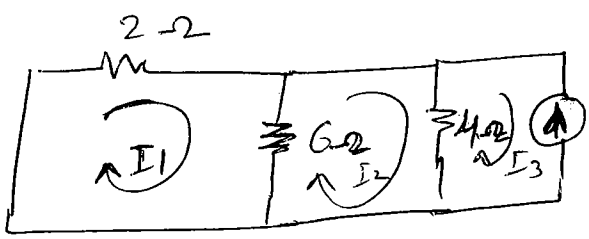
$$-8I_1 + 6I_2 = -25 \quad -(1)$$

$$-4I_2 - 6(I_2 - I_1) = 0$$

$$6I_1 - 10I_2 = 0 \quad -(2)$$

$$I_1 = 5.68 \qquad I_2 = 3.4$$

$$I_{4\Omega} = 3.4\ A$$




$$-2I_1 - 6(I_1 - I_2) = 0$$

$$-8I_1 + 6I_2 = 0 \quad -(1)$$

$$-6(I_2 - I_1) - 4(I_2 + 10) = 0$$

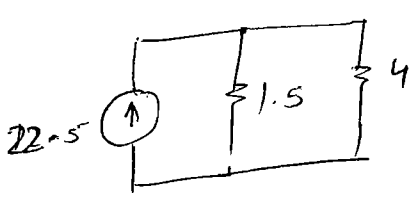
$$6I_1 - 10I_2 = 40 \quad -(2)$$

$$I_1 = -5.45 \qquad I_2 = -7.27$$

$$I''_{4\Omega} = I_3 - I_2 \quad (\uparrow)$$

$$= -10 + 7.27$$

$$I''_{4\Omega} = 2.73 \downarrow$$




$$I_{4\Omega} = 6.15\ A$$

Q4

b $V_m = 141.4 \text{ V}$

$V_{RMS} = 99.98 \text{ V}$

$W = 377$

$f = \frac{377}{2\pi} = 60 \text{ Hz}$

$T = \underline{0.016 \text{ Sec}}$

Q4c $f_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$

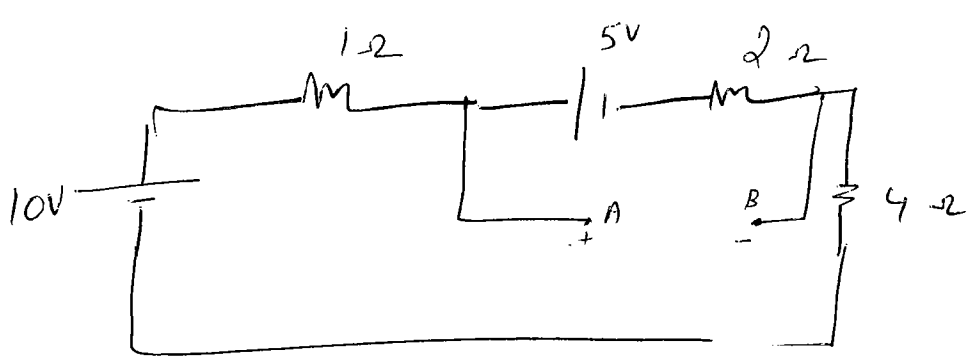
$= \frac{1}{2\pi}\sqrt{33333.33 - 15625}$

$= \underline{21.179 \text{ Hz}}$

$Z_D = \frac{L}{RC} = \underline{53.33 \Omega}$

$I = \frac{230}{Z_D} = \underline{4.3125 \text{ A}}$

Q.4 d




$$10 - 1\,I - 5 - 2\,I - 4\,I = 0$$

$$5 = 7\,I$$

$$I = \frac{5}{7}$$

$$V_{AB} - 5 - 2 \times \frac{5}{7} = 0$$

$$V_{AB} = 5 + \frac{10}{7}$$

$$V_{TH} = \underline{6.428\ V}$$

$$R_{TH} = 1.428\ \Omega$$

$$P_{max} = \frac{V_{TH}^2}{4 R_{TH}} = \underline{7.233\ W}$$