Assignment-2

Q1) 1. $P = V_{rms} \cdot I_{rms} \cos(\theta_r - \theta_i)$

$S = V_{rms} \cdot I_{rms} \sin(\theta_r - \theta_i)$

1. $P = \frac{340 \times 20}{2} \times \cos 45 = 2.404\,kW$ absorbing

$Q = \frac{340 \times 20}{2} \times \sin 45 = 2.404\,kW$ absorbing

2. $P = \frac{75 \times 16}{2} \cdot \cos(-75) = 0.155\,kW$ absorbing

$Q = \frac{-75 \times 16}{2} \sin(75) = 0.579\,kW$ delivering.

3. $P = \frac{625 \times 4}{2} \cos(-110) = 0.427\,kW$ delivering

$Q = \frac{625 \times 4}{2} \sin(-110) = -1.174\,kVA$

4. $P = \frac{180 \times 10}{2} \cos(110) = 0.307\,kW$ delivering

$Q = 0.845\,kVA_r$ absorbing.

Q2) $50\,kW = 40\,kW + I_{rms}^2 \times 20$

$I_{rms} = \sqrt{500}\,A$

$30 \times 10^3\,VA_r = V_{rms} \sqrt{500} \sin(\theta)$ $\Rightarrow$ $\theta \approx 37^\circ$

$40 \times 10^3\,W = V_{rms} \sqrt{500} \cos(\theta)$ $\quad V_{rms} = 2236.06\,V$

$$40 \times 10^3 = I_{rms}^2 \times R_2 \Rightarrow R_2 = 80\Omega$$

$$30 \times 10^3 = I_{rms}^2 \times X_L \rightarrow X_L = 60\Omega$$

$$Z_L = 80 + j60\Omega \qquad Z_{eff} = 100 + j(60 - x)$$

$$I_s \angle\theta = \frac{2500 \angle 0^\circ}{|Z_{eff}| \angle\phi} \Rightarrow |Z_{eff}| = \frac{2500}{\sqrt{500}}$$

$$\left(\sqrt{100^2 + (60-x)^2}\right)^2 = \frac{2500^2}{500}$$

$$x = 10\Omega \text{ or } 110\Omega$$

Q3)

1. $$V_{rms} = \sqrt{\frac{20^2 + 100^2 + 20^2 + 20^2 + 100^2 + 20^2}{6}} = 24.5\ V$$

2. $$P_{avg} = \frac{\text{Total energy dissipated}}{\text{total time}}$$

$$\Rightarrow \underline{\underline{300W}}$$

Q4)

1. $$R_1 = \frac{2400 \times 2400}{(18 + j24) \times 10^3} = \cancel{96(0.6 - j0.8)}$$
$$= \frac{192}{5}(3 - 4j)$$

$$R_2 = \frac{2400 \times 2400}{(0.6 - j0.8)\, 60 \times 10^3} = 96(0.6 - j0.8)$$

$$R_3 = 320\Omega.$$

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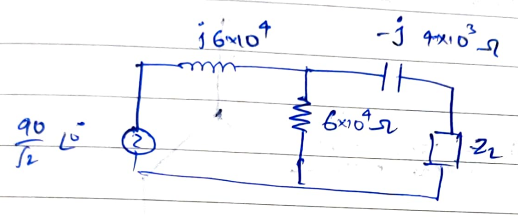
$$\frac{1}{Z_{eq}} = \frac{1}{320} + \frac{3+4j}{960} + \frac{0.6-j0.8}{96} = \frac{3+3+4j+6-8j}{960} = \frac{12-4j}{960}$$

$$Z_{eq} = 72+24j$$

2.) $$Pf = \frac{72}{\sqrt{72^2+24^2}} = \frac{3}{\sqrt{10}}$$

Q5



i.) $$Z_T = -j \times 4\times10^3 + \frac{j\times6\times10^4\times6\times10^4}{(1+j)\,6\times10^4} = 30\times10^3 - j10\times10^3$$

for max power, $Z_L = Z_T^*$

$$Z_L = 30\times10^3 + j10\times10^3\,\Omega$$

2.) $$V_{TH} = \frac{90}{\sqrt{2}}\angle0^\circ \times \frac{60k\Omega}{60k\Omega + j60k\Omega} = 45\angle-45^\circ$$

P_{avg} across $Z_L = Re\,(I_s^2 \cdot Z_L)$

$$I_s = \frac{45(-45^\circ)}{60} = 0.75\angle-45^\circ$$

$$P_{avg} = Re\,(0.75\times0.75\times(30\times10^3 + j\cdot10\times10^3\,\Omega))$$
$$= 16.875\text{ kW}$$

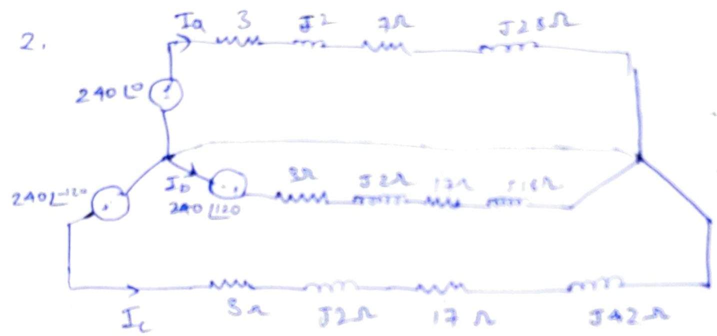
Q7)

1. Balanced +ve
2. Balanced -ve
3. Balanced +ve
4. Balanced -ve
5. Unbalanced, Vb and Vc dont have 120° phase difference
6. Unbalanced, Vb and Vc dont have 120° phase difference

Q8)

1. Unbalanced as load impedences are not equal.

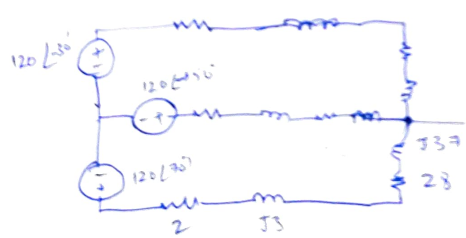
2.



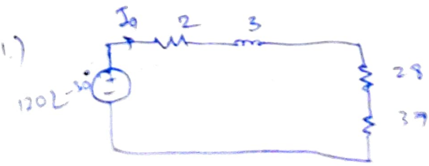
$$I_a = \frac{-24\angle 0°}{1+J3} \qquad I_b = \frac{-12\angle 120}{1+j} \qquad I_c = \frac{-12\angle -120}{1-J2}$$

$$I_0 = I_a + I_b + I_c = 8.3\angle 24.8° \text{ A}$$

Q9)



1)



$$120\angle -30 = I_a(30 + j40)$$

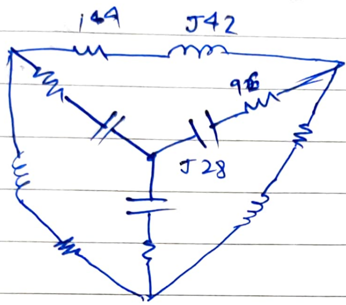
$$I_a = 2.4\angle -83.15$$

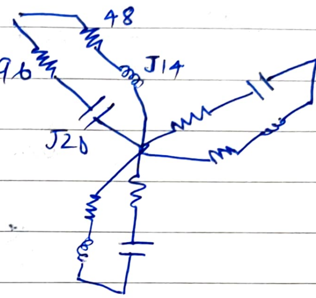
2. $V_L = 120\angle{-30} - 2.4\angle{-83.15} \times \sqrt{13}\angle{\tan^{-1}(\frac{3}{2})}$

$= 120\angle{-30} - 2.4\sqrt{13}\angle{-83.15 + 56.34}$

$120\angle{-30} - 8.65\angle{-26.81} \approx 112\angle{-30}$

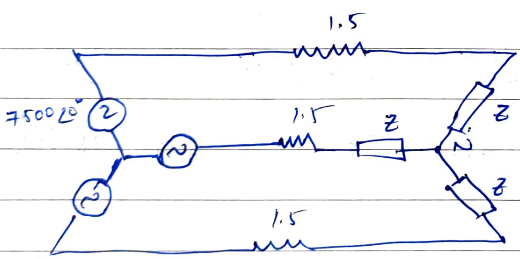
Q 10)





$Z_{eff} = \frac{(48+14J)\times 2(48-14J)}{48+96\cdot J14} = \frac{5000}{144-J14}$

$= 34.56\angle{5.55}$



$Z = \frac{2500}{5233}(72+J7)$

$= 34.40 + J3.34$

$7500\angle{0^\circ} = I_a \times 36.09\angle{5.3^\circ} \Rightarrow I_a = 2078\angle{-5.3^\circ}$

$|I_a| = 207.8\,A$

2. $|I_\Delta| = 207.8\angle{-5.3^\circ} \times \frac{96-J28}{144-J14} = 82.92\angle{4^\circ}$

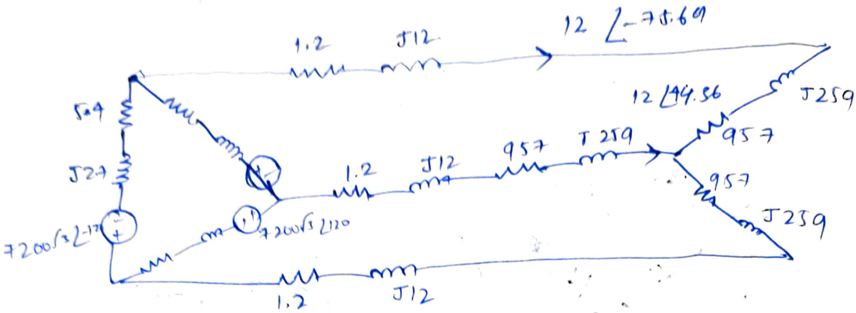
3. $\frac{207.8 \times 50}{144.68} = 71.81\,A$

4. $7500\angle 0^\circ - 1.5 \times 207.8 \angle -5.3^\circ$

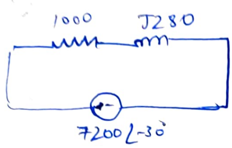
$7500\angle 0^\circ - 311.7 \angle -5.3^\circ = 7189.6 + j28.8$

$|V| = 7189.6$ V.

Q11)



1.



2. phase currents $= \dfrac{7200\angle -30^\circ}{1000 + j280} = \dfrac{7200}{1038.46} \angle -45.64$

$= 6.93 \angle -45.64^\circ$

Line currents $= 12 \angle -75.64,\ 12\angle 44.36^\circ,\ 12\angle -195.64^\circ$

$7200\sqrt{3}\angle 0^\circ = 6.93\angle -45.64\,(5.4 + j27) + 12\angle -75.64\,(1.2 + j12 + j259 + 957)$

$- 12\angle 44.36\,(1.2 + j12 + j259 + 957)$

load line voltages $= 12\angle -75.64\,(958.2 + j271)$

$= 12\angle -75.64 \times 995.78\angle 15.79^\circ$

$= 11949\angle -59.85^\circ$ V.

3. 6.93

4. $7200\sqrt{3}$

Q12) $S = P + JQ$

$S = 14\,kVA \qquad P = 0.75$

$S = S_1 + S_2$

$S_1 = 9\,kVA \qquad P_1 = 0.6$

$S = 10.5\,kW + J\,9.26\,kVA_r$

$S_2 = 5.1\,kW + J\,2.06\,VA_r$

$S_1 = 5.4\,kW + J\,\cancel{7}.2\,kVA_r$

1.) $\frac{2.06}{3} = 0.6866\,kVA_r \approx 0.69\,kVA_r$

2) Power $= \sqrt{3}\, V_L I_L \cos\theta$

$14\,kV = \sqrt{3} \cdot V_L \cdot \sqrt{3}\; 10 \times \angle 0^\circ$

$V_L = \frac{1400}{3}\,V = 466.67\,V$