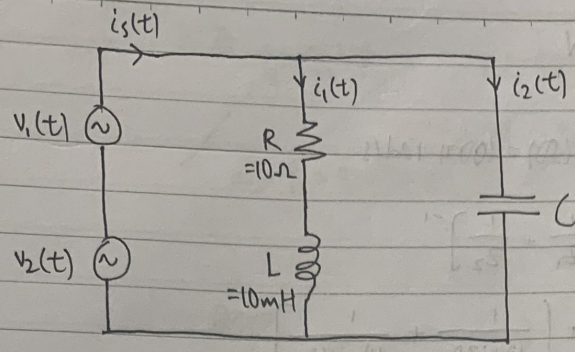
Subject: No:

Date:

A0204844H.

1.



$V_1 = \frac{200}{\sqrt{2}} \angle -45° \text{ V}$

$V_2 = \frac{100}{\sqrt{2}} \angle -60° \text{ V}$

$V_{total} = V_1 + V_2 = \frac{200}{\sqrt{2}} \angle -45° + \frac{100}{\sqrt{2}} \angle -60°$

$= 210.52 \angle -49.99° \text{ V}$

$Z_{R+L} = 10 + jWL = 10 + j(1000)(10 \times 10^{-3})$

$= 14.14 \angle 45° \ \Omega$

$\Rightarrow I_1 = \frac{V}{Z_{R+L}} = \frac{210.52 \angle -49.99°}{14.14 \angle 45°}$

$= 14.89 \angle -94.99° \text{ A}$

~~$\therefore i_1(t) = 21.06 \angle -94.9$~~

$\therefore i_1(t) = 21.06 \cos(1000t - 95°) \text{ A}$ //

$Z_C = \frac{1}{jWL} = \frac{1}{j(1000)(100 \times 10^{-6})}$

$= 10 \angle -90° \ \Omega$

$\Rightarrow I_2 = \frac{V}{Z_C} = \frac{210.52 \angle -49.99°}{10 \angle -90°}$

$= 21.05 \angle 40.01° \text{ A}$

~~$\therefore i_2(t) = 21.05 \cos(t$~~

$\therefore i_2(t) = 29.77 \cos(1000t + 40°) \text{ A}$ //

~~next page~~

By KCL: $I_S = I_1 + I_2 = 14.89 \angle -94.99° + 21.05 \angle 40.01°$

$= 14.88 \angle -5.01° \text{ A}$

$\therefore i_S(t) = 21.04 \cos(1000t - 5.01°) \text{ A}$ //

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2. (i).

$V_{LN,S} = 230\angle 0°\ V$

$f = 50Hz$

$\Rightarrow \omega = 2\pi f = 2\pi(50) = 100\pi\ rad/s$

$$Z_{eff} = Z_0 + \left[\frac{1}{Z_1} + \frac{1}{Z_2}\right]^{-1}$$

$$= (1+j5) + \left[\frac{1}{10+j30} + \frac{1}{10-j60}\right]^{-1}$$

$$= 57.76\angle 49.97°\ \Omega$$

$$\Rightarrow I_0 = \frac{V_{LN,S}}{Z_{eff}} = \frac{230\angle 0°}{57.76\angle 49.97°}$$

$$= 3.98\angle -49.97°\ A$$

$$V_{Z_1} = V_{Z_2} = V_{LN,S} - V_{Z_0} \quad \text{——— (1)}$$

$$V_{Z_0} = I_0 \cdot Z_0 = (3.98\angle -49.97°)[1+j5]$$

$$= 20.29\angle 28.72°\ V$$

$$\Rightarrow V_{Z_1} = V_{Z_2} = 230\angle 0° - 20.29\angle 28.72°$$

$$= 212.43\angle -2.63°\ V$$

$$\Rightarrow I_1 = \frac{V_{Z_1}}{Z_1} = \frac{212.43\angle -2.63°}{10+j30}$$

$$= 6.72\angle -74.2°\ A$$

$$\Rightarrow I_2 = \frac{V_{Z_2}}{Z_2} = \frac{212.43\angle -2.63°}{10-j60}$$

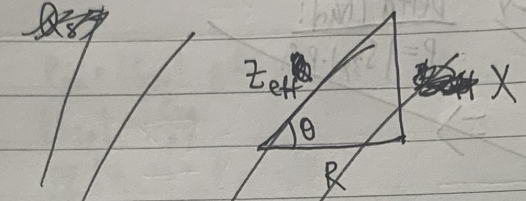
$$= 3.49\angle 77.91°\ A$$

(ii).

$P_s = I_o^2 R = (3.98\angle -49.97°)^2 [57.76]$

$= 914.94\angle -99.94° \text{ W}$

$\Rightarrow P_s = 914.94 \text{ W}$ //



$P_s = I_o^2 R$ ——— (1)

$R = Z_{eff} \cos\theta = 57.76 \cos 49.97°$

$= 37.15 \Omega$

$\Rightarrow P_s =$

$S = VI_o^* = P + jQ$

$\Rightarrow 230\angle 0° [3.98\angle 49.97°] = P + jQ$

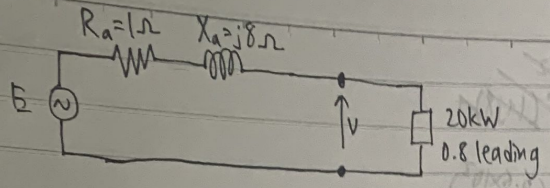
$P + jQ = 588.77 + j700.93 \text{ VA}$

$\therefore P = 588.77 \text{ W}$ // $\therefore Q = 700.93 \text{ VAR}$ //

$|S| = |VI_o| = 230(3.98)$

$= 915.4 \text{ VA}$ //

4.



(i).

$|V_{LL}| = \sqrt{3}\,|V_{LN}|$

$V = \frac{6.6\times10^3}{\sqrt{3}} \angle 0°\ V$ (reference point)

$P_{3\phi} = |S_{3\phi}| \cdot p.f.$

$|S_{3\phi}| = \frac{P_{3\phi}}{p.f.}$

$\sqrt{3}\,|V_{LL}||I_L| = \frac{P_{3\phi}}{p.f.}$

$\Rightarrow |I_L| = \frac{20\times10^3}{\sqrt{3}\,(6.6\times10^3)(0.8)}$

$= 2.19\ A$

Since p.f. = 0.8 leading,

$\theta = \cos^{-1}(0.8) = 36.87°$

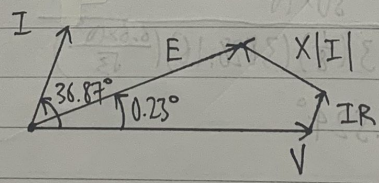
$\Rightarrow I_L = 2.19 \angle 36.87°\ A$

$E = I[R+jX] + V_T$

$= 2.19\angle 36.87°\,(1+j8) + \frac{6.6\times10^3}{\sqrt{3}} \angle 0°$

$= 3801.78 \angle 0.23°\ V$ //

(ii).



(iii).

Since field current is kept constant, $|I_2| = |I_1|$.

$P_{initial} = 3\frac{|V||E_1|}{X}\sin\delta_1 = 3\frac{\left(\frac{6.6\times10^3}{\sqrt{3}}\right)(3801.78)}{8}\sin 0.23°$

$= 21.807\ kW$

$P_{new} = 50\ kW$

$P_{new} = 3\frac{|V||E_2|}{X}\sin\delta_2 = 50\ kW$

$\Rightarrow 3\frac{\left(\frac{6.6\times10^3}{\sqrt{3}}\right)|E_2|}{8}\sin\delta_2 = 50\ kW$ ——— (1)

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~~$E_2 = I_2(R+jX) + V_2$~~

~~$= 2.19\angle 36.87°\,(1+j8)$~~

Initial:

$$|Z| = \frac{|V|}{|I_1|} = \frac{\left(\frac{6.6\times10^3}{\sqrt{3}}\right)}{2.19}$$

$$= 1739.96\ \Omega$$

New:

$$|V| = |I_2||Z| = 2.19(\quad$$

$$E_2 = |I_2|\angle\theta\,[R+jX] + V_2$$

$$= 2.19\angle\theta\,[1+j8] + \frac{6.6\times10^3}{\sqrt{3}}\angle 0° \quad \text{——— (2)}$$

$$\Rightarrow |E_2| = 2.19(8.06) + \frac{6.6\times10^3}{\sqrt{3}}$$

$$= 3828.16\ \text{V} \quad \text{——— (3)}$$

$$S_{3\phi} = 3\frac{|V||E|}{X}\sin\delta + j\left[3\frac{|V||E|}{X}\cos\delta - 3\frac{|V|^2}{X}\right]$$

$$Q_{3\phi} = 3\frac{|V||E|}{X}\cos\delta - 3\frac{|V|^2}{X}$$

Sub. (3) into (1):

$$\sin\delta_2 = \frac{50\times10^3}{3\left(\frac{1}{8}\right)(3828.16)\left(\frac{6.6\times10^3}{\sqrt{3}}\right)}$$

$$\therefore \delta_2 = 0.524°$$

~~$\Rightarrow S_{3\phi} = 3\dfrac{\left(\frac{6.6\times10^3}{\sqrt{3}}\right)(3828.16)}{\quad}$~~

$$\Rightarrow S_{3\phi} = (50\times10^3) + j\left[3\frac{\left(\frac{6.6\times10^3}{\sqrt{3}}\right)(3828.16)}{8}\cos 0.524° - 3\frac{\left(\frac{6.6\times10^3}{\sqrt{3}}\right)^2}{8}\right]$$

$$= 50\,000 - j3866\,250\ \text{VA}$$

$$\therefore Q_{3\phi} = -3\,866\,250\ \text{VAR}$$