1. Given,

rms value of voltage, $V_{rms} = 240$ V

Frequency, $f = 60$ Hz

$\therefore$ Angular frequency, $\omega = 2\pi f$

$= 376.992$ rad s^{-1}

Power,

resistive, $P = 10$ kW

capacitive, $Q_c = 15$ kVAR

inductive, $Q_L = 22$ kVAR

a) We know,

Apparent power, $S = |S|$, where, S = complex power

$\therefore S = P - Q_c + Q_L$

$= 10 - j15 + j22$

$= 10 + j7$ kVA

$\therefore S = \sqrt{10^2 + 7^2}$

$= 12.21$ kVA

b) We know,

$$S = VI^*$$

here, I^* is the complex conjugate of current I

$$\therefore I^* = \frac{S}{V}$$

$$= \frac{(10+j7)\times 1000}{240}$$

$$= 41.667 + j29.166$$

$$\therefore I = 41.667 - j29.166$$

$$= 50.86 \angle -34.99^\circ \text{ A}$$

$\therefore$ The current drawn from the supply,

$$I = 50.86 \angle -34.99^\circ \text{ A}$$

c) let,

phase difference before correction = θ_1

Phase difference after correction = θ_2

~~$\therefore \theta_1 = \tan^{-1}\left(\frac{Re(S}{}\right.$~~

~~$\therefore \theta_1 = \tan^{-1}\left(\frac{Img}{}\right.$~~

$$\therefore \theta_1 = \tan^{-1}\left(\frac{Q}{P}\right)$$

$$= \tan^{-1}\left(\frac{7}{10}\right)$$

$$= 35^\circ$$

Here,

Gotten, complex power,

$S = 10 + j7$ kVA

Real power, $P = 10$ kW

Reactive power, $Q = 7$ kVAR

Improved pf $= 0.96$ (lagging)

and,

$$\theta_2 = \cos^{-1}(pf)$$

$$= \cos^{-1}(0.96)$$

$$= 16.26^\circ$$

$\therefore$ The kVAR rating,

$$Q_c = P\left[\tan\theta_1 - \tan\theta_2\right]$$

$$= 10\left[\tan(35^\circ) - \tan(16.26^\circ)\right]$$

$$= 4.083 \text{ kVAR}$$

And, the required capacitance to improve the power factor to 0.96,

$$C = \frac{Q_c}{\omega V_{rms}^2} = \frac{4.083 \times 1000}{2\pi \times 60 \times (240)^2} = 188.03\ \mu F$$

$\therefore$ The kVAR rating is 4.083 kVAR and required capacitance 188.03 μF.

(P.T.O)

d) The complex power under the new pf condition,

$S_2 = P + jQ_2$ [the real power will remain the same] that is not to be altered.

the new reactive power,

$Q_2 = Q - Q_c$

$= 7 - 4.083$

$= 2.917$ kVAR

$\therefore S_2 = 10 + j2.917$ kVAR

Again,

$S_2 = V_{rms} I_2^*$

$\therefore I_2^* = \dfrac{S_2}{V_{rms}}$

$= \dfrac{(10 + j2.919) \times 1000}{240}$

$= 41.667 + j12.159$

$\therefore I_2 = 41.667 - j12.159$

$= 43.4 \angle -16.26^\circ$ A

$\therefore$ The current drawn from the supply under the new pf, is $43.4 \angle -16.26^\circ$ A

2. Given ,

Period, $T = 5$ s

Current $i(t) = t$ when $0 < t < 5$

$\therefore$ rms value of the current,

$$I_{rms} = \sqrt{\frac{1}{T} \int_0^T (i(t))^2 dt}$$

$$= \sqrt{\frac{1}{5} \int_0^5 t^2 dt}$$

$$= \sqrt{\frac{1}{5} \left[\frac{t^3}{3} \right]_0^5}$$

$$= 2.88 \text{ A}$$

$\therefore$ The rms value of the current, $I_{rms} = 2.88$ A