1. The circuit of figure below is excited by a 240-V, 60-Hz sinusoidal source. If \( C = 10 \mu F \), determine:

(a) The magnitude of current \( I \)
(b) The average value of power dissipated by resistor \( R \)

Solution:

(a) It is convenient to assume \( \bar{V} \) on the reference. The two branch impedances are found as

\[
Z_1 = -j \left( \frac{1}{\omega C} \right) = \frac{1}{\omega C} \angle -90^\circ = \frac{1 \angle -90^\circ }{120\pi \left( 10 \times 10^{-6} \right) } = 265.258 \angle -90^\circ \Omega
\]

\[
Z_2 = R + j \omega L = 10 + j(120\pi)(0.025) = 10 + j9.425 = 13.742 \angle 43.3^\circ \Omega
\]

The branch current can now be determined.

\[
\bar{I}_1 = \frac{\bar{V}}{Z_1} = \frac{240 \angle 0^\circ }{265.258 \angle -90^\circ } = 0.905 \angle 90^\circ \text{ A}
\]

\[
\bar{I}_2 = \frac{\bar{V}}{Z_2} = \frac{240 \angle 0^\circ }{13.742 \angle 43.3^\circ } = 17.465 \angle -43.3^\circ \text{ A}
\]

 Applying KCL,

\[
\bar{I} = \bar{I}_1 + \bar{I}_2 = 0.905 \angle 90^\circ + 17.465 \angle -43.3^\circ
\]

\[
= 12.710 - j11.073 = 16.857 \angle -41.06^\circ \text{ A}
\]

Hence,

\[ I = 16.857 \text{ A} \]

(b) The power dissipated by \( R \) is

\[
P_R = I^2 R = (17.465)^2 (10) = 3050.26 \text{ W}
\]
2. A set of balanced three-phase voltages is impressed on a balanced, three-phase, delta-connected load. If \( V_{ab} = 7200 \angle 0^\circ \) V and \( I_a = 12 \angle 0^\circ \) A. Determine:

(a) The phase current \( I_{ab} \)

(b) The total average power supplied to the load.

Solution:

Assume \( a \cdot b \cdot c \) phase sequence.

(a) The phase current \( I_{ab} \)

\[
I_{ab} = \frac{T_a}{\sqrt{3} \angle -30^\circ} = \frac{12 \angle 0^\circ}{\sqrt{3} \angle -30^\circ}
\]

\( I_{ab} = 6.928 \angle 30^\circ \) A

(b) The total average power supplied to the load.

\[
\theta = \angle V_{ab} - \angle I_{ab} = -30^\circ,
\]

\[
P_r = \sqrt{3}V_I I_c \cos \theta = \sqrt{3}(7200)(12)\cos(-30^\circ) = 129.60 \text{ kW}
\]

3. Capacitors \( C \) are added to the 60-Hz, three-phase network given below to correct the input power factor to unity. Determine:

(a) The value of \( C \)

(b) If \( V_{AB} = 480 \) V, find the total kVAR rating of the capacitor bank.

Solution:

(a) The \( R-L \) branches of the delta network can be converted to an equivalent wye network by

\[
Z_y = \frac{1}{3} Z_A = \frac{1}{3}(3 + j4) \ \Omega
\]
In order for a unity PF to exist, the reactive power supplied by the capacitor of each phase must equal the reactive power supplied to the inductor of each phase.

\[ \omega CV_\phi^2 = \left( \frac{V_\phi}{Z_Y} \right)^2 \omega L_Y \]

or

\[ C = \frac{L_Y}{Z_Y^2} = \frac{L_Y}{\left( \frac{R}{3} \right)^2 + \left( \frac{\omega L}{3} \right)^2} = \frac{1}{3} \left( \frac{4}{120\pi} \right) = 1273.2 \ \mu F \]

(b)

\[ Q_T = 3\omega CV_\phi^2 = 3(120\pi) \left( 1273.2 \times 10^{-6} \right) \left( \frac{480}{\sqrt{3}} \right)^2 = 110.59 \text{ kVARs} \]