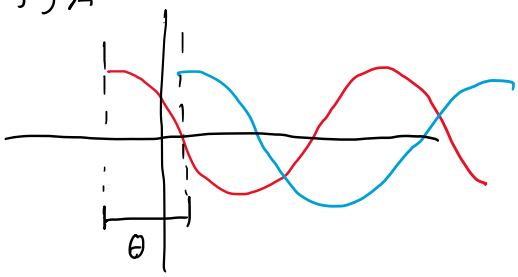
Soal 3 :

Diketahui pada sebuah beban nilai $v = 200 \cos(\omega t - 15^0)$ V dan $i = 10\sqrt{2} \cos(\omega t + 45^0)$ A.
Hitung nilai *P, Q, S,* faktor daya, dan sifat beban?

$v = 200 \cos(\omega t - 15^\circ) V \qquad i = 10\sqrt{2} \cos(\omega t + 45^\circ) A$

$\omega = \frac{2\pi}{T} \qquad V_m = 200 \qquad I_m = 10\sqrt{2}$

$T = \frac{2\pi}{\omega}$



$S = \frac{1}{2} V_m I_m = \frac{1}{2} \cdot 200 \cdot 10\sqrt{2} = 1000\sqrt{2}$ W

$P = S \cos\theta \qquad \theta = \theta_i - \theta_v$

$Q = S \sin\theta \qquad = 45 - (-15)$

$Pf = \cos\theta \qquad = 60^\circ$

$P = 1000\sqrt{2} \cdot \cos 60 = 1000\sqrt{2} \cdot \frac{1}{2} = 500\sqrt{2}$

$Q = 1000\sqrt{2} \cdot \sin 60 = 1000\sqrt{2} \cdot \frac{1}{2}\sqrt{3} = 500\sqrt{6}$

$Pf = \cos 60^\circ = \frac{1}{2} = 0,5$

Sifat beban => Leading

Soal 2 :

Sebuah sistem paralel 3 beban disuplai oleh tegangan efektif sebesar 550 V frekuensi 60 Hz terdiri dari beban 1 sebuah motor dengan daya 60 kW pf 0,75 *lagging*, beban 2 sebuah kapasitor 20 kVAR, dan beban 3 sebuah lampu 20 kW murni. Tentukan :

a. Segitiga daya total ketiga beban tersebut
b. *Power factor* keseluruhan beban
c. Jika diinginkan perbaikan *power factor* menjadi 0,97, berapa nilai komponen yang harus dipasang paralel !

$V_{rms} = 550\ V$ $\quad Q_2 = 20\ k\ VAR$

$f = 60\ Hz$ $\quad P_3 = 20\ kW$

$P_1 = 60\ kW$

$PF_1 = 0,75$

$P_1 = S_1\ PF$ $\quad \cos^{-1}(0,75) = 41,4^\circ$

$60.000 = S_1 \cdot 0,75$ $\quad \sin 41,4^\circ = 0,66$

$S_1 = 80.000\ VA$

$Q_1 = S_1 \cdot \sin\theta$

$Q_1 = 80.000 \cdot 0,66$

$Q_1 = 52.800\ VAR$

a. $S_1 + S_2 + S_3 = (P_1 + jQ_1) + (P_2 + jQ_2) + (P_3 + jQ_3)$

$= (60.000 + j52.800) + (0 + j20.000) + (20.000 + j0)$

$S_T = \underset{P_T}{80.000} + j\ \underset{Q_T}{72.800}$

$S_T = \sqrt{80.000^2 + 72.800^2} = 108.165,7987\ VA$

b. $\tan^{-1}\theta = \frac{72.800}{80000}$

$\theta = 42,3^\circ$

$\cos\theta = 0,74$

c. $\cos\theta' = 0,97$

$\theta' = 14,07^\circ$

$Q' = P \tan\theta' = 80.000 \cdot \tan 14,07^\circ$

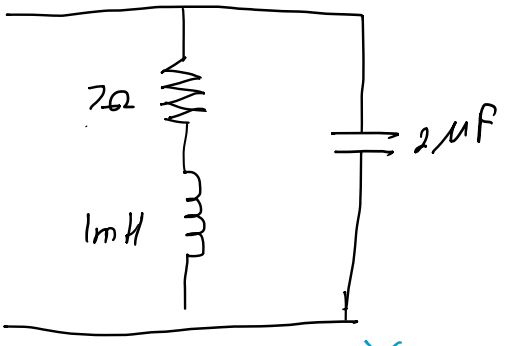
$= 20.000$

$Q_k = Q - Q' = 72.800 - 20000 = 52.800\ VAR$

$52.800 = \frac{V_{rms}^2}{X_C} \rightarrow X_C = \frac{550^2}{52800} = 5,73 = \frac{1}{\omega C}$

$C = \frac{1}{\omega \cdot 5,73} = \frac{1}{2\pi f \cdot 5,73} = \frac{1}{2\pi \cdot 60 \cdot 5,73} = 4,63 \times 10^{-4}\ F$

$= 463\ \mu F$



frekuensi resonansi = ... ?

X_L

$$Z_{seri} = R + j\omega L$$

$$= 7 + j.\omega.10^{-3}$$

$$\frac{1}{Z_T} = \frac{1}{Z_{seri}} + \frac{1}{\frac{j}{\omega C}} = \frac{1}{R + j\omega L} - \frac{\omega C}{j}$$

X_C

$$\frac{1}{Z_T} = \frac{j - \omega C(R + j\omega L)}{(R + j\omega L)\,j}$$

$$Z_T = \frac{jR - \omega L}{j - \omega CR + j\omega^2 LC}$$

$$Z_T = \frac{-\omega L + jR}{-\omega CR + j(\omega^2 LC + 1)} \cdot \frac{-\omega CR - j(\omega^2 LC+1)}{-\omega CR - j(\omega^2 LC+1)}$$

$(a+jb)(a-jb) = a^2 + b^2$

$a \quad +jb$ $\qquad$ $a \quad -jb$

$$Z_T = \frac{\omega^2 RLC + j(\omega^3 L^2 C + \omega L) - j\omega R^2 C - j(\omega^2 RLC + R)}{\omega^2 R^2 C^2 + (\omega^2 LC+1)^2}$$

$$Z_T = \frac{\omega^2 RLC + j(\omega^3 L^2 C + \omega L - \omega R^2 C - \omega^2 RLL - R)}{\omega^2 R^2 C^2 + \omega^4 L^2 C^2 + 2\omega^2 LC + 1}$$

Saat Resonansi $\rightarrow \omega^3 L^2 C - \omega^2 RLC + \omega(L - R^2 C) - R = 0$

$$\omega^3 \omega^{-6} 2.\omega^{-1} - \omega^2 7.\omega^{-3} 2.\omega^{-6} + \omega(\omega^{-3} - 49.2\times\omega^{-6}) - 7 = 0$$

$$2\times\omega^{-12}\,\omega^3 - 14\times10^{-9}\,\omega^2 + 9{,}02\times\omega^{-4}\omega - 7 = 0$$

$$\frac{1}{Z_T} = \frac{j - \omega C(R + j\omega L)}{jR - \omega L} \cdot \frac{-\omega L - jR}{-\omega L - jR}$$

$$= \frac{-j\omega L + R + \omega^2 LC(R + j\omega L) + j\omega RC(R + j\omega L)}{\omega^2 L^2 + R^2}$$

$$= \frac{-j\omega L + R + \omega^2 RLC + j\omega^3 L^2 C + j\omega R^2 C - \omega^2 RLC}{\omega^2 L^2 + R^2}$$

$$\frac{1}{Z_T} = \frac{R + j(-\omega L + \omega^3 L^2 C + \omega R^2 C)}{\omega^2 L^2 + R^2}$$

$$-\omega L + \omega^3 L^2 C + \omega R^2 C = 0$$

$$-L + \omega^2 L^2 C + R^2 C = 0$$

$$\omega^2 L^2 C = L - R^2 C$$

$$\omega^2 = \frac{L - R^2 C}{L^2 C}$$

$$\omega = \sqrt{\frac{L - R^2 C}{L^2 C}}$$

$$2\pi f = \sqrt{\frac{L - R^2 C}{L^2 C}}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{\omega^{-3} - 49 \cdot 2 \cdot \omega^{-6}}{\omega^{-6} \cdot 2 \cdot \omega^{-6}}}$$

$$f = 3729{,}12 \text{ Hz}$$