

第三章例题

Sunday, October 15, 2023 11:12 AM

3.1. 已知: $f=50\text{Hz}$, 初相角 $\varphi_e = \frac{\pi}{4}$, 有效值 $U=220\text{V}$, 求:

(1) 电压最大值:

$$\text{由 } U_m = \sqrt{2}U = 220\sqrt{2} = 311(\text{V})$$

(2) 电压瞬时值的表达式:

$$\text{由 } \omega = \frac{2\pi}{T} = 2\pi f = 100\pi = 314(\text{rad/s})$$

$$\therefore u = 311 \sin(314t + \frac{\pi}{4}) \rightarrow \text{代入 } t = 0.0025$$

$$u = 0.3715(\text{V}) \approx 0 \rightarrow \text{由 } 100\pi = \omega$$

算是0.

相量运算, 代入 $t=0.0025$ $u = 311(\text{V})$.

3.2. $i_1 = \sqrt{2} \cdot 8 \sin(\omega t + 60^\circ) \text{A}$

$$i_2 = \sqrt{2} \cdot 6 \sin(\omega t - 30^\circ) \text{A}, \rightarrow \text{求 } i = i_1 + i_2$$

$$\therefore i_1 + i_2 = 8 \angle 60^\circ + 6 \angle -30^\circ$$

$$= 8 \times \frac{1}{2} + 6 \times \frac{\sqrt{3}}{2} + 8 \times \frac{\sqrt{3}}{2}j - 6 \times \frac{1}{2}j$$

$$= (4 + 3\sqrt{3}) + j(4\sqrt{3} - 3) \quad \varphi = 0.4037(\text{rad})$$

$$= 10 \angle 23.13^\circ$$

$$\text{则: } i = 10\sqrt{2} \cos(\omega t + 23.13^\circ)$$

例3. 同频率两个电压为:

$$u_A = 220\sqrt{2} \sin 314t$$

$$\text{即: } u_A = 220 \angle 0^\circ$$

$$u_B = 220\sqrt{2} \sin(314t - 120^\circ)$$

$$u_B = 220 \angle -120^\circ$$

$$u_C = 220\sqrt{2} \sin(314t + 120^\circ)$$

$$u_C = 220 \angle 120^\circ$$

$$220 + 220(-\frac{1}{2} - \frac{\sqrt{3}}{2}j) + 220(-\frac{1}{2} + \frac{\sqrt{3}}{2}j) = 0,$$

例4. 电感量为 150mH 的电感, 忽略电阻: 求:

(1) 400Hz , $U=100\text{V}$ 正弦交流电源的电流:

$$\omega = \frac{2\pi}{T}, T = \frac{1}{f} \rightarrow \omega = 2\pi f = 400 \times 2\pi = 800\pi(\text{rad/s})$$

$$\omega = \frac{2\pi}{T}, T = \frac{1}{f} \rightarrow \omega = 2\pi f = 400 \times 2\pi = 800\pi \text{ (rad/s)}$$

$$I = \frac{U}{X_L} = \frac{100}{\omega L} = \frac{100}{800\pi \times 150 \times 10^{-3}} = 0.265 \text{ (A)} \\ = 265 \text{ (mA)}$$

②. 50Hz, 流过的电流:

$$X_L = \omega L = 2\pi f \cdot L = 2\pi \times 50 \times 150 \times 10^{-3} = 15\pi$$

$$\therefore I = \frac{U}{X_L} = \frac{100}{15\pi} = 2.122 \text{ (A)}$$

P63 例 5. 0.1μF 电容, 频率 400Hz, 电压为 100V 的正弦交流电源上, 求电流

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = 3978.87 (\Omega).$$

$$I = \frac{U}{X_C} = 25.1 \text{ (mA)}$$

$$\text{在 } 50\text{Hz}: X_C = \frac{1}{\omega C} = \frac{1}{2\pi \times 50 \times C} = 3.18 \times 10^4 (\Omega) = 31.8 \text{ (k}\Omega\text{)}$$

$$I = \frac{U}{X_C} = 3.14 \text{ (mA)}.$$

P66 例 6 RLC 串联电路: $R=20\Omega$, $L=100\text{mH}$, $C=30\mu\text{F}$, 电源电压

$$u=220\sqrt{2} \sin(314t+30^\circ), \text{求:}$$

(1) 电路中的电流 i ,

(2) 各元件电压: $\omega=314 \text{ (rad/s)}$

$$\text{解: (1) } X_L = \omega L = 314 \times 100 \times 10^{-3} = 31.4 (\Omega)$$

$$X_C = \frac{1}{\omega C} = \frac{1}{314 \times 30 \times 10^{-6}} = 106.15 (\Omega) \quad \text{则 } Z = R + j(X_L - X_C) \\ = 20 - 74.76j$$

$$I = \frac{U}{Z} = \frac{220 \angle 30^\circ}{77.4 \angle -75^\circ} = 2.84 \angle 105^\circ = 77.4 \angle -75^\circ$$

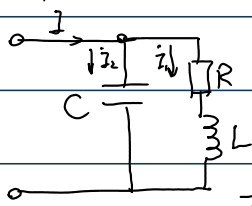
$\xrightarrow{30^\circ - (-75^\circ)}$

$$(2) U_R = IR = 56.84 \angle 105^\circ$$

$$U_L = I \cdot jX_L = 89.176 \angle 175^\circ \quad \text{瞬时值略去。}$$

$$U_C = -jX_C \cdot I = 301.466 \angle 15^\circ$$

P69 例 7. 如图: $R=2\Omega$, $L=18\mu\text{H}$, $C=1\mu\text{F}$, 电源电压 $U=10\text{V}$,



$f=53\text{ kHz}$, 求:

(1) 电路电流:

$$\text{有: } X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = 3 (\Omega)$$



有:

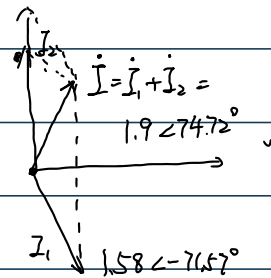
$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = 3(\Omega)$$

$$\therefore \dot{I}_2 = j \frac{\dot{U}}{X_C} = \frac{10 \angle 0^\circ}{3} \times -j = \frac{10}{3} \angle -90^\circ, \text{ 又: } X_L = 2\pi f L = 6(\Omega)$$

$$\text{而: } R + jX_L = 2 + 6j = 6.324 \angle 71.57^\circ$$

$$\therefore \dot{I}_1 = \frac{10 \angle 0^\circ}{6.324 \angle 71.57^\circ} = 1.58 \angle -71.57^\circ \quad ②$$

$$\begin{aligned} \text{则 } \dot{I} = \dot{I}_1 + \dot{I}_2 &= \frac{10}{3} (-j) + 1.58 \cos(-71.57^\circ) + 1.58 \sin(-71.57^\circ)j \\ &= 0.5 + 1.83j = 1.9 \angle 74.72^\circ \end{aligned}$$



P 68. 例8. RLC 串联电路, 功率分别为:

$$u = 220\sqrt{2} \sin(\omega t + 30^\circ) (V) \rightarrow \dot{U} = 220 \angle 30^\circ$$

$$i = 2.8\sqrt{2} \sin(\omega t + 105^\circ) (A) \quad \dot{I} = 2.8 \angle 105^\circ$$

$$\therefore S = \dot{U} \dot{I} = 220 \angle 30^\circ \cdot 2.8 \angle 105^\circ = 616 (W)$$

* 求功率不可用 $\dot{U} \dot{I}$ 相乘求 P , 要用 $P_u - P_i = P = -75^\circ$

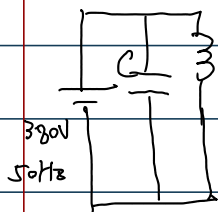
$$\therefore P = UI \cos \varphi = 159.43 (W)$$

$$Q = UI \sin \varphi = -595 (var) \rightarrow \text{无功功率 616 单位 var (乏)}$$

P 75. 例 3.6.1, 一感性负载接于如图电源上, 功率 $P = 20kW$,

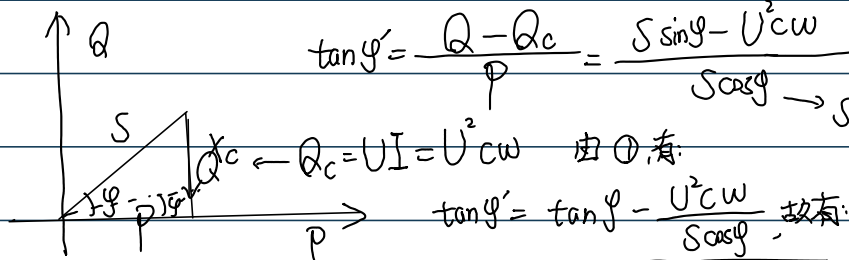
$\cos \varphi = 0.6$, 现并联一个电容 C 使功率因数

提升至 $\cos \varphi' = 0.9$, 求并联电容器的电容:



解: 有: $Q = S \sin \varphi$, 则有:

$$\tan \varphi' = \frac{Q - Q_C}{P} = \frac{S \sin \varphi - U^2 \omega C}{S \cos \varphi} \quad ①$$



$$U = I X_C = I \frac{1}{\omega C}$$

$$C = \frac{P}{U^2 \omega} (\tan \varphi - \tan \varphi')$$

$$C = \frac{20 \times 10^3}{(380)^2 \times 2\pi \times 50} (1.333 - 0.484) = 3.74 \times 10^{-4} (F) = 374.159 (\mu F)$$

②: 并联前后的电流 $\times \frac{S}{P}$

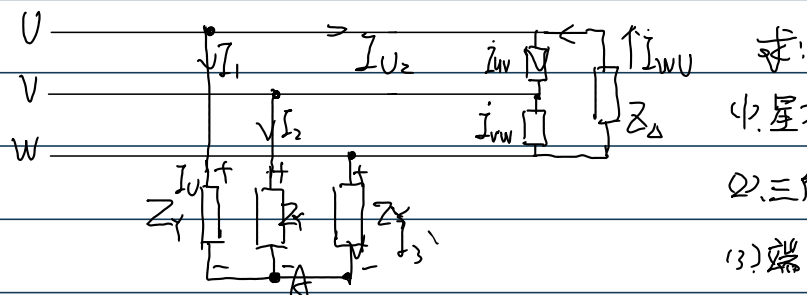
$$\dot{I}_1 = \frac{P}{U \cos \varphi} = \frac{20 \times 10^3}{380 \times 0.6} = 87.7 (A)$$

$$\rightarrow X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = 8.5 (\Omega)$$

$$I_2 = \frac{P}{U \cos \varphi_2} = \frac{20 \times 10^3}{380 \times 0.9} = 58.47 \text{ (A)}$$

由于U相同, P是总功率 I 可使用此计算, (电容无功功率)

例8. 如图三相负载中: 电源线电压为380V, $Z_Y = 3 + 4j (\Omega)$, $Z_\Delta = 10 \Omega$,



求: (1) 星形负载连接的相电压 $\dot{U}_Y, \dot{U}_V, \dot{U}_W$

(2) 三角形负载的相电压 I_{UV}, I_{VW}, I_{WU}

(3) 端线电流 $\dot{I}_1, \dot{I}_2, \dot{I}_3$

(1) 解: 由于三相负载 (星形电源)

$$\varphi_U = 220 \angle 0^\circ$$

$$\varphi_V = 220 \angle -120^\circ$$

$$\varphi_W = 220 \angle 120^\circ$$

则: 由于三相负载对称: 则: $\varphi_\Delta = 0$

$$\dot{U}_Y = \varphi_U = 220 \angle 0^\circ$$

$$\dot{U}_V = \varphi_V = 220 \angle -120^\circ$$

$$\dot{U}_W = \varphi_W = 220 \angle 120^\circ$$

(2) 由 $\dot{U}_{UV} = 380 \angle 30^\circ$, $\dot{U}_{VW} = 380 \angle -90^\circ$, $\dot{U}_{WU} = 380 \angle 150^\circ$

则 $I = \frac{U}{Z} \Rightarrow I_{UV} = 38 \angle 30^\circ$, $I_{VW} = 38 \angle -90^\circ$, $I_{WU} = 38 \angle 150^\circ$. 全减 30° 是课本上的答案

(3) $\dot{I}_U = \dot{I}_1 + \dot{I}_{UV} - \dot{I}_{WU}$ 由 $\dot{I}_1 = \frac{\dot{U}_U}{Z} = \frac{220 \angle 0^\circ}{5 \angle 53^\circ}$

$$= 44 \angle -53^\circ, \quad \dot{I}_2 = 44 \angle -173^\circ, \quad \dot{I}_3 = 44 \angle 67^\circ$$

$$\therefore \dot{I}_U = 44 \angle -53^\circ + 38 \angle 30^\circ - 38 \angle 150^\circ$$

注意三角形电流和负载关系: 大小倍 相位滞后 30°

$$= 92.92 - 35.13j = 99.34 \angle -20.84^\circ$$

也可由三角形负载: $\dot{I}_2 = \sqrt{3} \dot{I}_{UV} \angle -30^\circ$

$$= 38\sqrt{3} \angle 0^\circ$$

$$\dot{I}_{V2} = \sqrt{3} \dot{I}_{VW} \angle -30^\circ = 38\sqrt{3} \angle -120^\circ$$

$$\dot{I}_{W2} = \sqrt{3} \dot{I}_{WU} \angle -30^\circ = 38\sqrt{3} \angle 120^\circ$$

$$\therefore \dot{I}_U = 44 \angle -53^\circ + 38\sqrt{3} \angle 0^\circ$$

$$= 92.3 - 35.14j = 98.76 \angle -20.84^\circ$$

$$\dot{I}_U = 44 \angle -173^\circ + 38\sqrt{3} \angle -120^\circ \quad \dot{I}_2 = 44 \angle -173^\circ + 38\sqrt{3} \angle -120^\circ = 98.76 \angle -140.84^\circ$$

$$= 92.3 - 35.14j = 98.76 \angle -20.84^\circ.$$

$$I_v = 44 \angle -173^\circ + 38\sqrt{3} \angle -120^\circ = I_U \angle -120^\circ = 98.76 \angle -140.84^\circ.$$

$$I_w = I_v \angle -120^\circ = 98.76 \angle 99.16^\circ.$$

另外需要说明：不一定实际解题中选负载 U 为 $220 \angle 0^\circ$ ，

也可选线电压 $\dot{U}_{uv} = 380 \angle 0^\circ$ ，为参考电压、