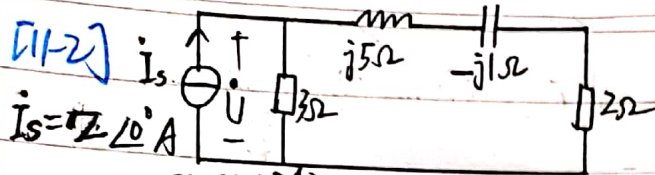


第十一章作业



$$Z_{eq} = \frac{3 \times (2 + j4)}{3 + 2 + j4} = \frac{78}{41} + \frac{36}{41}j = 2.10 \angle 24.78^\circ \Omega$$

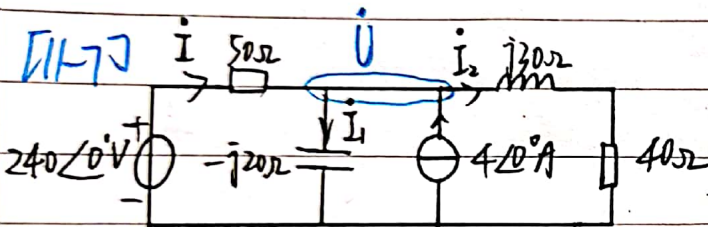
$$U = I_s \cdot Z_{eq} = 4.2 \angle 24.78^\circ \text{ V}$$

$$P = UI \cos(\phi_u - \phi_i) = 4.2 \times 2 \times \cos \angle 24.78^\circ = 7.61 \text{ W}$$

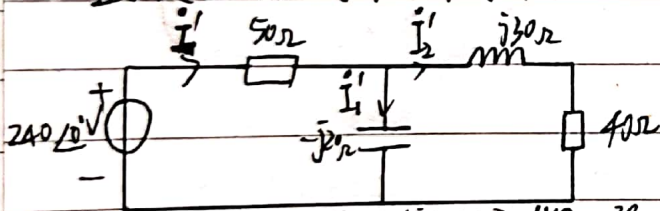
$$Q = UI \sin(\phi_u - \phi_i) = 4.2 \times 2 \times \sin \angle 24.78^\circ = 3.51 \text{ var}$$

\dot{U}, \dot{I} 为非关联参考方向, 提供功率

\therefore 提供有功功率 7.61 W, 无功功率 3.51 var



由叠加定理: 电压源单独作用时



$$Z_{eq1} = 50 + \frac{-j20 \times (j30 + 40)}{-j20 + j30 + 40} = \frac{110}{17} - \frac{380}{17}j \Omega$$

$$= 69.01 \angle 18.9^\circ \Omega$$

$$\dot{I}' = \frac{U}{Z_{eq1}} = \frac{240 \angle 0^\circ}{69.01 \angle 18.9^\circ} = 3.48 \angle 18.9^\circ \text{ A}$$

$$\dot{I}_1' = \frac{j30 + 40}{j10 + 40} \dot{I}' = \left(\frac{19}{17} + \frac{8}{17}j \right) \times 3.48 \angle 18.9^\circ$$

$$= 1.21 \angle 22.83^\circ \times 3.48 \angle 18.9^\circ = 4.21 \angle 41.73^\circ \text{ A}$$

$$\dot{I}_2' = \frac{-j20}{j10 + 40} \dot{I}' = \left(\frac{-2}{17} - \frac{8}{17}j \right) \times 3.48 \angle 18.9^\circ$$

$$= 0.48 \angle -104.04^\circ \times 3.48 \angle 18.9^\circ = 1.67 \angle -85.1^\circ \text{ A}$$

(用叠加定理太麻烦了, 换节点法)

$$\left(\frac{1}{50} + \frac{1}{-j20} + \frac{1}{j30 + 40} \right) \dot{U} = \frac{240 \angle 0^\circ}{50} + 4 \angle 0^\circ$$

$$\therefore \dot{U} = 167.93 \angle -46.54^\circ \text{ V}$$

$$\dot{I} = \frac{240 \angle 0^\circ - 167.93 \angle -46.54^\circ}{50} = 2.49 + j2.44 \text{ A}$$

$$= 3.49 \angle 44.41^\circ \text{ A}$$

$$\dot{I}_1 = \frac{167.93 \angle -46.54^\circ}{-j20} = 8.39 \angle 43.46^\circ \text{ A}$$

$$\dot{I}_2 = \frac{167.93 \angle -46.54^\circ}{j30 + 40} = \frac{167.93 \angle -46.54^\circ}{50 \angle 36.87^\circ} = 3.36 \angle -83.41^\circ \text{ A}$$

$$j30\Omega \text{ 电感: } \dot{U}_1 = j30 \dot{I}_2$$

$$40\Omega \text{ 电阻: } \dot{U}_2 = 40 \dot{I}_2$$

两个受控源电压电流均为非关联参考方向

输出功率

$$240 \angle 0^\circ \text{ V 的 } \bar{S}_1 = 240 \angle 0^\circ \cdot \dot{I}^* = (598.34 - j586.14) \text{ V} \cdot \text{A}$$

$$4 \angle 0^\circ \text{ A 的 } \bar{S}_2 = 167.93 \angle 46.54^\circ \angle 0^\circ$$

发出

$$= (462.54 - j488.21) \text{ V} \cdot \text{A}, \text{ 发出}$$

$$50\Omega \text{ 电阻: } \bar{S}_3 = (240 \angle 0^\circ - \dot{U}) \cdot \dot{I}^* = 609.01 \text{ V} \cdot \text{A} \text{ 吸收}$$

$$-j20\Omega \text{ 电感: } \bar{S}_4 = \dot{U} \times \dot{I}_1^* = 1408.93 \angle -90^\circ = (-j1408.93) \text{ V} \cdot \text{A}$$

$$j30\Omega \text{ 电容: } \bar{S}_5 = \dot{U} \times \dot{I}_2^* = 30 \angle 90^\circ \times 11.29 \angle 0^\circ = (338.69j) \text{ V} \cdot \text{A}$$

吸收

$$40\Omega \text{ 电阻: } \bar{S}_6 = \dot{U}_2 \times \dot{I}_2^* = 451.58 \text{ V} \cdot \text{A}, \text{ 吸收}$$

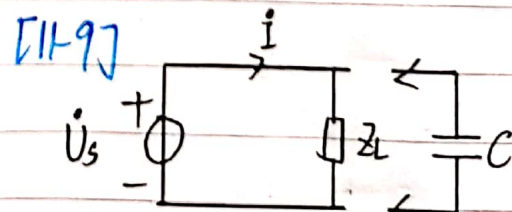
$$\therefore \text{Re}[\bar{S}_1] + \text{Re}[\bar{S}_2]$$

$$= \text{Re}[\bar{S}_3] + \text{Re}[\bar{S}_4] + \text{Re}[\bar{S}_5] + \text{Re}[\bar{S}_6]$$

$$\text{Im}[\bar{S}_1] + \text{Im}[\bar{S}_2]$$

$$= \text{Im}[\bar{S}_3] + \text{Im}[\bar{S}_4] + \text{Im}[\bar{S}_5] + \text{Im}[\bar{S}_6]$$

\therefore 复功率守恒



$$U_s = 220 \text{ V}, f = 50 \text{ Hz}, Z = (10 + j5) \Omega$$

$$\dot{I} = \frac{U_s}{Z} = \frac{88}{13} - \frac{132}{13}j = 12.20 \angle -56.31^\circ \text{ A}$$



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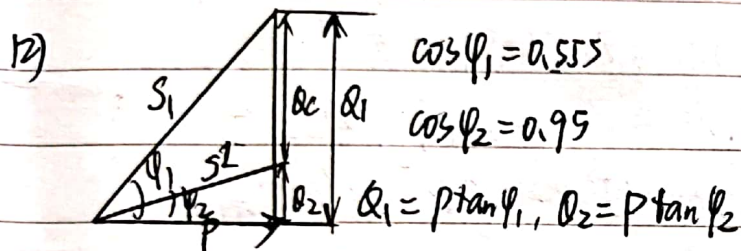
$$P = U_s I \cos(\phi_{us} - \phi_i) = 220 \times 12.20 \times \cos(56.31^\circ) = 1488.41 \text{ W}$$

$$Q = U_s I \sin(\phi_{us} - \phi_i) = 220 \times 12.20 \times \sin(56.31^\circ) = 2232.63 \text{ var}$$

$$S = \sqrt{P^2 + Q^2} = 2684.0 \text{ V}\cdot\text{A}$$

$$\lambda = \frac{P}{S} = \cos(\phi_{us} - \phi_i) = 0.5546 \approx 0.555 \text{ 感性}$$

$$I = 12.20 \text{ A}$$

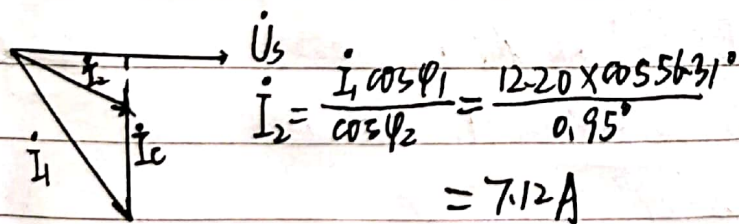


$$C = \frac{Q_1 - Q_2}{\omega U_s^2} = \frac{P(\tan \phi_1 - \tan \phi_2)}{\omega U_s^2} = \frac{1488.41 \times 0.78}{2\pi \times 50 \times 220 \times 220} = 114.56 \mu\text{F}$$

$$P' = P = 1488.41 \text{ W}$$

$$Q' = P' \tan \phi_2 = 489.21 \text{ var}$$

$$S' = \sqrt{P'^2 + Q'^2} = 1566.75 \text{ V}\cdot\text{A}$$



∴ 线路电流 7.12 A

$$C = \frac{I_1 \sin \phi_1 - I_2 \sin \phi_2}{\omega U_s} = 114.56 \mu\text{F}$$

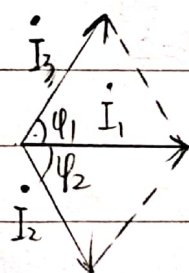
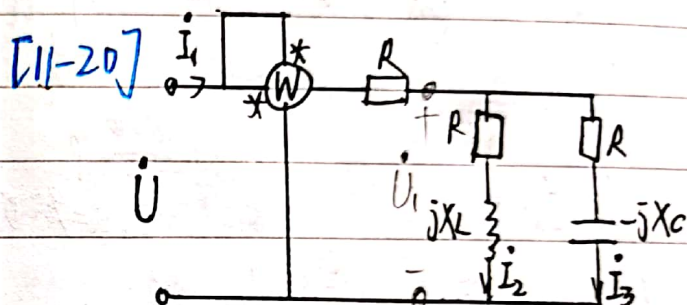
$$Z_{eq} = j1 + \frac{6 \times (3 - j2)}{6 + 3 + (-j2)} = \left(\frac{186}{85} + \frac{13}{85}j \right) \Omega$$

$$\dot{U}_{oc} = \frac{3 - j2}{6 + 3 + (-j2)} \times 4 \angle 0^\circ \times 6 = \left(\frac{744}{85} - \frac{288}{85}j \right) \Omega$$

∴ $R_L = |Z_{eq}| = 2.19 \Omega$ 时, 功率最大

$$P_{Lmax} = \frac{U_{oc}^2}{(R_L + R_{eq})^2 + X_{eq}^2} \times R_L = 10.05 \text{ W}$$

∴ $R_L = 2.19 \Omega$ 时有功功率最大, 10.05 W.



$$\therefore I_1 = I_2 + I_3 \text{ 又 } I_1 = I_2 = I_3$$

$$\therefore \phi_1 = \phi_2 = 60^\circ$$

$$I_1 = U = U_R + U_1$$

$$\text{又 } U_1 = \frac{U_R}{\cos 60^\circ} = 2U_R$$

$$\therefore U_R = 50 \text{ V}$$

$$I_1 = \frac{P}{U} = 10 \text{ A}$$

I_1, U 为关联参考方向

$$\therefore R = \frac{U_R}{I_1} = 5 \Omega$$

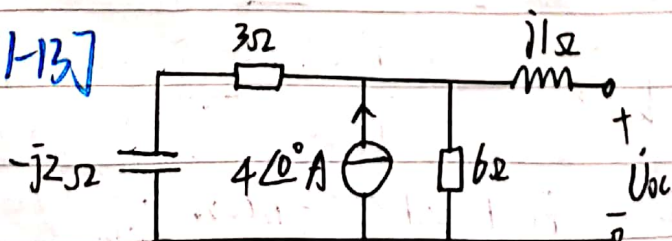
$$U_L = U_C = U_R \tan \phi_2 = 50\sqrt{3} \text{ V}$$

$$X_L = \frac{U_L}{I_2} = 5\sqrt{3} \Omega, X_C = \frac{U_C}{I_3} = 5\sqrt{3} \Omega$$

[11-26] (见下-面)

写不下了

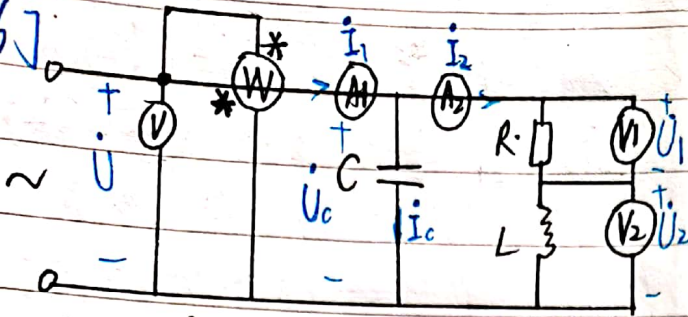
[11-13]



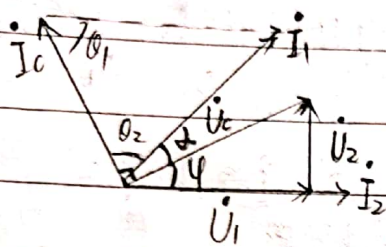
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其他题目

[11-26]



如图, 选 \dot{I}_2 为参考相量



$$\dot{U} = \dot{U}_C = \dot{U}_1 + \dot{U}_2$$

$$\text{知 } \arctan \varphi = \frac{U_2}{U_1} = \frac{1}{2}$$

$$\dot{I}_1 = \dot{I}_C + \dot{I}_2 \quad I_1 = I_2 \quad \therefore \theta_1 = \theta_2 = \theta, \alpha = 90^\circ - \theta = \varphi$$

$$P = UI_1 \cos \alpha = 100 \text{ W} \quad I_1 = \frac{\sqrt{2}}{2} \text{ A} \quad I_2 = \frac{\sqrt{2}}{2} \text{ A}$$

$$\alpha = 90^\circ + \varphi = 180^\circ \quad \therefore \tan \theta = 2$$

$$\therefore I_C = 2I_1 \cos \theta = 1 \text{ A}$$

$$X_C = \frac{U_C}{I_C} = 100 \Omega$$

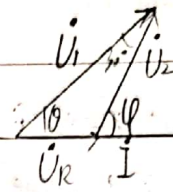
$$U_1 = U_C \cos \varphi = 40\sqrt{2} \text{ V} \quad U_2 = U_C \sin \varphi = 20\sqrt{2} \text{ V}$$

$$R = \frac{U_1}{I_2} = 80 \Omega \quad X_L = \frac{U_2}{I_2} = 40 \Omega$$

[11-4] $P_2 = U_2 I \cos(\phi_{u2} - \phi_i)$

$$\text{又 } \frac{Q_2}{P_2} = \tan(\phi_{u2} - \phi_i) = 3$$

$$\text{知 } \tan \varphi = 3, \tan \theta = \tan(\varphi - 30^\circ)$$



$$\theta = 41.57^\circ$$

$$\frac{U_2}{U_R} = \frac{\sin \theta}{\sin 30^\circ} = 1.23 = 1.2327$$

$$\therefore \frac{|Z|}{R} = \frac{U_2}{U_R}$$

$$\therefore |Z| = 13.3$$

$$\text{又 } Z = R + jX \quad \frac{X}{R} = \tan \varphi = 3$$

$$\therefore Z = (4.21 + j12.62) \Omega$$

$$P = I^2 \cdot 4.21 = 4 \text{ W} \quad \therefore I = 0.9747 \text{ A}$$

[11-5] 统一用 cos 表示

$$\dot{U}_1 = 60 \angle -90^\circ \text{ V}, \quad U_L = 80 \angle 0^\circ \text{ V}$$

$$\dot{Z}_L = j8 \Omega$$

$$\dot{U}_1 = \dot{U}_L + \dot{U}_2 \quad \dot{I} = \frac{\dot{U}_1}{\dot{Z}_L} = 10 \angle -90^\circ \text{ A}$$

$$\dot{U}_2 = \dot{U}_1 - \dot{U}_L = -80 - j60 = 100 \angle 143.13^\circ \text{ V}$$

$$\therefore P = U_2 I \cos(\phi_{u2} - \phi_i) = 600 \text{ W}$$

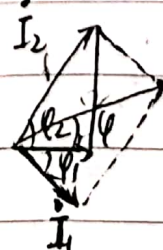
$$Q_2 = U_2 I \sin(\phi_{u2} - \phi_i) = -800 \text{ var}$$

$$S_2 = \sqrt{P_2^2 + Q_2^2} = 1000 \text{ VA}$$

$$\cos \phi_2 = \frac{P_2}{S_2} = 0.6 \quad (\text{感性})$$

$$Z = (6 - j8) \Omega$$

[11-6] $\dot{I} = \dot{I}_1 + \dot{I}_2$



$$I_1 = \sqrt{I_2^2 + I^2 - 2I_2 I \cos(\varphi_2 - \varphi)}$$

$$= \sqrt{36 + 144 - 2 \times 6 \times 12 \times \frac{3}{5}} = 6.46 \text{ A}$$

$$P_1 = I_1^2 |Z_1| \cos \varphi_1 = 1200 \text{ W}$$

$$\therefore |Z_1| \cos \varphi_1 = 28.74 \Omega$$



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