

习 题 八

8—1 已知对称三相电路线电压有效值为 380V 的三相电源接在星形连接的三相负载上, 每相负载电阻 $R=5\ \Omega$, 感抗 $X_L=10\ \Omega$ 。试求此负载的相电流 \dot{I}_A 、 \dot{I}_B 、 \dot{I}_C 及相电压 \dot{U}_A 、 \dot{U}_B 、 \dot{U}_C 。

解

$$\text{设 } \dot{U}_A = 220 \angle 0^\circ \text{ V}$$

$$\dot{U}_B = 220 \angle -120^\circ \text{ V}$$

$$\dot{U}_C = 220 \angle -240^\circ \text{ V}$$

$$\dot{I}_A = \frac{\dot{U}_A}{R + jX_L}$$

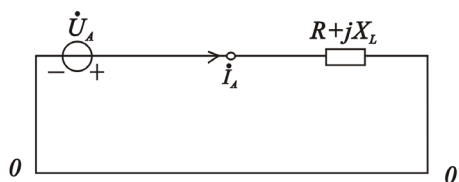
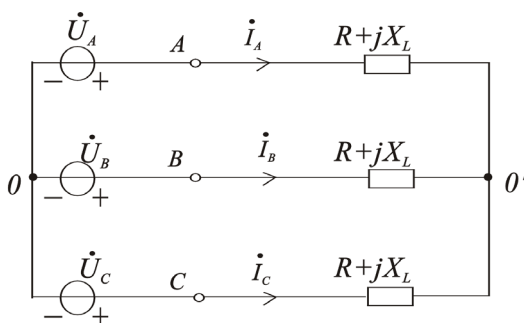
$$= \frac{220 \angle 0^\circ}{5 + j10}$$

$$= \frac{220 \angle 0^\circ}{5(1 + j2)} = \frac{44 \angle 0^\circ}{\sqrt{5} \angle 63.4^\circ}$$

$$= 19.7 \angle -63.4^\circ$$

$$\dot{I}_B = 19.7 \angle (-120^\circ - 63.4^\circ) = 19.7 \angle -183.4^\circ \text{ A}$$

$$\dot{I}_C = 19.7 \angle (120^\circ - 63.4^\circ) = 19.7 \angle 56.6^\circ \text{ A}$$

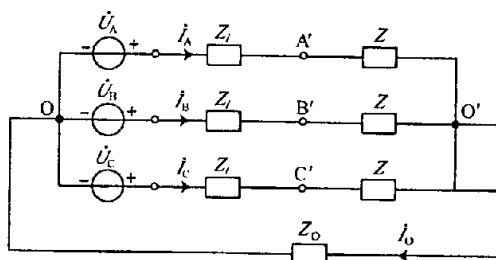


8—2 题 8—2 图示对称三相电路中, $u_A = 220\sqrt{2} \cos(314t + 30^\circ) \text{ V}$,

$z = (20 + j10\sqrt{5})\ \Omega$, $Z_l = (2 + j1)\ \Omega$, $Z_o = (2 + j1)\ \Omega$ 。求:

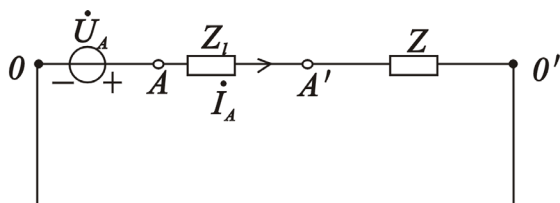
(1) 线电流 \dot{I}_A 、 \dot{I}_B 、 \dot{I}_C 及中线电流 \dot{I}_O ;

(2) 电压 $u_{A'B'}$ 的瞬时表达式。



题 8—2 图

解



$$\text{设 } \dot{U}_{AB} = 380 \angle 60^\circ \text{ V}$$

$$\dot{I}_A = \frac{\dot{U}_A}{Z_l + Z} = \frac{220 \angle 30^\circ}{(2 + j) + (20 + j10\sqrt{5})} = \frac{220 \angle 30^\circ}{32.1 \angle 46.8^\circ} = 6.85 \angle (-16.8^\circ) \text{ A}$$

$$\dot{I}_B = 6.85 \angle (-136.8^\circ) \text{ A} \quad \dot{I}_C = 6.85 \angle 103.2^\circ \text{ A}$$

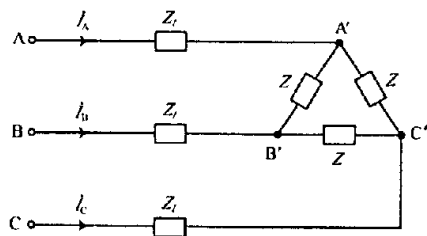
$$\dot{I}_O = 0 \text{ A}$$

$$\begin{aligned} \therefore \dot{U}_{A'O'} &= Z \dot{I}_A = (20 + j10\sqrt{5}) \times 6.85 \angle -16.8^\circ \\ &= 30 \angle 48.2^\circ \times 6.85 \angle -16.8^\circ \\ &= 205.5 \angle 31.4^\circ \end{aligned}$$

$$\therefore \dot{U}_{A'B'} = 205.5 \sqrt{3} \angle (31.4^\circ + 30^\circ) = 355.9 \angle 61.4^\circ \text{ A}$$

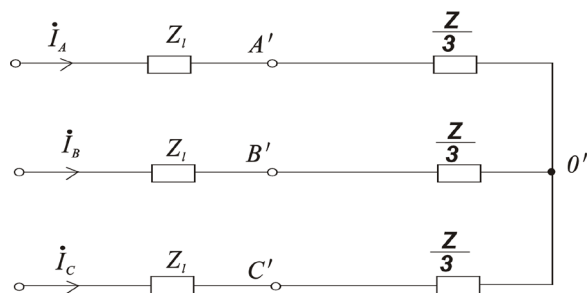
$$u_{A'B'}(t) = 355.9 \sqrt{2} \cos(314t + 61.4^\circ)$$

8—3 已知对称三相电路如题 8—3 图所示，线电压 $U_l = 380 \text{ V}$ ，输电线阻抗 $Z_l = 5 \Omega$ ，负载阻抗 $Z = (15 + j30) \Omega$ 。求线电流相量 \dot{I}_A 、 \dot{I}_B 、 \dot{I}_C 及相电流相量 $\dot{I}_{A'B'}$ 、 $\dot{I}_{B'C'}$ 、 $\dot{I}_{C'A'}$ 。

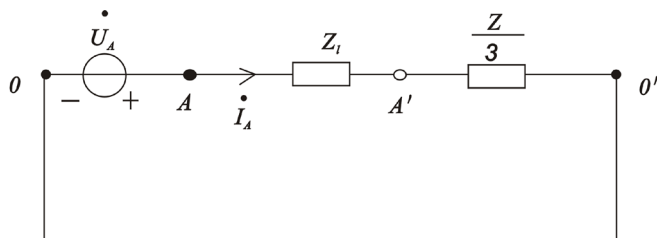


题 8—3 图

解：



A 相单相计算图:



设 $\dot{U}_A = 220 \angle 0^\circ \text{ V}$

$$\dot{I}_A = \frac{\dot{U}_A}{Z_l + \frac{Z}{3}} = \frac{220 \angle 0^\circ}{5 + (5 + j10)} = \frac{220}{10\sqrt{2} \angle 45^\circ} = 11\sqrt{2} \angle -45^\circ \text{ A}$$

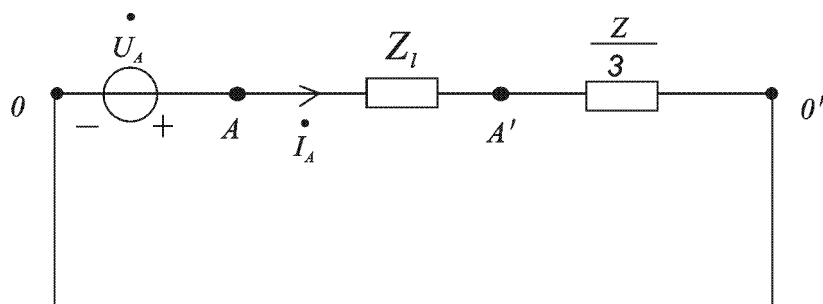
$$\dot{I}_B = 11\sqrt{2} \angle -165^\circ \text{ A} \qquad \dot{I}_C = 11\sqrt{2} \angle 75^\circ \text{ A}$$

$$\dot{I}_{A'B'} = \frac{\dot{I}_A}{\sqrt{3}} \angle (-45^\circ + 30^\circ) = \frac{11\sqrt{2}}{\sqrt{3}} \angle -15^\circ \text{ A}$$

$$\dot{I}_{B'C'} = \frac{11\sqrt{2}}{\sqrt{3}} \angle -135^\circ \text{ A}, \qquad \dot{I}_{C'A'} = \frac{11\sqrt{2}}{\sqrt{3}} \angle -105^\circ \text{ A}$$

8—4 题 8—3 图示对称三相电路中，若要使三角形连接的负载相电压 $\dot{U}_{A'B'} = \dot{U}_{B'C'} = \dot{U}_{C'A'} = 380 \text{ V}$ ，且阻抗 $Z = (10\sqrt{3} + j10) \Omega$ ， $Z_l = (1 + j\sqrt{2}) \Omega$ 。试求电源线电压 U_{AB} 的有效值。

图如 8—3 题所示，设 $\dot{U}_{A'O'} = 220 \angle 0^\circ \text{ V}$

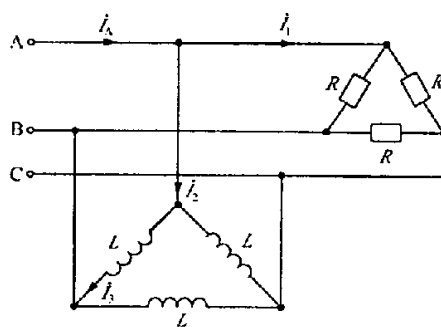


$$\dot{I}_A = \frac{220 \angle 0^\circ}{\frac{10\sqrt{3} + j10}{3}} = \frac{660 \angle 0^\circ}{10 \times 2 \angle 30^\circ} = 33 \angle -30^\circ \text{ A}$$

$$\begin{aligned} \therefore \dot{U}_A &= \dot{U}_{AO'} = Z_l \dot{I}_A + \dot{U}_{A'O'} \\ &= (1 + j\sqrt{2}) 33 \angle -30^\circ + 220 \angle 0^\circ \\ &= \sqrt{3} \angle 54.7^\circ 33 \angle -30^\circ + 220 \\ &= 33\sqrt{3} \angle 24.7^\circ + 220 \\ &= 51.9 + j23.9 + 220 \\ &= 272.9 \angle 5^\circ \text{ V} \end{aligned}$$

$$\therefore U_{AB} = 272.9 \times \sqrt{3} = 472.7 \text{ V}$$

8—5 对称三相电路如题 8—5 图所示，电源角频率 $\omega = 2\pi \times 50 \text{ rad/s}$ ，电源线电压为 380 V ，有一组三角形连接电阻负载，每相电阻值为 20Ω ，另有一组三角形连接电感负载，已知两组负载的线电流有效值 $I_1 = I_2$ 。求三角形电感负载每相电感系数 L 及负载相电流 \dot{I}_3 、线电流 \dot{I}_A 。



题 8-5 图

解 若要 $I_1 = I_2$ ，应有 R 与 L 的阻抗相等。

$$R = \omega L \rightarrow L = \frac{R}{\omega} = \frac{20}{2\pi \times 50} = \frac{1}{5\pi} (H)$$

$$\text{设 } \dot{U}_{AB} = 380 \angle 0^\circ \text{ V}, \quad \dot{I}_{ABR} = \frac{380 \angle 0^\circ}{20} = 19 \angle 0^\circ \text{ A}$$

$$\dot{I}_1 = \sqrt{3} I_{ABR} \angle (0^\circ - 30^\circ) = 19\sqrt{3} \angle -30^\circ \text{ A}$$

$$\dot{I}_{ABL} = \dot{I}_3 = \frac{380 \angle 0^\circ}{j\omega L} = \frac{380 \angle 0^\circ}{j20} = 19 \angle -90^\circ \text{ A}$$

$$i_2 = \sqrt{3} I_{ABL} \angle (-90^\circ - 30^\circ) = 19\sqrt{3} \angle -120^\circ \text{ A}$$

$$\begin{aligned} \therefore i_A &= i_1 + i_2 = 19\sqrt{3} (\angle -30^\circ + \angle -120^\circ) \\ &= 19\sqrt{3} (0.87 - j0.5 - 0.5 + j0.87) \\ &= 19\sqrt{3} (0.37 + j0.37) \\ &= 19\sqrt{3} \times 0.37\sqrt{2} \angle 45^\circ \\ &= 17.2 \angle 45^\circ \text{ A} \end{aligned}$$

8—6 某对称三相用电设备的额定线电压为 380V，假定线电流为 150A，功率因数为 0.8，试求此设备的有功功率、无功功率、视在功率。

$$\begin{aligned} \text{解 } p &= \sqrt{3} U I_l \cos \varphi \\ &= \sqrt{3} \times 380 \times 150 \times 0.8 = 78981.5 \text{ W} \end{aligned}$$

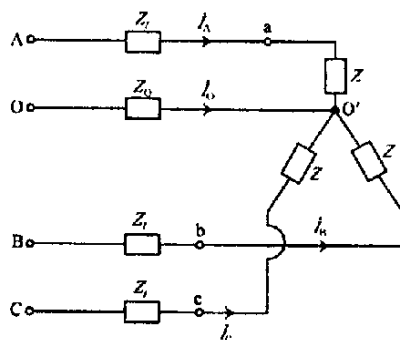
$$\therefore \varphi = \arccos(0.8) = 36.9^\circ$$

$$\begin{aligned} \text{无功功率 } Q &= \sqrt{3} U I_l \sin \varphi = \sqrt{3} \times 380 \times 150 \times 0.6 \\ &= 59236 \text{ VAR} \end{aligned}$$

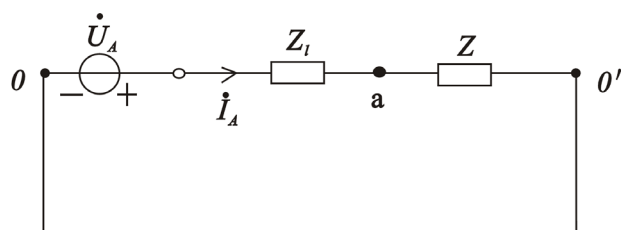
$$\text{视在功率: } S = \sqrt{3} \times 380 \times 150 = 98726.9 \text{ VA}$$

8—7 题 8—7 图示对称三相电路，电源端线电压 $U_{AB}=380\text{V}$ 。端线阻抗 $Z_l=(1+j2)\Omega$ ，中线阻抗 $Z_0=(1+j)\Omega$ ，负载每相阻抗 $Z=(12+j3)\Omega$ ，求：

- (1) i_A 、 i_B 、 i_C 、 i_O
- (2) 负载端线电压 \dot{U}_{ab} 、 \dot{U}_{bc} 、 \dot{U}_{ca} 。
- (3) 三相负载吸收的总有功功率。



题 8—7 图



(1) 设 $\dot{U}_A = 220 \angle 0^\circ \text{ V}$, 由题知 $Z_l = 1 + j2 \Omega$, $Z = 12 + j3 \Omega$

$$\dot{I}_A = \frac{220 \angle 0^\circ}{Z_l + Z} = \frac{220}{13 + j5} = \frac{220}{5.8 \angle 59^\circ} = 37.9 \angle -59^\circ \text{ A}$$

$$\dot{I}_B = 37.9 \angle -17.9^\circ \text{ A} \quad \dot{I}_C = 37.9 \angle 61^\circ \text{ A}$$

$$\dot{I}_o = 0$$

$$\begin{aligned} (2) \because \dot{U}_{ao'} &= Z \dot{I}_A = (12 + j3) 37.9 \angle -59^\circ \\ &= 12.4 \angle 14^\circ \times 37.9 \angle 59^\circ \\ &= 470 \angle -45^\circ \end{aligned}$$

$$\therefore \dot{U}_{ab} = 470 \sqrt{3} \angle (-45^\circ + 30^\circ) = 470 \sqrt{3} \angle -15^\circ \text{ V}$$

$$\dot{U}_{bc} = 470 \sqrt{3} \angle -135^\circ \text{ V}, \quad \dot{U}_{ca} = 470 \sqrt{3} \angle 105^\circ \text{ V}$$

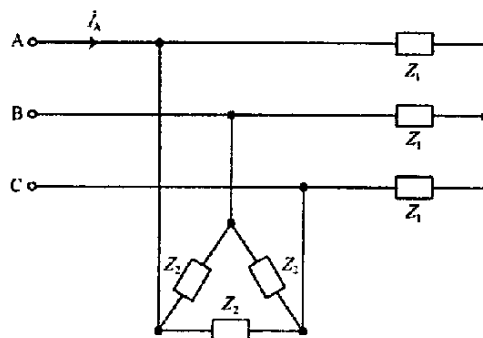
$$(3) P = \sqrt{3} U_{ab} I_A \cos[\arccos(12 + j3)]$$

$$= \sqrt{3} \times 470 \sqrt{3} \times 37.9 \cos 14^\circ = 51.9 \text{ kW}$$

8—8 对称三相电路如题 8—8 图所示, 当负载星形连接, 每相阻抗 $Z_l = (5 + j5) \Omega$; 当负载三角形连接, 每相阻抗 $Z_2 = (15 + j12) \Omega$, 已知电源线电压 380 V, 频率 $f = 50 \text{ Hz}$ 。试求:

(1) 两组负载总有功功率 P 、线电流 I_A 、电路功率因数。

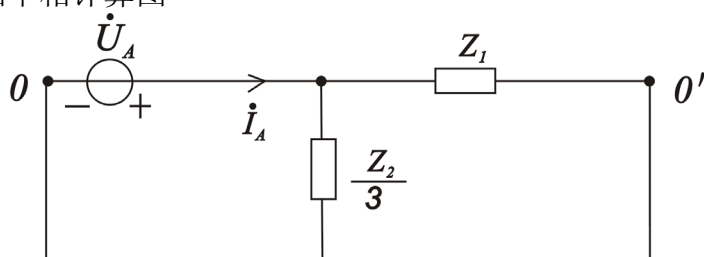
(2) 若要使负载总的功率因数提高到 0.95, 应该将补偿电容如何连接? 并计算出每相电容的值。



题 8 - 8 图

解 A 相单相计算图

(1)



$$\text{设 } \dot{U}_A = 220 \angle 0^\circ$$

$$\frac{Z_2}{3} // Z_1 = Z_{eq} = \frac{(5 + j4)5\sqrt{2} \angle 45^\circ}{(5 + j4) + 5 + j5}$$

$$= \frac{6.4 \angle 38.7^\circ \times 5\sqrt{2} \angle 45^\circ}{10 + j9}$$

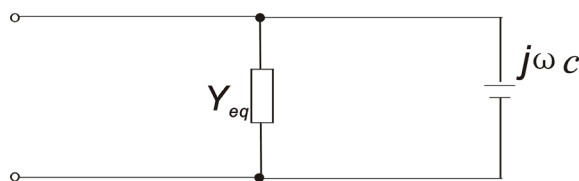
$$= \frac{45.3 \angle 83.7^\circ}{13.5 \angle 42^\circ}$$

$$= 3.36 \angle 41.7^\circ \Omega$$

$$\dot{I}_A = \frac{\dot{U}_A}{Z_{eq}} = \frac{220 \angle 0^\circ}{3.36 \angle 41.7^\circ} = 65.5 \angle -41.7^\circ \text{ A}$$

$$\therefore p = \sqrt{3} \times 380 \times 65.5 \times \cos 41.7^\circ = 32.3 \text{ kW}$$

(2) 提高功率因数到 $\cos \varphi = 0.95$

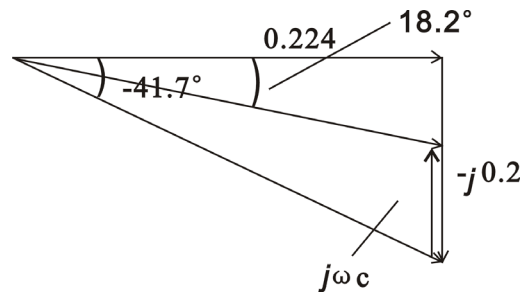


$$\varphi = \arccos 0.95 = 18.2^\circ$$

$$Z_{eq} = 3.36 \angle 41.7^\circ = 2.5 + j2.2$$

$$Y_{eq} = \frac{1}{Z_{eq}} = \frac{1}{3.36 \angle 41.7^\circ} = 0.3 \angle -41.7^\circ$$

$$= 0.224 - j0.2$$



并电容后 $Y = Y_{eq} + j\omega c = 0.224 - j0.2 + j\omega c = |Y| \angle -18.2^\circ$

$$\therefore \tan(-18.2^\circ) = \frac{-0.2 + \omega c}{0.224} = -0.33$$

$$\omega c = (-0.33 \times 0.224) + 0.2 = -0.074 + 0.2 = 0.126$$

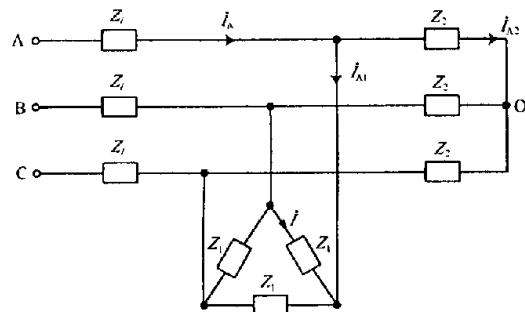
$$c = \frac{0.126}{\omega} = \frac{0.126}{2\pi \times 50} = 0.04 \times 10^{-2} = 400 \times 10^{-6}$$

$$= 400 \mu F$$

8—9 对称三相电路如题 8—9 图所示, 已知 $\dot{U}_{AB} = 380 \angle 30^\circ \text{ V}$, $Z_l = (2 + j3) \Omega$, $Z_l = (48 + j36) \Omega$, $Z_2 = (12 + j16) \Omega$ 。求,

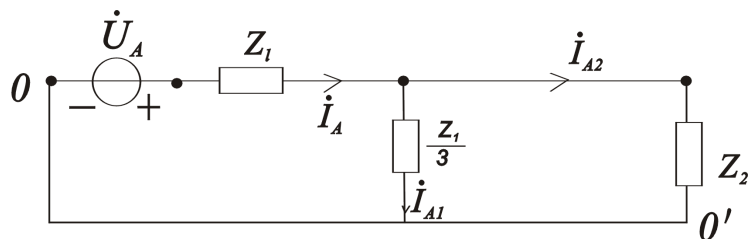
(1) 图示的 \dot{I}_A 、 \dot{I}_{A1} 、 \dot{I}_{A2} 及 \dot{I} 。

(2) 三相电源发出的总功率 P 。



题 8-9 图

解 A 相单相计算图



(1) 设 $\dot{U}_{AB} = 380 \angle 30^\circ$ 则

$$\dot{U}_A = 220 \angle 0^\circ \text{ V}$$

$$\dot{I}_A = \frac{\dot{U}_A}{Z_l + \frac{Z_l \times \frac{1}{3} \times Z_2}{\frac{Z_l}{3} + Z_2}}$$

$$= \frac{220 \angle 0^\circ}{2 + j3 + \frac{(16 + j12)(12 + j16)}{(16 + j12) + (12 + j16)}}$$

$$= \frac{220}{2 + j3 + 10.1 \angle 45^\circ}$$

$$= \frac{220}{2 + j3 + 7.14 + j7.14}$$

$$= \frac{220}{9.14 + j10.14}$$

$$= \frac{220}{13.7 \angle 48^\circ}$$

$$= 16.1 \angle -48^\circ \text{ A}$$

$$\begin{aligned} \dot{I}_{A2} &= \frac{\frac{Z_l}{3}}{\frac{Z_l}{3} + Z_2} \times \dot{I}_A = \frac{20 \angle 36.9^\circ}{28\sqrt{2} \angle 45^\circ} \times 16.1 \angle -48^\circ \\ &= 8.13 \angle -56.1^\circ \text{ A} \end{aligned}$$

$$\begin{aligned} \dot{I}_{A1} &= \dot{I}_A - \dot{I}_{A2} = 16.1 \angle -48^\circ - 8.13 \angle -56.1^\circ \\ &= 10.8 - j12 - (4.53 - j6.75) \\ &= 10.8 - j12 - 4.53 + j6.75 \\ &= 6.27 - j5.25 \end{aligned}$$

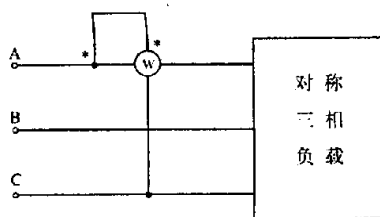
$$=8.2\angle-40^\circ \text{ A}$$

$$\begin{aligned}\therefore \dot{I}_{A1} &= \sqrt{3} \dot{I}_{AB} \angle -30^\circ \\ &= \sqrt{3} \times (-\dot{I}) \angle -30^\circ\end{aligned}$$

$$\therefore \dot{I} = \frac{-\dot{I}_{A1}}{\sqrt{3}\angle-30^\circ} = \frac{-8.2\angle-40^\circ}{\sqrt{3}\angle-30^\circ} = -4.7\angle-10^\circ \text{ A}$$

$$\begin{aligned}(2) P &= \sqrt{3} U_l I_l \cos \varphi = \sqrt{3} \times 380 \times 16.1 \cos(-48^\circ) \\ &= \sqrt{3} \times 380 \times 16.1 \times 0.669 \\ &= 7089 \text{ W}\end{aligned}$$

8—10 三相对称电源向三相对称负载供电如题 8—10 图所示。电源线电压为 380V，负载吸收总功率为 2.4kW，功率因数为 0.6。若负载为星形连接，求每相阻抗 Z 及功率表的读数。



题 8 - 10 图

(1) 设 $\dot{U}_{AB} = 380\angle30^\circ$ 则

$$\dot{U}_A = 220\angle0^\circ \text{ V}$$

$$\begin{aligned}\dot{I}_A &= \frac{\dot{U}_A}{Z_1 + \frac{Z_1 \times \frac{1}{3} \times Z_2}{\frac{Z_1}{3} + Z_2}} \\ &= \frac{220\angle0^\circ}{2 + j3 + \frac{(16 + j12)(12 + j16)}{(16 + j12) + (12 + j16)}} \\ &= \frac{220}{2 + j3 + 10.1\angle45^\circ}\end{aligned}$$

$$= \frac{220}{2 + j3 + 7.14 + j7.14}$$

$$= \frac{220}{9.14 + j10.14}$$

$$= \frac{220}{13.7 \angle 48^\circ}$$

$$= 16.1 \angle -48^\circ \text{ A}$$

$$i_{A2} = \frac{\frac{Z_1}{3}}{\frac{Z_1}{3} + Z_2} \times i_A = \frac{20 \angle 36.9^\circ}{28\sqrt{2} \angle 45^\circ} \times 16.1 \angle -48^\circ$$

$$= 8.13 \angle -56.1^\circ \text{ A}$$

$$i_{A1} = i_A - i_{A2} = 16.1 \angle -48^\circ - 8.13 \angle -56.1^\circ$$

$$= 10.8 - j12 - (4.53 - j6.75)$$

$$= 10.8 - j12 - 4.53 + j6.75$$

$$= 6.27 - j5.25$$

$$= 8.2 \angle -40^\circ \text{ A}$$

$$\therefore i_{A1} = \sqrt{3} i_{AB} \angle -30^\circ$$

$$= \sqrt{3} \times (-i) \angle -30^\circ$$

$$\therefore i = \frac{-i_{A1}}{\sqrt{3} \angle -30^\circ} = \frac{-8.2 \angle -40^\circ}{\sqrt{3} \angle -30^\circ} = -4.7 \angle -10^\circ \text{ A}$$

$$(2) P = \sqrt{3} U_l I_l \cos \varphi = \sqrt{3} \times 380 \times 16.1 \cos(-48^\circ)$$

$$= \sqrt{3} \times 380 \times 16.1 \times 0.669$$

$$= 7089 \text{ W}$$

8—11 某三相电动机绕组为三角形连接，它的输出功率为 60 kW ，满载时的功率因数为 0.82 (滞后)，电机的效率为 87% ，电源的线电压为 415 V 。试计算电机在满载运行情况下的线电流 I_l 及相电流 I_p 。

解：取 \dot{U}_A 为参考正弦量： $\dot{U}_A = \frac{415}{\sqrt{3}} \angle 0^\circ \text{ V}$

$$\text{三相电动机实际吸收有功功率 } P = 60 \times 10^3 \times \frac{100}{87} = 68965.5 \text{ W}$$

$$\therefore I_l = \frac{P}{\sqrt{3} U_l \cos \varphi} = \frac{68965.5}{\sqrt{3} \times 415 \times 0.82}$$

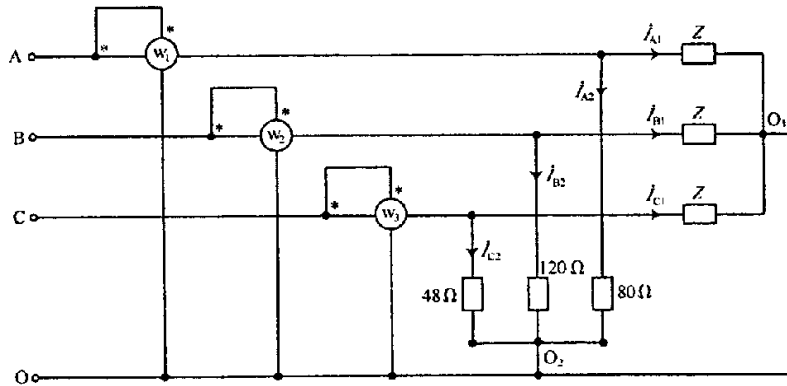
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$$=117 \text{ A}$$

由于电动机绕组是三角形联接，所以

$$I_P = \frac{I_l}{\sqrt{3}} = \frac{117}{\sqrt{3}} = 67.6 \text{ A}$$

8—12 已知对称三相电源的线电压 U_l 为 380V，并在三相四线制系统中，一组为三相对称负载，每相阻抗为 $Z=31.35\angle 30^\circ \Omega$ ；另一组为三相不对称电阻性负载，如题 8—12 图所示。试求三个功率表的读数。



题 8 - 12 图

解 设 $\dot{U}_A = 220\angle 0^\circ \text{ V}$

$$\dot{I}_{A1} = \frac{220\angle 0^\circ}{Z} = \frac{220}{31.35\angle 30^\circ} = 7\angle -30^\circ \text{ A}$$

$$\dot{I}_{B1} = 7\angle -150^\circ \text{ A}, \quad \dot{I}_{C1} = 7\angle 90^\circ \text{ A}$$

$$\dot{I}_{A2} = \frac{220\angle 0^\circ}{80} = 2.75\angle 0^\circ \text{ A}$$

$$\dot{I}_{B2} = \frac{220\angle -120^\circ}{120} = 1.8\angle -120^\circ \text{ A}$$

$$\dot{I}_{C2} = \frac{220\angle 120^\circ}{48} = 4.6\angle 120^\circ \text{ A}$$

$$\begin{aligned} \dot{I}_A &= \dot{I}_{A1} + \dot{I}_{A2} = 7\angle -30^\circ + 2.75\angle 0^\circ = 6.95 - j0.85 + 2.75 \\ &= 9.74\angle -5^\circ \text{ A} \end{aligned}$$

$$\begin{aligned} \dot{I}_B &= \dot{I}_{B1} + \dot{I}_{B2} = 7\angle -150^\circ + 1.8\angle -120^\circ \\ &= -6.95 - j0.85 - 0.9 - j1.56 \\ &= -7.85 - j2.41 = 8.2\angle -163^\circ \text{ A} \end{aligned}$$

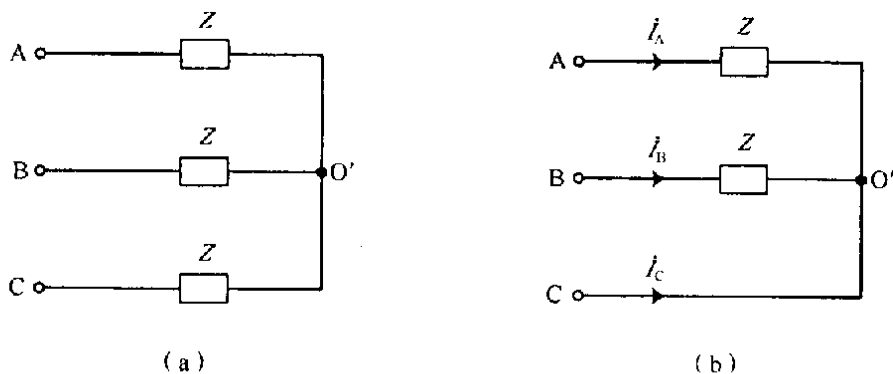
$$\begin{aligned}
 \dot{I}_C &= \dot{I}_{C1} + \dot{I}_{C2} = 7 \angle 90^\circ + 4.6 \angle 120^\circ \\
 &= j7 - 2.3 + j4 \\
 &= -2.3 + j11 = 11.2 \angle 102^\circ \text{ A}
 \end{aligned}$$

$$\begin{aligned}
 \therefore W_1 \text{ 表的 } P_1 &= U_A I_A \cos(\varphi_{uA} - \varphi_{IA}) \\
 &= 220 \times 9.74 \cos [0^\circ - (-5^\circ)] \\
 &= 2134.6 \text{ W} \\
 W_2 \text{ 表的 } P_2 &= U_B I_B \cos [(-120^\circ) - (-163^\circ)] \\
 &= 220 \times 8.2 \times 0.7314 \\
 &= 1319.4 \text{ W} \\
 W_3 \text{ 表的 } P_3 &= U_C I_C \cos(120^\circ - 102^\circ) \\
 &= 220 \times 11.2 \times 0.951 \\
 &= 2343.4 \text{ W}
 \end{aligned}$$

8—13 现测得对称三相电路的线电压、线电流及平均功率分别为 $U_l = 380\text{V}$ 、 $I_l = 10\text{A}$ 、 $P = 5.7 \text{ kW}$ 。求：

(1) 三相负载的功率因数及复阻抗 Z [电路如题 8—13 图(a)所示，阻抗 Z 呈感性]。

(2) 当 C 相负载短路，试说明 A、B 两组负载上承受多大电压，并求 \dot{I}_A 、 \dot{I}_B 、 \dot{I}_C [电路如题 8—13 图(b)所示，阻抗 Z 呈感性]。



题 8 - 13 图

解： (1) $P = \sqrt{3} U_l I_l \cos \varphi$

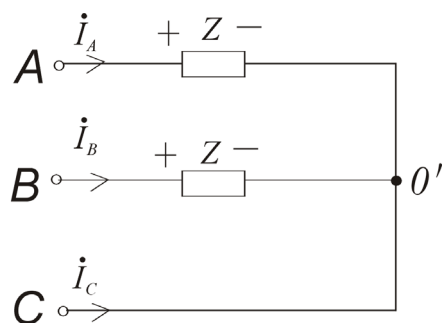
$$\cos \varphi = \frac{P}{\sqrt{3} U_l I_l} = \frac{5.7 \times 10^3}{380 \times 10 \times \sqrt{3}} = 0.87$$

$$Z = \frac{U_A}{I_l} \angle \arccos 0.87 = \frac{220}{10} \angle 29.5^\circ \Omega$$

$$=22\angle 29.5^{\circ} \Omega$$

$$\text{设 } \dot{U}_{BC}=380\angle 0^{\circ}, \quad \dot{U}_{CA}=380\angle -120^{\circ}$$

(2) 当 C 相短路, A 相阻抗 Z 上压为 $\dot{U}_{AC}=380\angle 60^{\circ} \text{ V}$



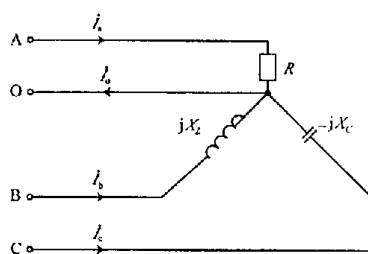
, B 相阻抗 Z 上压 $\dot{U}_{BC}=380\angle 0^{\circ} \text{ V}$

$$\begin{aligned} i_A &= \frac{\dot{U}_{AC}}{Z} = \frac{380\angle 60^{\circ}}{22\angle 29.5^{\circ}} \\ &= 17.3\angle 30.5^{\circ} \text{ A} \end{aligned}$$

$$\begin{aligned} i_B &= \frac{\dot{U}_{BC}}{Z} = \frac{380\angle 0^{\circ}}{22\angle 29.5^{\circ}} \\ &= 17.3\angle -29.5^{\circ} \text{ A} \end{aligned}$$

$$\begin{aligned} i_C &= -(\dot{i}_A + \dot{i}_B) = -(14.9 + j8.8 + 15.1 - j8.52) \\ &= -(30 + j0.28) = -30\angle 0.5^{\circ} = 30\angle -179.5^{\circ} \text{ A} \end{aligned}$$

8—14 三相四线制供电系统, 线电压为 380V, 电路如题 8—14 图所示, 各相负载 $R=X_L=X_C=10\Omega$, 求各相电流、中线电流、三相有功功率, 并画出相量图。



题 8—14 图

$$\text{设 } \dot{U}_A = 220 \angle 0^\circ \text{ V}$$

$$\dot{I}_a = \frac{\dot{U}_A}{R} = \frac{220}{10} = 22 \angle 0^\circ \text{ A}$$

$$\dot{I}_b = \frac{\dot{U}_B}{jx_L} = \frac{220 \angle -120^\circ}{j10} = 22 \angle -210^\circ$$

$$= 22 \angle 150^\circ \text{ A} = -22 \angle -30^\circ \text{ A}$$

$$\dot{I}_c = \frac{\dot{U}_c}{-jx_c} = \frac{220 \angle 120^\circ}{-j10} = -22 \angle 30^\circ \text{ A}$$

$$\dot{I}_o = \dot{I}_a + \dot{I}_b + \dot{I}_c$$

$$= 22 + (-22 \angle -30^\circ) - 22 \angle 30^\circ$$

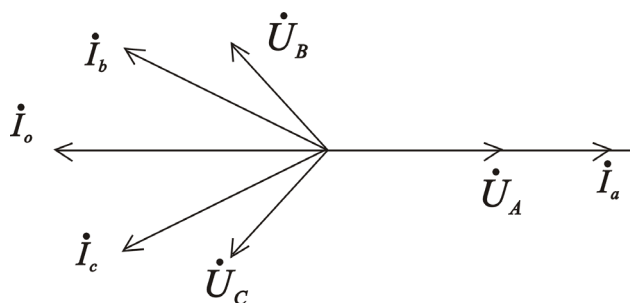
$$= 22 - (19.1 - j11) - (19.1 + j11)$$

$$= 22 - 19.1 + j11 - 19.1 - j11$$

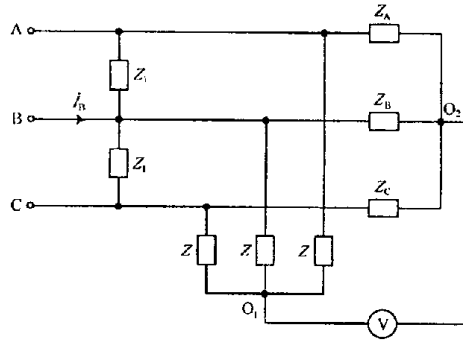
$$= -16.2 \angle 0^\circ \text{ A}$$

三相有功功率，即电阻吸收功率之和。

$$P = R I_a^2 = 10 \times 22^2 = 4840 \text{ W}$$



8—15 题 8—15 图示三相电路的外加电源是对称的，其线电压的有效值为 380V。两组星形负载并联，其中一组对称， $Z=10\Omega$ ；另一组星形负载不对称，阻抗分别为 $Z_A=10\Omega$ 、 $Z_B=j10\Omega$ 、 $Z_C=-j10\Omega$ 。电路中阻抗 $Z_1=-j10\Omega$ 。试求电压表的读数及电源端线电流 \dot{I}_B 。



题 8-15 图

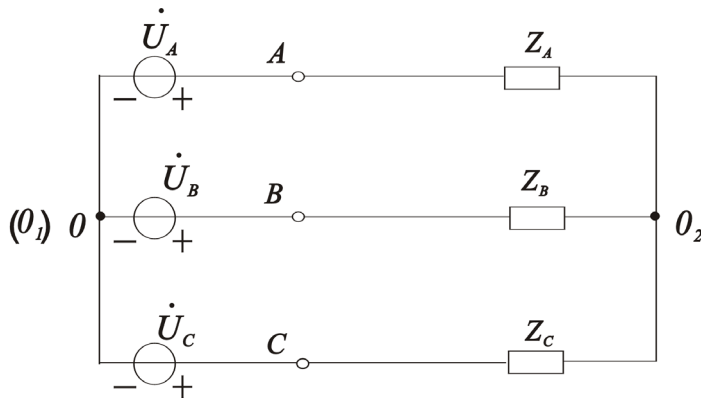
解 (1) 对称 Y 形负载, O 与 O₁ 点等位。

$$\dot{U}_{AO_1} = \dot{U}_A = 220 \angle 0^\circ$$

$$\dot{I}_{AO_1} = \frac{\dot{U}_A}{Z} = \frac{220}{10} = 22 \angle 0^\circ \text{ A}$$

$$\dot{I}_{BO_1} = 22 \angle -120^\circ \text{ A}, \quad \dot{I}_{CO_1} = 22 \angle 120^\circ \text{ A}$$

(2) 不对称 Y 形负载



$$\dot{U}_{O_2O} = \frac{\frac{\dot{U}_A}{Z_A} + \frac{\dot{U}_B}{Z_B} + \frac{\dot{U}_C}{Z_C}}{\frac{1}{Z_A} + \frac{1}{Z_B} + \frac{1}{Z_C}}$$

$$= \frac{\frac{220 \angle 0^\circ}{10} + \frac{220 \angle -120^\circ}{j10} + \frac{220 \angle 120^\circ}{-j10}}{\frac{1}{10} + \frac{1}{j10} - \frac{1}{j10}}$$

$$= 10 (22 + 22 \angle -210^\circ + 22 \angle 210^\circ)$$

$$= 220 (1 - \angle -30^\circ - \angle -30^\circ)$$

$$\begin{aligned}
&=220 [1 - (0.87-j0.5) - (0.87+j0.5)] \\
&=220 \times (-0.74) \\
&=-162.8 \angle 0^\circ \text{ V}
\end{aligned}$$

由 (1) 知 $\dot{\phi}_o = \dot{\phi}_{o_1}$ 得出 $\dot{U}_{o_2 o_1} = \dot{U}_{o_2 o}$

$\therefore V$ 表读数 1.6V

(3) 负载 Z_1 上电流 \dot{I}_{BA} 及 \dot{I}_{BC} 为

$$\dot{I}_{BA} = \frac{\dot{U}_{BA}}{Z_1} = \frac{-\dot{U}_{AB}}{Z_1} = \frac{-380 \angle 30^\circ}{-j10} = 38 \angle -60^\circ \text{ A}$$

$$\dot{I}_{BC} = \frac{\dot{U}_{BC}}{Z_1} = \frac{380 \angle -90^\circ}{-j10} = 38 \angle 0^\circ \text{ A}$$

$$\therefore \dot{U}_A = 220 \angle 0^\circ$$

$$\therefore \dot{U}_{AB} = 380 \angle 30^\circ, \quad \dot{U}_{BC} = 380 \angle (30^\circ - 120^\circ) = 380 \angle -90^\circ$$

$$\begin{aligned}
\dot{I}_B &= \dot{I}_{BA} + \dot{I}_{BC} + \dot{I}_{BO_1} + \dot{I}_{BO_2} \\
&= 38 \angle -60^\circ + 38 + \frac{\dot{U}_{BO_1}}{Z} + \frac{\dot{U}_{BO_2}}{Z_B} \\
&= 19 - j32.9 + 38 + \frac{\dot{U}_A \angle -120^\circ}{10} + \frac{\dot{U}_B + \dot{U}_{OO_2}}{j10} \\
&= 57 - j32.9 + \frac{22 \angle -120^\circ}{10} + \frac{22 \angle -120^\circ + 162.8}{j10} \\
&= 57 - j32.9 + 22 \angle -120^\circ + 22 \angle -210^\circ + 16.3 \angle -90^\circ \\
&= 57 - j32.9 - 22 \angle 60^\circ - 22 \angle -30^\circ + 16.3 \angle -90^\circ \\
&= 57 - j32.9 - (11 + j19.1) - (19.1 - j11) - j16.3 \\
&= 57 - j32.9 - 11 - j19.1 - 19.1 + j11 - j16.3 \\
&= 26.9 - j57.3 \\
&= 63.3 \angle -64.9^\circ \text{ A}
\end{aligned}$$