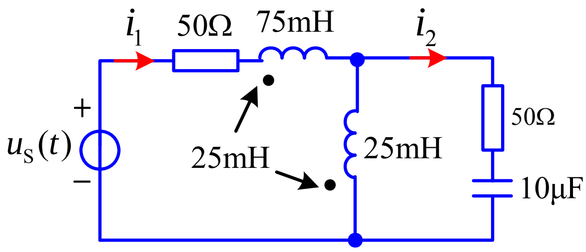
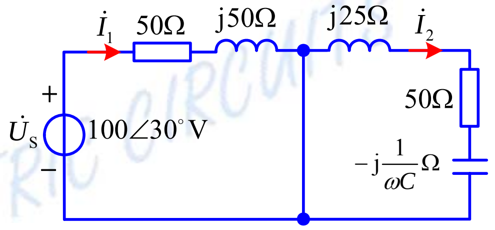
【题 1】已知：$u_S(t)=100\cos(10^3t+30^\circ)\text{V}$，

求：$i_1(t)$ 和 $i_2(t)$。



解：相量法，去耦变换



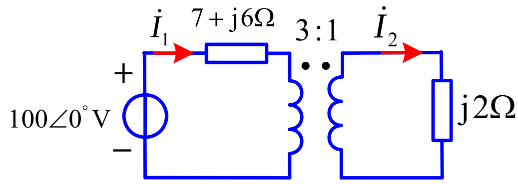
$$\dot I_1=\frac{\dot U_S}{50+\text{j}50}=\frac{100\angle30^\circ}{50\sqrt2\angle45^\circ}=\sqrt2\angle-15^\circ\text{A}$$

$$i_1(t)=1.414\cos(10^3t-15^\circ)\text{A}$$

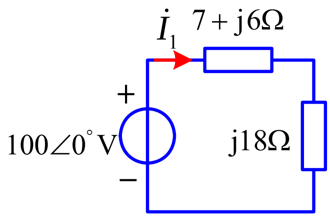
$$i_2(t)=0\text{A}$$

【题 2】已知图示电路，

求：$\dot I_1$ 和 $\dot I_2$。



解：



$$\dot I_1=\frac{100\angle0^\circ}{7+\text{j}6+\text{j}18}=\frac{100\angle0^\circ}{7+\text{j}24}=\frac{100\angle0^\circ}{25\angle73.74^\circ}=4\angle-73.74^\circ\text{A}$$

$$\dot I_2=3\dot I_1=12\angle-73.74^\circ\text{A}$$

【题 3】Y-Y 联接对称三相电路，负载线电压为 208V，线电流为 6A（均为有效值），三相负载的总功率为 1800W，求每相负载的阻抗 Z。

解：

$$U_L=208\text{V},I_L=6\text{A},P=1800\text{W}$$

$$P=\sqrt3U_LI_L\cos\varphi \qquad \cos\varphi=\frac{1800}{\sqrt3\times208\times6}=0.833 \qquad \varphi=33.6^\circ$$

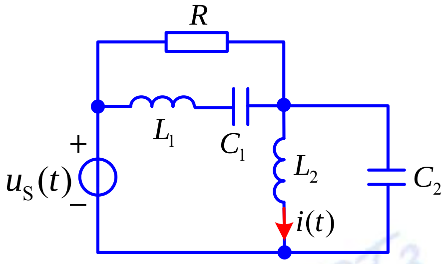
$$U_P=\frac{U_L}{\sqrt3}=\frac{208}{\sqrt3}=120.09\text{V} \qquad I_P=I_L=6\text{A}$$

$$|Z|=\frac{U_P}{I_P}=20.02\Omega \qquad Z=20.02\angle33.6^\circ=9.6+\text{j}17.56(\Omega)$$

【题 4】已知： $R=200\Omega,\omega L_1=\omega L_2=10\Omega,\dfrac{1}{\omega C_1}=160\Omega,\dfrac{1}{\omega C_2}=40\Omega$，

$$u_S(t)=100+14.14\cos(2\omega t+\frac{\pi}{6})+7.07\cos(4\omega t+\frac{\pi}{3})\text{V},$$

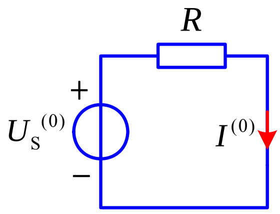
求： $i(t)$ 及其有效值 I 。



解： $u_S(t)=100+14.14\cos(2\omega t+\dfrac{\pi}{6})+7.07\cos(4\omega t+\dfrac{\pi}{3})\text{V}$

有直流分量+2 次谐波分量+4 次谐波分量

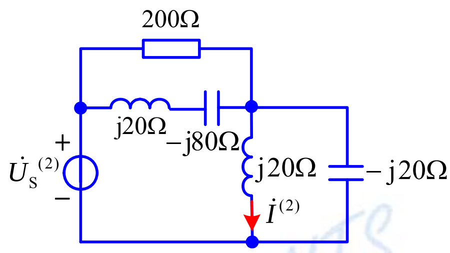
直流分量单独作用：



$$U_S^{(0)}=100\text{V}$$

$$I^{(0)}=\frac{100\text{V}}{200\Omega}=0.5\text{A}$$

2 次谐波单独作用：

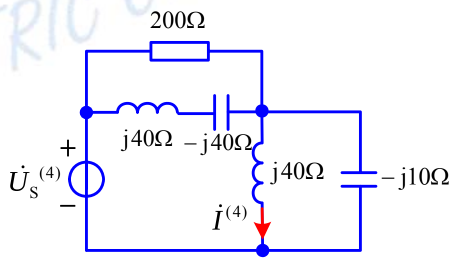


$$\dot{U}_S^{(2)}=10\angle\frac{\pi}{6}\text{V}$$

L_2C_2 并联谐振

$$\dot{I}^{(2)}=\frac{\dot{U}_S^{(2)}}{\text{j}20\Omega}=\frac{10\angle\frac{\pi}{6}}{\text{j}20}=0.5\angle-\frac{\pi}{3}\text{A}$$

4 次谐波单独作用：



$$\dot{U}_S^{(4)}=5\angle\frac{\pi}{3}\text{V}$$

L_1C_1 串联谐振

$$\dot{I}^{(4)}=\frac{\dot{U}_S^{(4)}}{\text{j}40\Omega}=\frac{5\angle\frac{\pi}{3}}{\text{j}40}=0.125\angle-\frac{\pi}{6}\text{A}$$

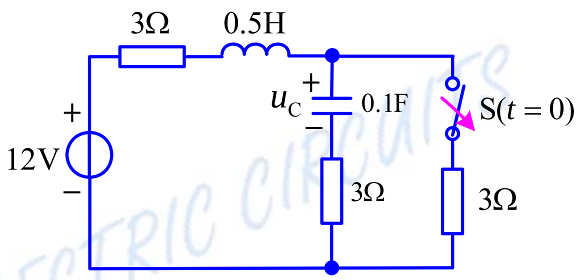
$$i(t)=0.5+0.5\sqrt{2}\cos(2\omega t-\frac{\pi}{3})+0.125\sqrt{2}\cos(4\omega t-\frac{\pi}{6})\text{A}$$

$$I=\sqrt{0.5^2+0.5^2+0.125^2}=0.718\text{A}$$

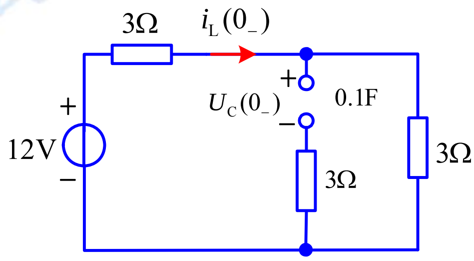
【题 5】已知：开关 S 打开前电路已达稳态，t=0 时，开关 S 打开，

求：1）画出 t>0 时运算电路图，并标明参数；

2）用运算法求 t>0 时 $u_C(t)$ 。



解：0_ 等效电路

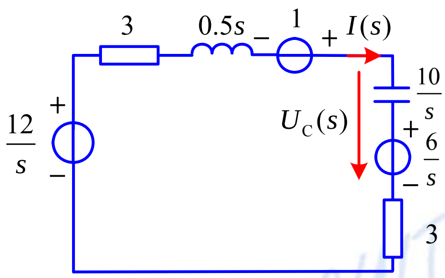


$$i_L(0\_)=\frac{12}{3+3}=2\text{A}$$

$$Li_L(0\_)=1$$

$$U_C(0\_)=\frac{3}{3+3}\times 12=6\text{V}$$

$t>0$ 时，运算电路图：



$$I(s)=\frac{\frac{12}{s}+1-\frac{6}{s}}{3+3+0.5s+\frac{10}{s}}$$

$$=\frac{6+s}{0.5s^2+6s+10}$$

$$=\frac{2(s+6)}{s^2+12s+20}$$

$$U_C(s)=I(s)+\frac{6}{s}$$

$$=\frac{2(s+6)}{s^2+12s+20}\times\frac{10}{s}+\frac{6}{s}$$

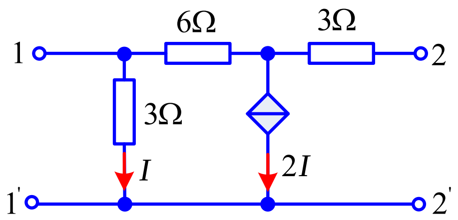
$$=\frac{20(s+6)}{s(s+2)(s+10)}+\frac{6}{s}$$

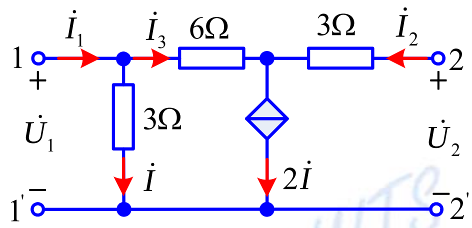
$$=20[\frac{\frac{6}{20}}{s}+\frac{\left(-\frac{1}{4}\right)}{s+2}+\frac{\left(-\frac{1}{20}\right)}{s+10}]+\frac{6}{s}$$

$$=\frac{12}{s}-\frac{5}{s+2}-\frac{1}{s+10}$$

$$u_C(t)=12\varepsilon(t)-5\mathrm{e}^{-2t}-\mathrm{e}^{-10t}\ \text{V}$$

【题 6】已知电路如图所示，求 Y 参数矩阵。





解：

$$\begin{cases} \dot I_1 = \dot I + \dot I_3 = \dfrac{\dot U_1}{3} + \dot I_3 \\ \dot I_2 = 2\dot I - \dot I_3 = \dfrac{2\dot U_1}{3} - \dot I_3 \end{cases}$$

$$\dot U_1 = 6\dot I_3 + \dot U_2 - 3\dot I_2 \quad \to \dot I_3 = \frac{1}{6}(\dot U_1 - \dot U_2 + 3\dot I_2)$$

$$\dot I_1 + \dot I_2 = 3\dot I \quad \to \dot I_2 = 3\dot I - \dot I_1 = \dot U_1 - \dot I_1$$

$$\to \dot I_1 = \dot U_1 - \dot I_2$$

$$\dot I_3 = \frac{1}{6}(\dot U_1 - \dot U_2 + 3\dot U_1 - 3\dot I_1)$$

$$= \frac{1}{6}(4\dot U_1 - \dot U_2 - 3\dot I_1)$$

$$\dot I_3 = \frac{1}{6}(4\dot U_1 - \dot U_2 - 3\dot U_1 + 3\dot I_2)$$

$$= \frac{1}{6}(\dot U_1 - \dot U_2 + 3\dot I_2)$$

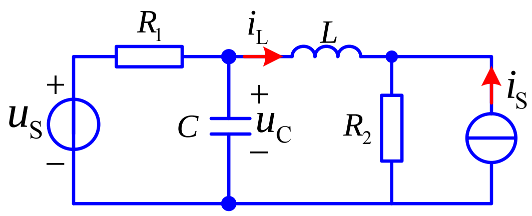
$$\Rightarrow \begin{cases} \dot I_1 = \dfrac{\dot U_1}{3} + \dfrac{1}{6}(4\dot U_1 - \dot U_2 - 3\dot I_1) \\ \dot I_2 = \dfrac{2\dot U_1}{3} - \dfrac{1}{6}(\dot U_1 - \dot U_2 + 3\dot I_2) \end{cases}$$

$$\Rightarrow \begin{cases} \dot I_1 = \dfrac{2}{3}\dot U_1 - \dfrac{1}{9}\dot U_2 \\ \dot I_2 = \dfrac{1}{3}\dot U_1 + \dfrac{1}{9}\dot U_2 \end{cases}$$

$$Y = \begin{bmatrix} \dfrac{2}{3} & -\dfrac{1}{9} \\ \dfrac{1}{3} & \dfrac{1}{9} \end{bmatrix}$$

BUAA DEPT3 ELECTRIC CIRCUITS

【题 7】写出图示电路状态方程的标准形式。



解：状态变量 i_L， u_C

$$\begin{cases} C\dfrac{\mathrm{d}u_C}{\mathrm{d}t} = -i_L + \dfrac{u_S - u_C}{R_1} \\ L\dfrac{\mathrm{d}i_L}{\mathrm{d}t} = u_C - (i_L + i_S)R_2 \end{cases}$$

$$\Rightarrow \begin{cases} \dfrac{\mathrm{d}u_C}{\mathrm{d}t} = -\dfrac{1}{R_1C}u_C - \dfrac{1}{C}i_L + \dfrac{1}{R_1C}u_S \\ \dfrac{\mathrm{d}i_L}{\mathrm{d}t} = \dfrac{1}{L}u_C - \dfrac{R_2}{L}i_L - \dfrac{R_2}{L}i_S \end{cases}$$

$$\begin{bmatrix} \dfrac{\mathrm{d}u_C}{\mathrm{d}t} \\ \dfrac{\mathrm{d}i_L}{\mathrm{d}t} \end{bmatrix} = \begin{bmatrix} -\dfrac{1}{R_1C} & -\dfrac{1}{C} \\ \dfrac{1}{L} & -\dfrac{R_2}{L} \end{bmatrix} \begin{bmatrix} u_C \\ i_L \end{bmatrix} + \begin{bmatrix} \dfrac{1}{R_1C} & 0 \\ 0 & -\dfrac{R_2}{L} \end{bmatrix} \begin{bmatrix} u_S \\ i_S \end{bmatrix}$$