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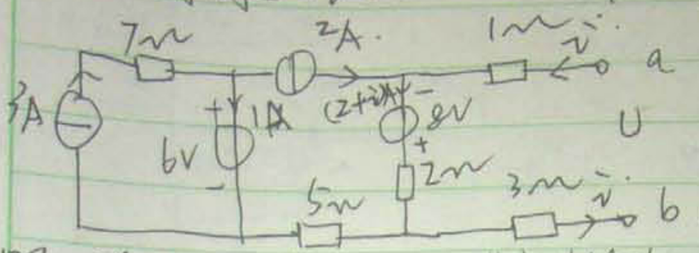
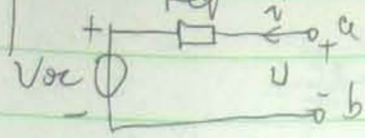
2007年.

一. 1. 化简图示电路.



解: 设从a、b端看进去的等效电路为:



$U = U_{oc} + R_{eq} i$

由图(a)知,

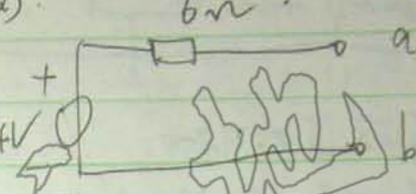
由KVL知:

$U = i - 8 + 2(2+i) + 3i$

$= 6i - 4$

$\therefore \begin{cases} U_{oc} = -4V \\ R_{eq} = 6\Omega \end{cases}$

∴ 图示电路化简为:



2. 已知 $\omega L = \frac{1}{\omega C} = R$, $\dot{U}_1 = U_1\angle 0^\circ$, 画出图示各支路电流、电压的相量图.

$\dot{U} = \dot{U}_1 + \dot{U}_2 = U_1\angle 90^\circ$

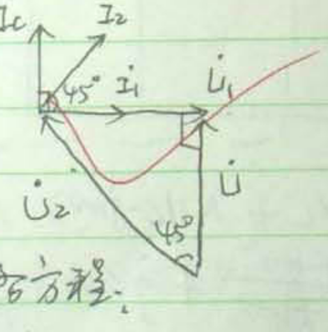
解: $\dot{I}_1 = \frac{\dot{U}_1}{R} = \frac{U_1}{R}\angle 0^\circ$, $\dot{U}_c = \dot{U}_1$

$\dot{I}_c = \frac{\dot{U}_c}{\frac{1}{\omega C}\angle -90^\circ} = \frac{U_1}{R}\angle 90^\circ$

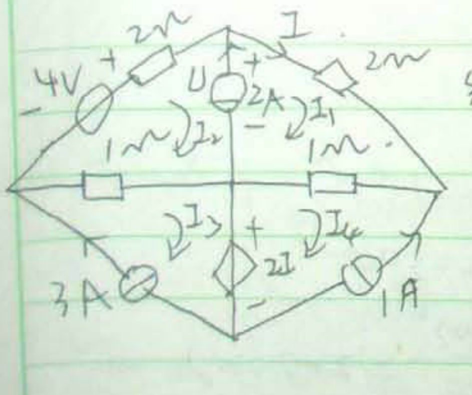
$\therefore \dot{I}_2 = \dot{I}_1 + \dot{I}_c = \sqrt{2}\frac{U_1}{R}\angle 45^\circ$

$\dot{U}_2 = j\omega L \dot{I}_2 = \sqrt{2} U_1 \angle 135^\circ$

∴ 相量图为:



二. 1. 用回路法求I.



解: 列回路方程:

$$\begin{cases} I_3 = 3A \\ I_4 = -1A \\ 3I_1 - I_4 = U \\ 3I_2 - I_3 = 4 - U \\ I_1 - I_2 = 2 \end{cases}$$

解得: $I_1 = 2A$.

$\therefore I = I_1 = 2A$.

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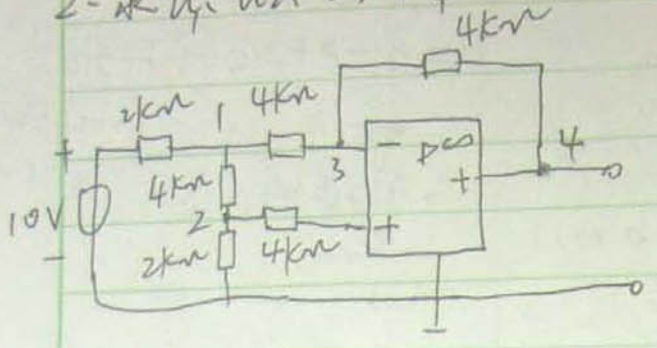
2、求 U_1、U_2、U_3、U_4.



解：由虚短、虚断可知：

$I_- = I_+ = 0,\ U_+ = U_- = 0$

$\therefore U_2 = U_3$ ④

$\frac{U_1}{4k+2k} = \frac{U_2}{2k}$

$\therefore U_1 = 3U_2$ ①

~~$\therefore Z = 2k + 4k // 4k + 2k$~~

~~$= 6k$~~

~~$\therefore U_1 = 10 - 10 \times \frac{2k}{6k}$~~

又 $\because U_1\left(\frac{1}{2k}+\frac{1}{4k}+\frac{1}{6k}\right) - \frac{1}{2k}\cdot 10 = \frac{10}{2k}$ ②

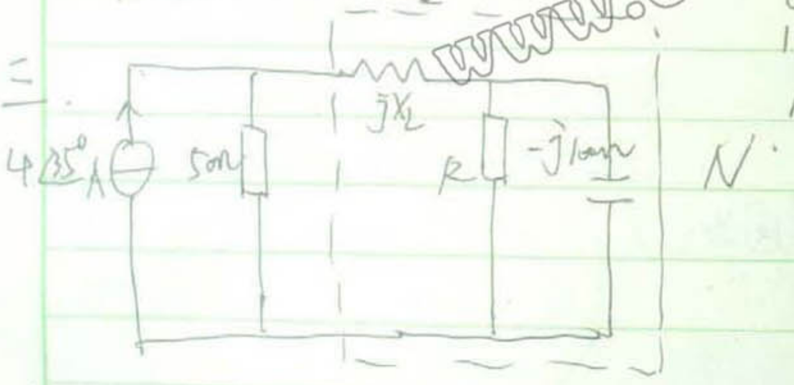
$\frac{U_1 - U_3}{4k} = \frac{U_3 - U_4}{4k}$ ③

由①②③④解得：$U_1 = 6V$

$U_2 = U_3 = 2V$

$U_4 = -2V$

三、



问 R、X_L 的值分别为多少？网络 N 获得的最大功率是多少？

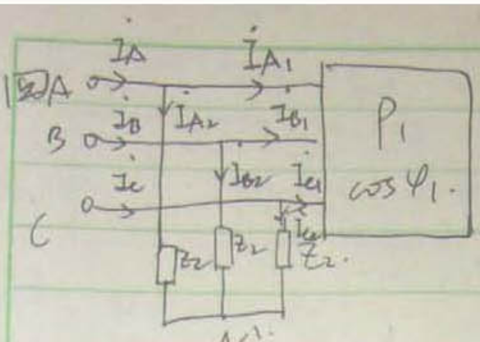
解：$Z_N = jX_L + R//(-j100)$

$$= \frac{R\,100^2}{R^2+100^2} + j\left(X_L - \frac{100R^2}{R^2+100^2}\right)$$

当 $Z_N = 50\Omega$ 时
$$\begin{cases} \frac{R\,100^2}{R^2+100^2} = 50 \\ X_L - \frac{100R^2}{R^2+100^2} = 0 \end{cases} \Rightarrow \begin{cases} R = 100\Omega \\ X_L = 50\Omega \end{cases}$$

网络 N 可获最大功率为 $P_{max} = \frac{(4\times 50)^2}{50\times 4} = 200\,(W)$

四、



$\dot U_{AB}=380\angle30^\circ V$

$P_1=5KW, \cos\varphi_1=0.85$

$Z_2=22\angle-30^\circ\Omega$

求 $\dot I_A$、$\dot I_B$、$\dot I_C$。

解：∵ $\dot U_{AB}=380\angle30^\circ V$

∴ $\dot U_A=220\angle0^\circ V$

$P_1=3U_AI_{A_1}\cos\varphi_1$

$5K=3\times220 I_{A_1}\times0.85$

$I_{A_1}=8.9(A)$

∴ $\dot I_{A_1}=8.9\angle-31.8^\circ (A)$

$\dot I_{A_2}=\frac{\dot U_A}{Z_2}=\frac{220\angle0^\circ}{22\angle-30^\circ}=10\angle30^\circ A$

∴ 由KCL知：

$\dot I_A=\dot I_{A_1}+\dot I_{A_2}=8.9\angle-31.8^\circ+10\angle30^\circ$

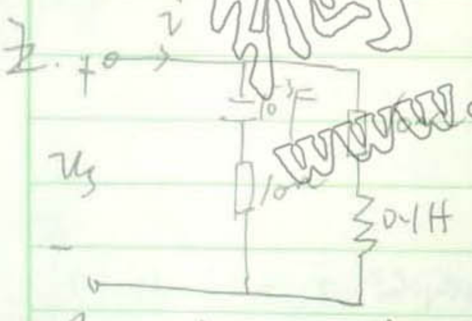
$=16.2\angle1.1^\circ (A)$

由于是对称的三相

∴ $\dot I_B=\dot I_A\angle-120^\circ=16.2\angle-118.9^\circ (A)$

$\dot I_C=\dot I_A\angle120^\circ=16.2\angle121.1^\circ (A)$

五、



$u_s=100+100\sin100t (V)$

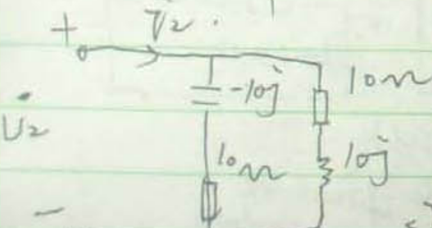
求 $i(t)$ 及电源发出的有功功率。

$U_1=100V$

解：(1) 当 u_s 中的直流分量作用时：

$I_1=\frac{U_1}{10}=\frac{100}{10}=10(A)$.

(2) 当 u_s 中的交流分量 $\dot U_2=\frac{100}{\sqrt2}\angle-90^\circ V$ 作用时



$Z=(10-10j)//(10+10j)$

$=10\Omega$

∴ $i_2=\frac{100\sin100t}{10}=10\sin100t (A)$

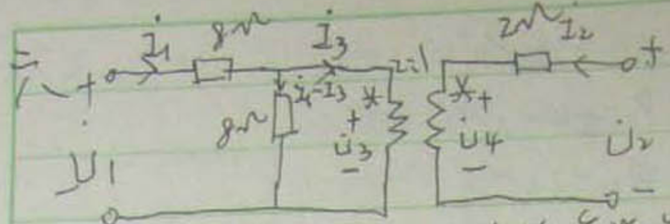
∴ $i=I_1+i_2=10+10\sin100t (A)$.

电源发出的有功功率：

$P=I_1^2\times10+\frac{100}{\sqrt2}\times\frac{10}{\sqrt2}\cos[-90^\circ-(-90^\circ)]$

$=1000+500=1500 (W)$.

六、



求图示双口网络的Z参数矩阵

解：$\dot U_3 = 2\dot U_4$

$\dot I_3 = -\frac{1}{2}\dot I_2$

$\dot U_1 = 8\dot I_1 + \dot U_3$

$\dot U_2 = 2\dot I_2 + \dot U_4$

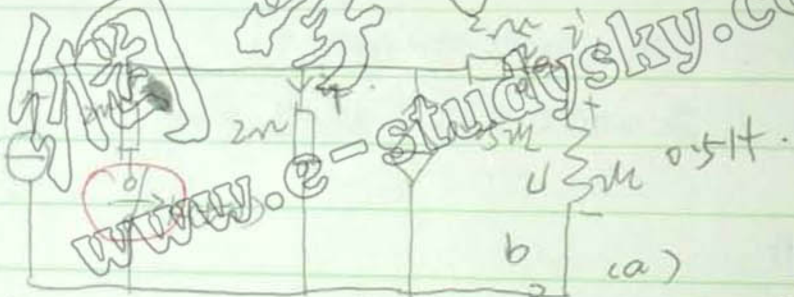
$\dot U_1 = 8\dot I_1 + 8(\dot I_1 - \dot I_3)$

$\therefore \dot U_1 = 16\dot I_1 + 4\dot I_2$

$\dot U_2 = 4\dot I_1 + 4\dot I_2$

$\therefore Z = \begin{bmatrix} 16 & 4 \\ 4 & 4 \end{bmatrix}\Omega$

七、



t<0时电路处于稳态，t=0，K打开，闭合时求 $i_L(t)$ 和 $u_L(t)$

解：t<0时

$i_L(0-) = 6\times\frac{2}{2+2+2} = 2\,(A)$

由换路定理知：$i_L(0+) = i_L(0-) = 2\,(A)$

t>0时，如图(a)所示从a、b端看进去等效电路为

$U = U_{oc} + R_{eq} i$

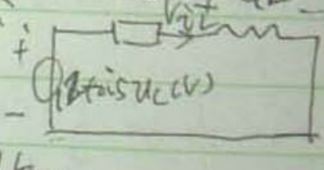
由图(a)知：$i_1 = 6 + i + 0.5 i_L$

$U = 2i + 2i_1$

$\therefore U = 12 + 0.5 i_L + 4i$

$\therefore U_{oc} = 12 + 0.5 u_L\,(V)$

$R_{eq} = 4\,\Omega$



由KVL知：

$12 + 0.5 i_L = 4 i_L + u_L$

$12 + 0.5 i_L = 4 i_L + \frac{1}{4} i_L'$

$\therefore i_L = Ce^{-16t} + 3\,(A)$

$\therefore i_L(0+) = 2A$

$\therefore C = -1$

$\therefore i_L = 3 - e^{-16t}\,(A)$

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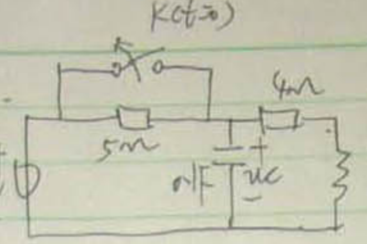
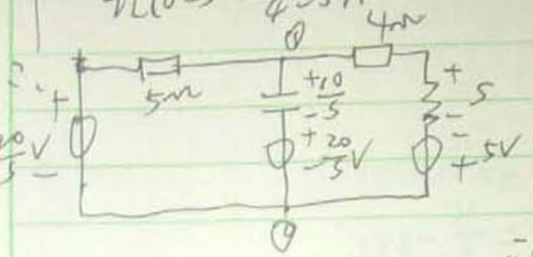
∴ $u_L(t)=L\frac{di_L}{dt}=0.5\times16e^{-16t}=8e^{-16t}$ (V)

八.



t=0时开关K打开.
用拉普拉斯变换求t≥0时的电压$u_C(t)$.

解: $u_C(0_-)=20V$
$i_L(0_-)=\frac{20}{4}=5A$



列结点电压方程:

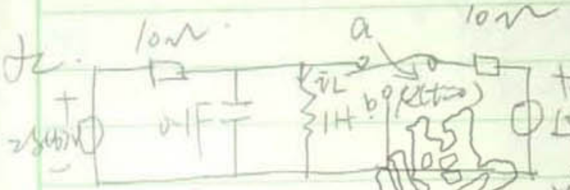
$$U(s)\left(\frac{1}{5}+\frac{s}{10}+\frac{1}{4+s}\right)=\frac{\frac{20}{s}}{5}+\frac{\frac{20}{s}}{\frac{10}{s}}-\frac{5}{4+s}$$

$$\therefore U(s)=\frac{\frac{80}{9}}{s}+\frac{\frac{100}{9}(s+3)}{(s+3)^2+3^2}-\frac{\frac{50}{9}\times3}{(s+3)^2+3^2}$$

∵ $u_C(s)=U(s)$

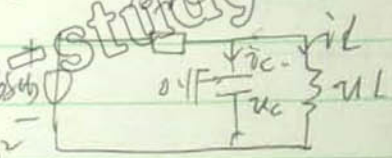
$$\therefore u_C(t)=\frac{80}{9}+\frac{100}{9}e^{-3t}\cos3t-\frac{50}{9}e^{-3t}\sin3t\ (V)$$

九.



t=0, K由a合向b. 列写换路后关于变量i_L的微分方程, 并求$i_L(0_+)$, $\frac{di_L}{dt}$的初始值

解:



$u_L=L\frac{di_L}{dt}$

$i_C=C\frac{du_C}{dt}=LC\frac{d^2i_L}{dt^2}$

由KVL知:

$2\delta(t)=10(i_C+i_L)+u_L$

$=10(LC\frac{d^2i_L}{dt^2}+i_L)+L\frac{di_L}{dt}$

$=\frac{d^2i_L}{dt^2}+\frac{di_L}{dt}+10i_L$

∴ $\frac{d^2i_L}{dt^2}+\frac{di_L}{dt}+10i_L=2\delta(t)$

∵ $i_L(0_-)=\frac{10}{10}=1A$, $u_C(0_-)=0V$

∴ 换路后: L无冲激电压

∴ $i_L(0_+)=i_L(0_-)=1(A)$

C上有冲激电流

$i_C=\frac{2\delta(t)}{10}-i_L$

∴ $u_C(0_+)=u_C(0_-)+\frac{1}{C}\int_{0_-}^{0_+}\left(\frac{2\delta(t)}{10}-i_L\right)dt$
$=2V$

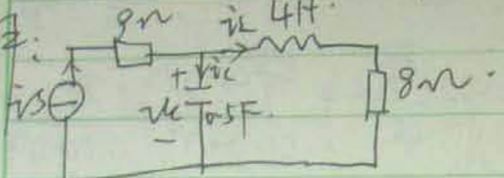
∵ $u_C(0_+)=u_L(0_+)=L\frac{di_L}{dt}\Big|_{0+}=\frac{di_L}{dt}\Big|_{0+}$

∴ $\frac{di_L}{dt}\Big|_{0+}=2$

十.1.

写出图示电路状态方程，并写成矩阵形式

解：



$$\begin{cases} i_s = i_L + i_C \\ i_C = C u_C' = 0.5 u_C' \\ u_L = L i_L' = 4 i_L' \\ u_L + 8 i_L = u_C \end{cases}$$

$\therefore u_C' = -2 i_L + 2 i_s$

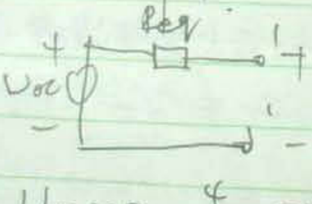
$i_L' = \frac{u_C}{4} - 2 i_L$

$$\therefore \begin{bmatrix} u_C' \\ i_L' \end{bmatrix} = \begin{bmatrix} 0 & -2 \\ \frac{1}{4} & -2 \end{bmatrix} \begin{bmatrix} u_C \\ i_L \end{bmatrix} + \begin{bmatrix} 2 \\ 0 \end{bmatrix} i_s$$

2. $u = \begin{cases} 0, & i < 0 \\ i^2, & i \geq 0 \end{cases}$

求 u、i

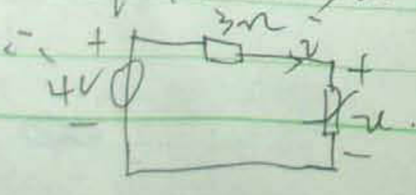
解：将非线性电阻以外的电路等效为：



$U_{oc} = 8 \times \frac{4}{4+4} = 4V$

$R_{eq} = 4 // 4 + 1 = 3\Omega$

$\therefore$



由此可知：

$4 = 3i + u$

当 $i < 0$ 时，$4 = 3i \Rightarrow i = \frac{4}{3}A$（舍去）

当 $i \geq 0$ 时，$4 = 3i + i^2$

$i = 1A$ 或 $-4A$（舍去）

$\therefore u = i^2 = 1V$