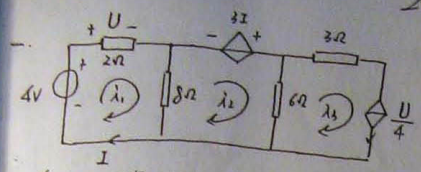
2004年试题 Key

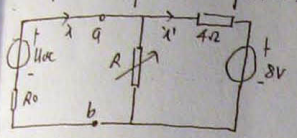
一、



列网孔KVL方程 $\begin{cases} 10\dot{\lambda}_1 - 8\dot{\lambda}_2 = 4 \\ -8\dot{\lambda}_1 + 14\dot{\lambda}_2 - 6\dot{\lambda}_3 = 3I \\ \dot{\lambda}_3 = \frac{U}{4} \end{cases}$

补充方程 $\dot{\lambda}_1 = I$ 而 $U = 2\dot{\lambda}_1$，联立解得 $I = 2A$

二、解：设二端网络N开路电压 U_{oc}，等效电阻 R_0，以戴维南等效电路接于网络N，则电路化为

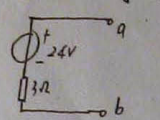


当 $R=0$ 时，$\dot{\lambda} = 8A$，则此时 $U_{oc} = 8R_0$；

当 $R=4\Omega$ 时，设图中电流为 $\dot{\lambda}'$，列KVL方程 $\begin{cases} (\dot{\lambda} - \dot{\lambda}')R + R_0\dot{\lambda} = U_{oc} \\ -4\dot{\lambda}' + (\dot{\lambda} - \dot{\lambda}')R = 8 \end{cases}$

得 $\dot{\lambda} = 4A$ 代入之，$\therefore R_0 = 3\Omega \Rightarrow U_0 = 24V$

则网络N的戴维南等效电路



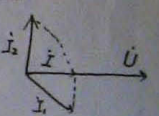
三、解：(1) $P = 3U_P I_P \cos\varphi$，$U_P = 220V$，$\Rightarrow I_A = 10A$，$\because \dot{U}_{AB} = 380\angle 0°V$ $\therefore \dot{U}_{A'O'} = 220\angle -30°V$

由 $\cos\varphi = 0.5$（活性）知 $\dot{I}_A$ 滞后 $\dot{U}_{A'O'}$ 60°，$\therefore \dot{I}_A = 10\angle -90°A \Rightarrow \dot{I}_B = 10\angle -210°A$，$\dot{I}_C = 10\angle 30°A$

(2) $\dot{U}_{AB} = Z_L\dot{I}_A + \dot{U}_{A'B'} - Z_L\dot{I}_B = 398.5\angle -43°V$

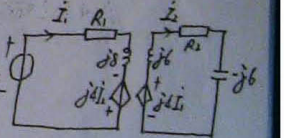
四、(1) $Y = \frac{1}{R+j\omega L} + j\omega C = \frac{R}{R^2+(\omega L)^2} + j\left[\omega C - \frac{\omega L}{R^2+(\omega L)^2}\right]$，因电路发生谐振，

$\Rightarrow \begin{cases} \frac{R}{R^2+(\omega L)^2} = \frac{1}{200} \\ \omega C = \frac{\omega L}{R^2+(\omega L)^2} \end{cases} \Rightarrow L = 0.2H$，$C = 250\mu F$ (2) 此 $\dot{U} = \frac{200}{\sqrt{2}}\angle 0°$ 为基准，



五、解：(1) $U_{S(0)} = 12V$ 作用于 R_1，$\dot{I}_1(0) = \frac{12}{4} = 3A$，$\dot{I}_2(0) = 0$

(2) $U_{S(2)} = 24\sqrt{2}\angle 45°$ 作用于 R_1，以受控源表示电压，电路如右图示



列KVL方程 $\begin{cases} \dot{U}_S = R_1\dot{I}_1 + j\omega L_1\dot{I}_1 - j\omega M\dot{I}_2 \\ j\omega M\dot{I}_1 = R_2\dot{I}_2 \end{cases}$

$\Rightarrow \dot{I}_1 = 3\angle 0°$，$\dot{I}_2 = 3\angle 90°$ $\therefore i_1 = (3 + 3\sqrt{2}\cos 2t)A$，$i_2 = \left[3\sqrt{2}\cos(2t + 90°)\right]A$

$P = 12\times 3 + \frac{48}{\sqrt{2}}\times 3\times \cos 45° = 108W$

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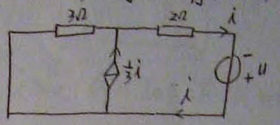
六. 解: $t<0$ 电路处于稳态, $u_{c1}(0-)=12V$. $t=0$ K闭合后, C_1 和 C_2 遵循电荷守恒的换路定则.

即 $C_1u_{c1}(0+)+C_2u_{c2}(0+)=C_1u_{c1}(0-)+C_2u_{c2}(0-)$ K闭合后有 $u_{c1}(0+)=u_{c2}(0+)$ $\therefore u_{c1}(0+)=u_{c2}(0+)=4V$

用外加电源法求与 C_2 串联的等效电阻 R_0.



则 $u=3\times\frac{2}{3}i+2i=4i$, $R_0=\frac{u}{i}=4\Omega$

又 $u_{oc}=12V$, $\tau=R_0C'=1.5\times4=6S$

$\therefore u_{c2}(t)=u_{c2p}+[u_{c2}(0+)-u_{c2p}]e^{-\frac{1}{\tau}t}=(12-8e^{-\frac{1}{6}t})V\ (t\geq0)$ $i_1(t)=C_1\cdot\frac{du_{c1}}{dt}+C_2\cdot\frac{du_{c2}}{dt}=2e^{-\frac{1}{6}t}A\ (t\geq0)$

七. 解: 设无源二端网络左侧端口电压 $\dot U_1$. $\therefore \dot U_1=\dot U_s$

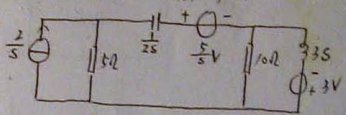
当 $Z_L=0$ 时, $\dot I_1=Y_{11}\dot U_1+Y_{12}\dot U_2=Y_{11}\dot U_1$ $\therefore Y_{11}=\frac{\dot I_1}{\dot U_1}=\frac{18\angle0^\circ}{90\angle0^\circ}=\frac{1}{5}S$ 又 $\dot I_2=Y_{21}\dot U_1+Y_{22}\dot U_2=Y_{21}\dot U_1\Rightarrow Y_{21}=\frac{\dot I_2}{\dot U_1}=-\frac{1}{10}S$

当 $Z_L=6\Omega$ 时, $\dot U_2=30\angle0^\circ\Rightarrow\dot I_2=-\frac{\dot U_2}{Z_L}=-5\angle0^\circ A$ $\therefore \dot I_2=Y_{21}\dot U_1+Y_{22}\dot U_2=-\frac{1}{10}\times90+Y_{22}\times30\Rightarrow Y_{22}=\frac{2}{15}S$

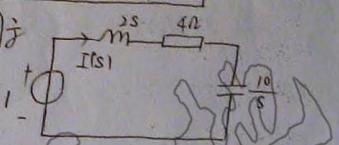
又 N_0 为无源二端网络, $Y_{12}=Y_{21}\Rightarrow Y$ 矩阵 $\begin{bmatrix}\frac{1}{5}S & -\frac{1}{10}S\\ -\frac{1}{10}S & \frac{2}{15}S\end{bmatrix}$. $Z=Y^{-1}=\begin{bmatrix}8\Omega & 6\Omega\\ 6\Omega & 12\Omega\end{bmatrix}$

八. 解: 开关K打开前电路处于稳态. $i_L(0-)=1A$, $u_C(0-)=5V$

于是K打开后 s 域运算电路为



2. 解: 此电路 s 域运算电路如图示



$\Rightarrow I(s)=\frac{1}{2s+4+\frac{10}{s}}$ $\therefore U_c(s)=\frac{10}{s}I(s)=\frac{5}{s^2+2s+5}$

故电容电压 u_c 的单位冲激响应 $u_c(t)=\mathcal{L}^{-1}[U_c(s)]=\frac{5}{2}e^{-t}\sin(2t-90^\circ)\varepsilon(t)$ V

九. 以 u_c, i_L 为状态变量, 即 $C\cdot\frac{du_c}{dt}=i_L$

对右边回路列 KVL 方程: $u_s=Ri_L+L\cdot\frac{di_L}{dt}+u_c$

$$\therefore \begin{bmatrix}\dot u_c\\ \dot i_L\end{bmatrix}=\begin{bmatrix}0 & \frac{1}{C}\\ -\frac{1}{L} & -\frac{R_1}{L}\end{bmatrix}\begin{bmatrix}u_c\\ i_L\end{bmatrix}+\begin{bmatrix}0\\ \frac{1}{L}\end{bmatrix}u_s$$

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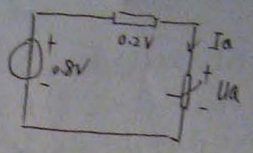
十 (1) 直流电源作用时，电路如图示



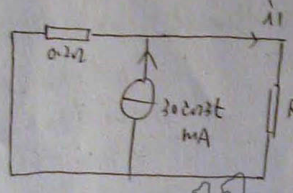
依KVL得 $0.1I_a^2+0.2I_a=0.8$

解得 $I_a=-4A$ 或 $I_a=2A$，又 $i>0$，所以 $I_a=2A$，代入非线性电阻伏安特性

得 $U_a=0.4V$

(2) 交流电源作用时，动态电阻 $R_d=\left.\frac{dU}{di}\right|_{i=2A}=0.2i\big|_{i=2A}=0.4\Omega$

小信号电路如图示，并可解得



$$i_1=\frac{0.2}{0.4}\times 30\cos t\,mA=10\cos t\,mA$$

$$u_1=4\cos t\,mV$$

$$\therefore i=I_a+i_1=(2000+10\cos t)\,mA$$

$$u=U_a+u_1=(400+4\cos t)\,mV$$