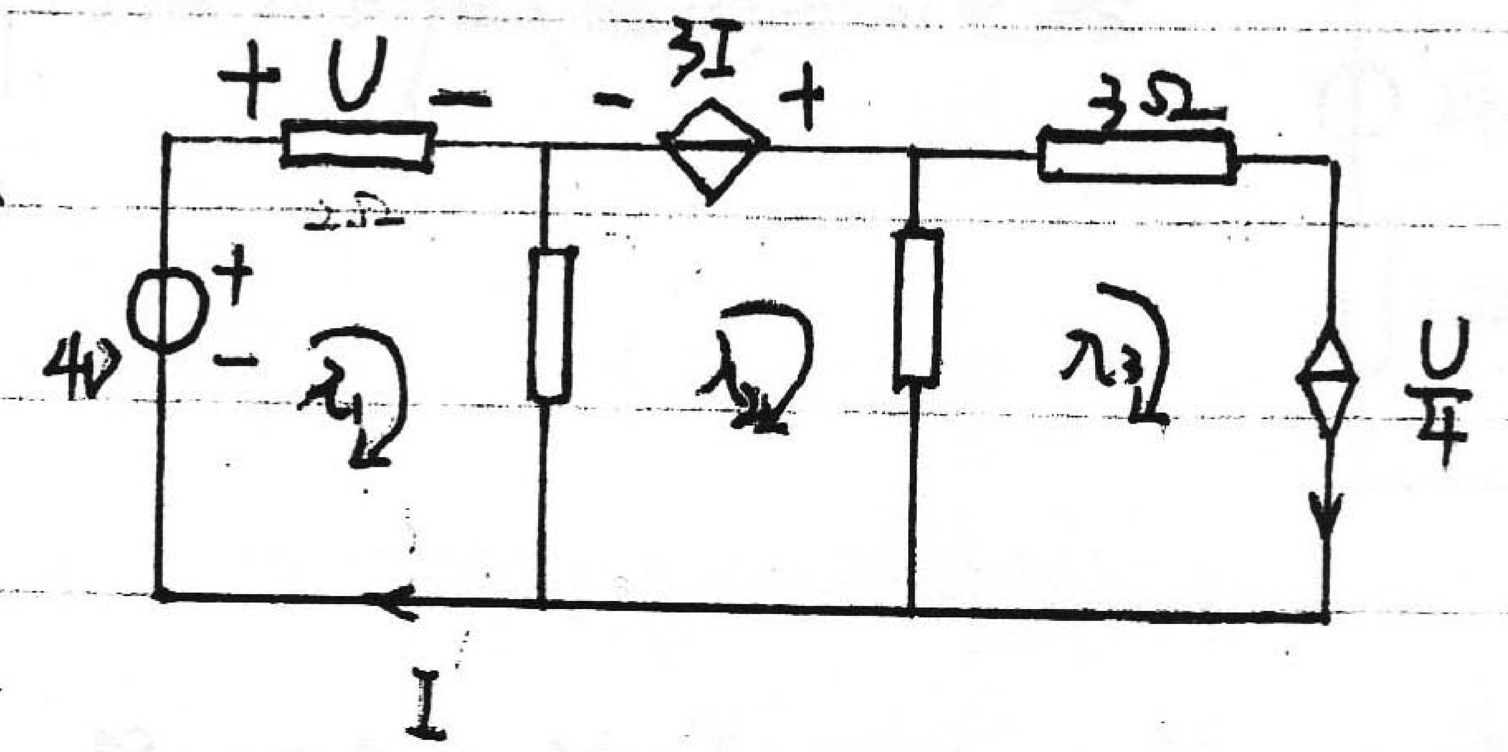
西南交通大学

电路分析一 2004年试题参考答案

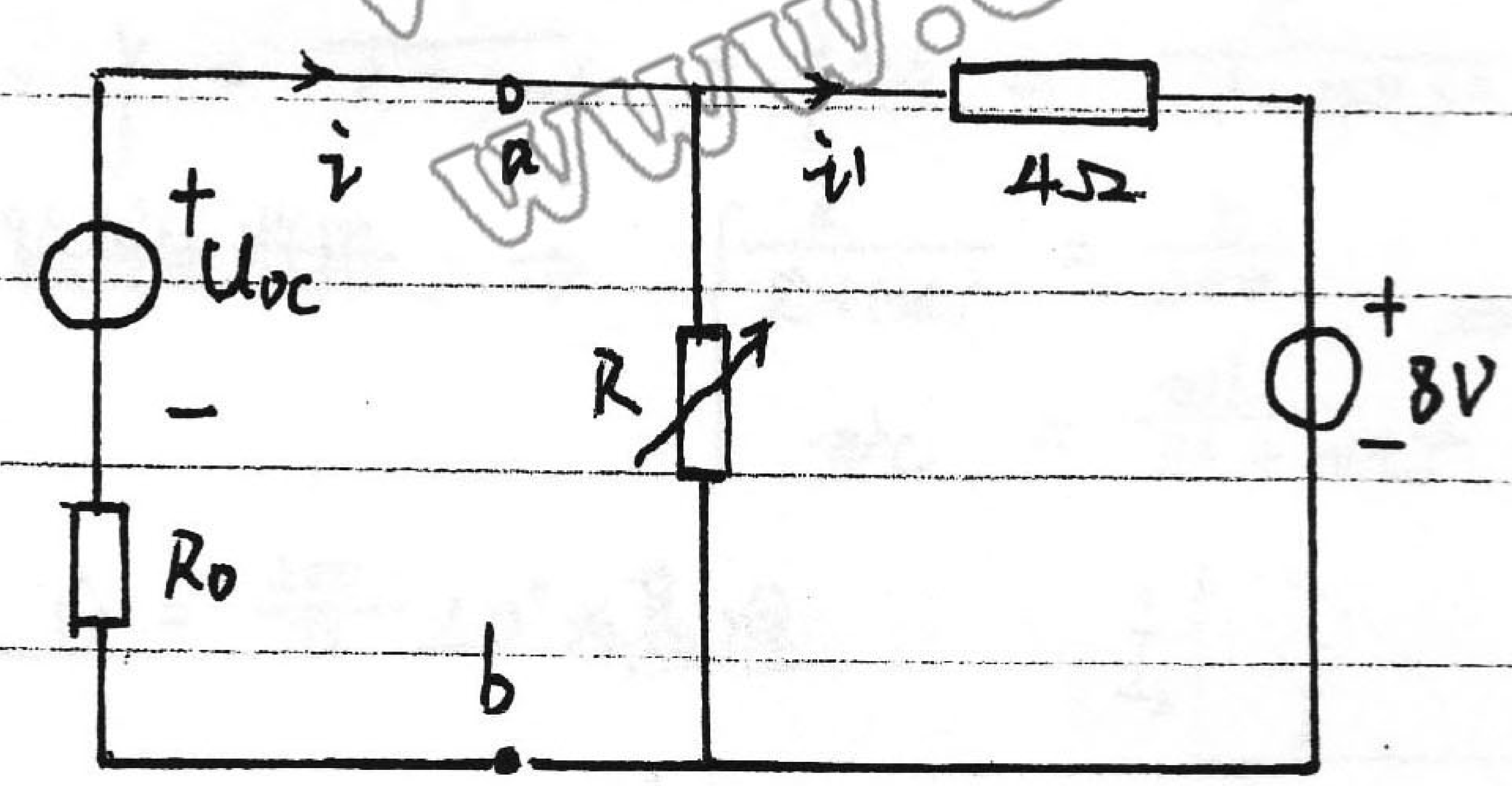
一、



$$\begin{cases} 10i_1 - 8i_2 = 4 \\ -8i_1 + 14i_2 - 6i_3 = 3I \\ i_3 = \frac{u}{4} \end{cases}$$

$i_1 = 1$ 而 $u = 2i_1$，联立求解之 $I = 2A$

二、



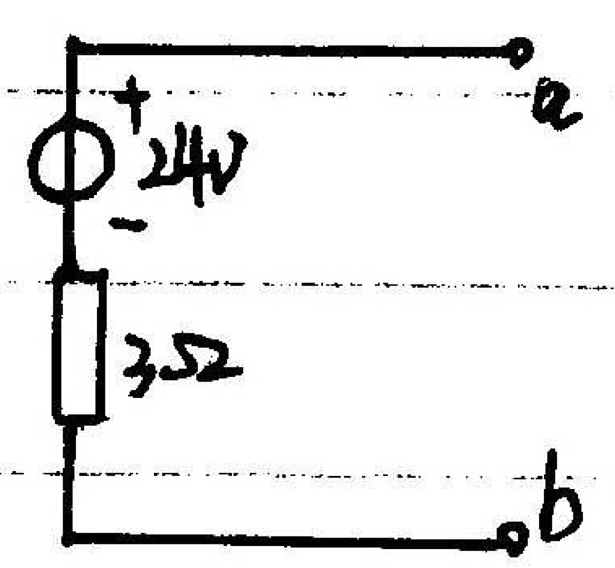
解：设二端网络N开路电压 U_{oc}，等效电阻 R_0，以戴维南等效电路表示网络N，则电路化为上图

当 $R=0$ 时，$i=8A$，则此时 $U_{oc}=8R_0$；

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

将 $i=4A$ 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) $P=3U_pI_p\cos\varphi$，$U_p=220V \Rightarrow I_A=10A$，$\because \dot{U}_{A'B'}=380\angle 0^\circ V$

$\therefore \dot{U}_{A'0'}=220\angle -30^\circ V$　由 $\cos\varphi=0.5$ 知 $\dot{I}_A'$ 滞后 $\dot{U}_{A'0'}$ 60° $\therefore \dot{I}_A'=10\angle -90^\circ A$

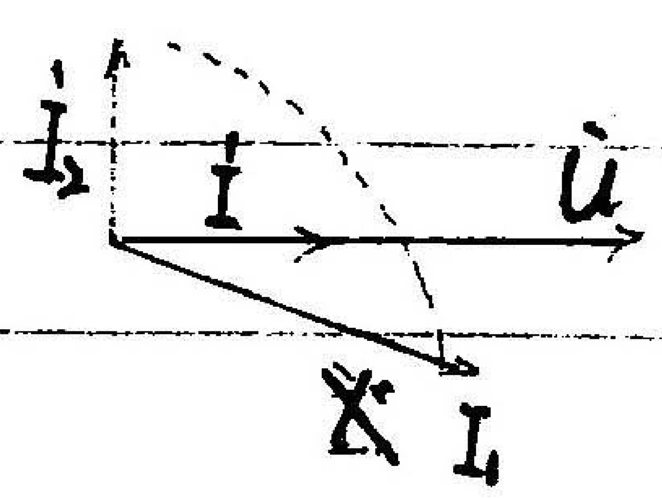
$\Rightarrow \dot{I}_B'=10\angle -210^\circ A$，$\dot{I}_C=10\angle 30^\circ A$

(2) $\dot{U}_{AB}=Z_C\dot{I}_A+\dot{U}_{A'B'}-Z_L\dot{I}_B=398.5\angle -4.3^\circ V$

四、(1) $Y=\frac{1}{R+j\omega L}+j\omega_C=\frac{R}{R^2+(\omega L)^2}+j\left[\omega_C-\frac{\omega L}{R^2+(\omega L)^2}\right]$，

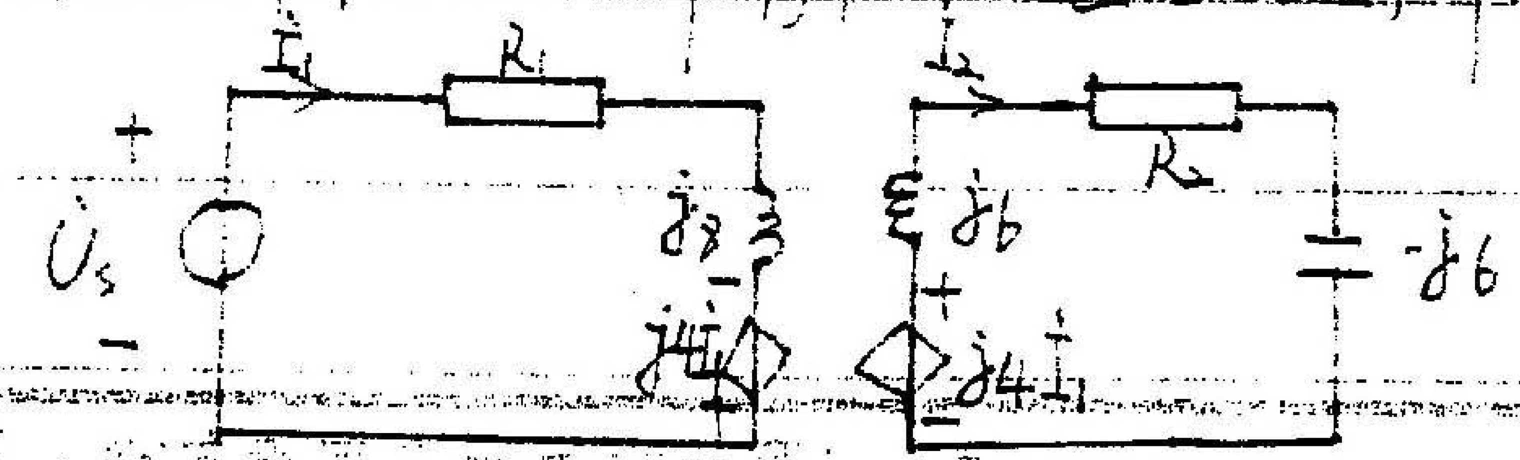
因电路发生谐振 $\Rightarrow \begin{cases}\frac{R}{R^2+(\omega L)^2}=\frac{5}{200} \\ \omega C=\frac{\omega L}{R^2+(\omega L)^2}\end{cases} \Rightarrow L=0.2H$，$C=250\mu F$

(2) 以 $\dot{U}=\frac{200}{\sqrt{2}}\angle 0^\circ$ 为基准



五、解 (1) $U_{S(0)}=12V$ 作用下，$I_{1(0)}=\frac{12}{4}=3A$，$I_{2(0)}=0$

(2) $\dot{U}_{S(2)}=24\sqrt{2}\angle 45^\circ$ 作用下，电路如图所示



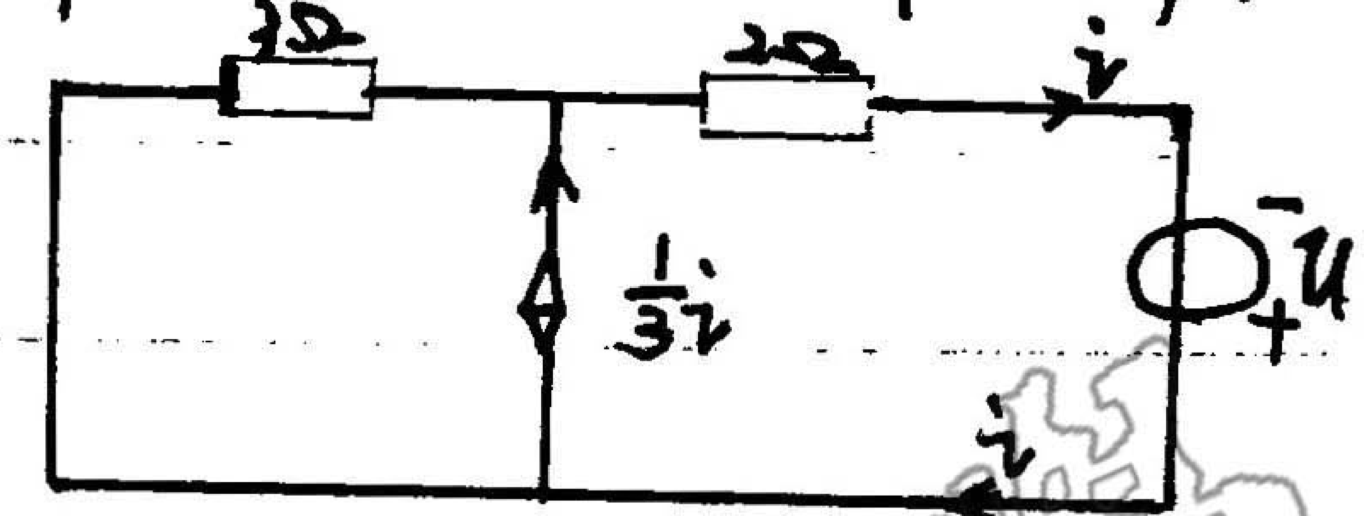
$\Rightarrow \dot{I}_1 = 3\angle 0^\circ$ ， $\dot{I}_2 = 3\angle 90^\circ$ $\therefore i_1 = (3+3\sqrt{2}\cos 2t)\ A$

$i_2 = [3\sqrt{2}\cos(2t+90^\circ)]\ A$ $\quad p = 12\times 3 + \frac{4\sqrt{2}}{\sqrt{2}}\times 3\times\cos 45^\circ = 10.8\ W$

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 $u_{c2p} = 12V$ ，$\tau = R_0C' = 1.5\times 4 = 6s$ $\therefore u_{c2}(t) = u_{c2p} + [u_{c2}(0+) - u_{c2p}]e^{-\frac{1}{\tau}t}$

$= (12 - 8e^{-\frac{1}{6}t})V\ (t\geq 0)$

七解：设无源二端网络左侧端电压$\dot{U}_1$ $\therefore \dot{U}_1 = \dot{U}_s$

当 $Z_L = 0$ 时，$\dot{I}_1 = Y_{11}\dot{U}_1 + Y_{12}\dot{U}_2 = Y_{11}\dot{U}_1$ $\therefore Y_{11} = \frac{\dot{I}_1}{\dot{U}_1} = \frac{18\angle 0^\circ}{90\angle 0^\circ} = \frac{1}{5}S$ ，$\dot{I}_2$

$= Y_{21}\dot{U}_1 + Y_{22}\dot{U}_2 = Y_{21}\dot{U}_1$

$\Rightarrow Y_{21} = \frac{\dot{I}_2}{\dot{U}_1} = -\frac{1}{10}S$

当 $Z_L = 6\Omega$ 时，$\dot{U}_2 = 30\angle 0^\circ \Rightarrow \dot{I}_2 = -\frac{\dot{U}_2}{Z_L} = -5\angle 0^\circ A$

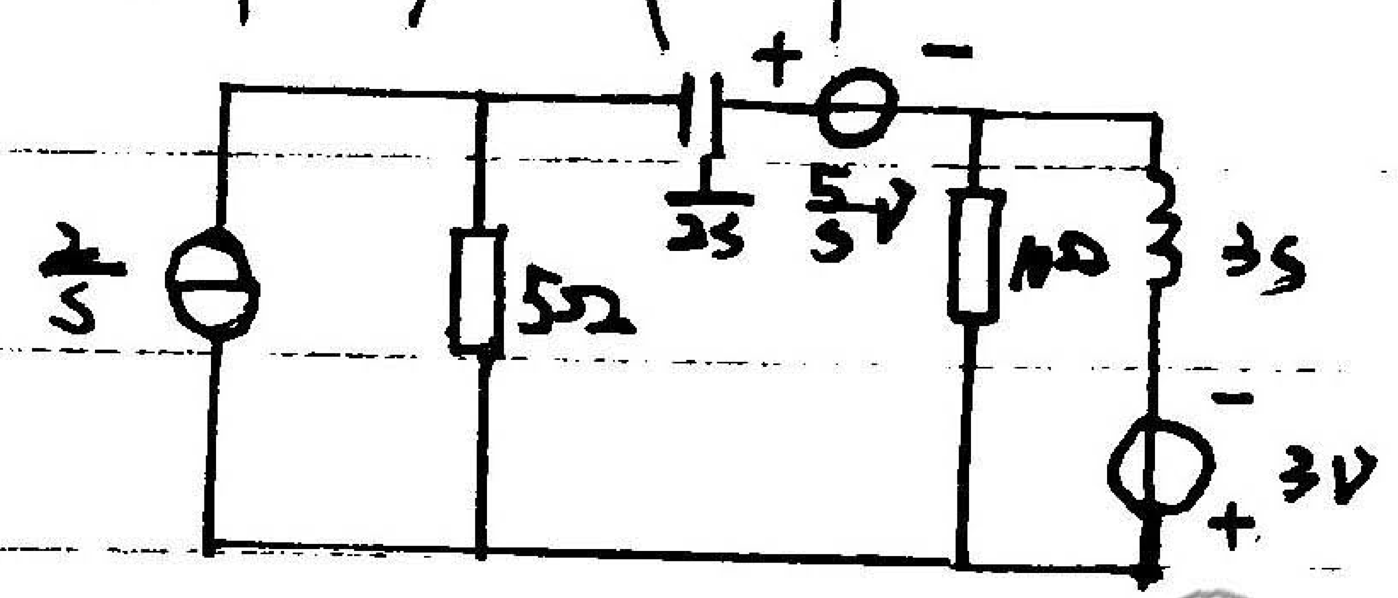
$\therefore \dot{I}_2 = Y_{21}\dot{U}_1 + Y_{22}\dot{U}_2 = -\frac{1}{10}\times 90 + Y_{22}\times 30 \Rightarrow Y_{22} = \frac{2}{15}S$

又N_0为无源二端网络，$Y_{12} = Y_{21} \Rightarrow$ Y参数 $\begin{bmatrix}\frac{1}{5}S & -\frac{1}{10}S \\ -\frac{1}{10}S & \frac{2}{15}S\end{bmatrix}$

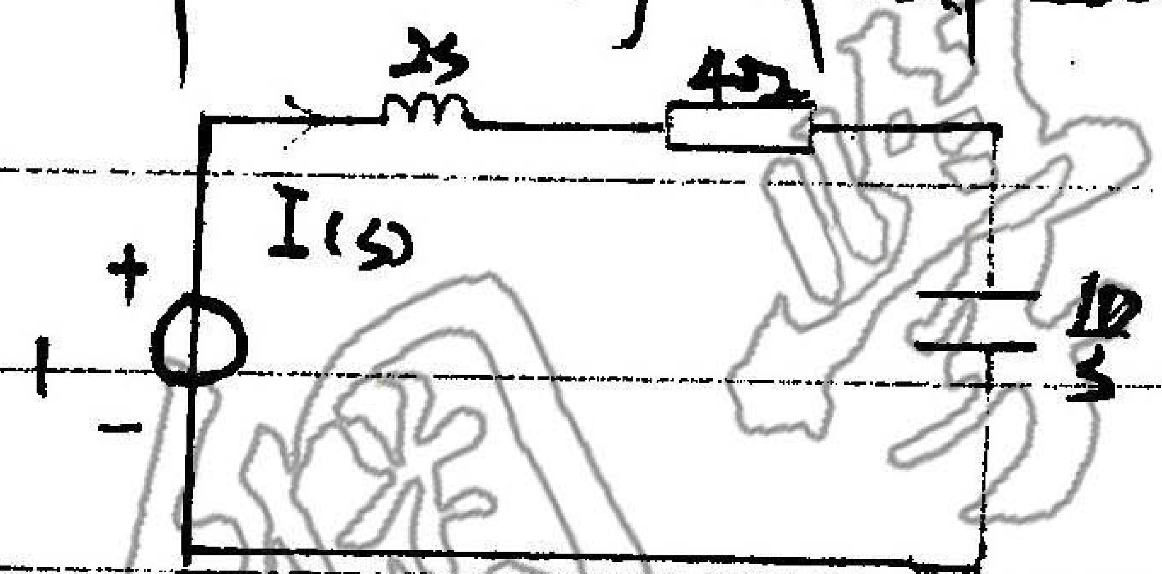
$$Z = Y^{-1} = \begin{bmatrix} 8\Omega & 6\Omega \\ 6\Omega & 12\Omega \end{bmatrix}$$

十、1、解：开关k打开前电路处于稳态 $i_L(0_-) = 1A$，$u_C(0_-) = 5V$

于是k打开后的s域运算电路为



2、解：此电路的s域运算电路如图所示



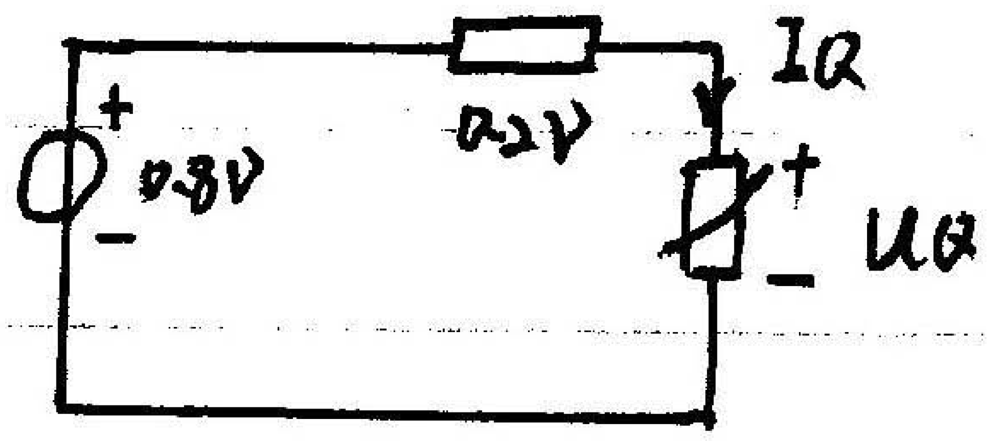
$\Rightarrow I(s) = \dfrac{1}{2s+4+\frac{10}{s}}$ ∴ $U_C(s) = \dfrac{10}{s} I(s) = \dfrac{5}{s^2+2s+5}$

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

十一、以u_C、i_L为状态变量，得 $C\dfrac{du_C}{dt} = i_L$

对左边回路列KVL方程 $u_s = R_1 i_L + L \cdot \dfrac{di_L}{dt} + u_C$

$$\therefore \begin{bmatrix} \dot{u}_C \\ \dot{i}_L \end{bmatrix} = \begin{bmatrix} 0 & \frac{1}{C} \\ -\frac{1}{L} & -\frac{R_1}{L} \end{bmatrix} \begin{bmatrix} u_C \\ i_L \end{bmatrix} + \begin{bmatrix} 0 \\ \frac{1}{L} \end{bmatrix} u_s$$



(1) 直流电源作用时，电路如上图示

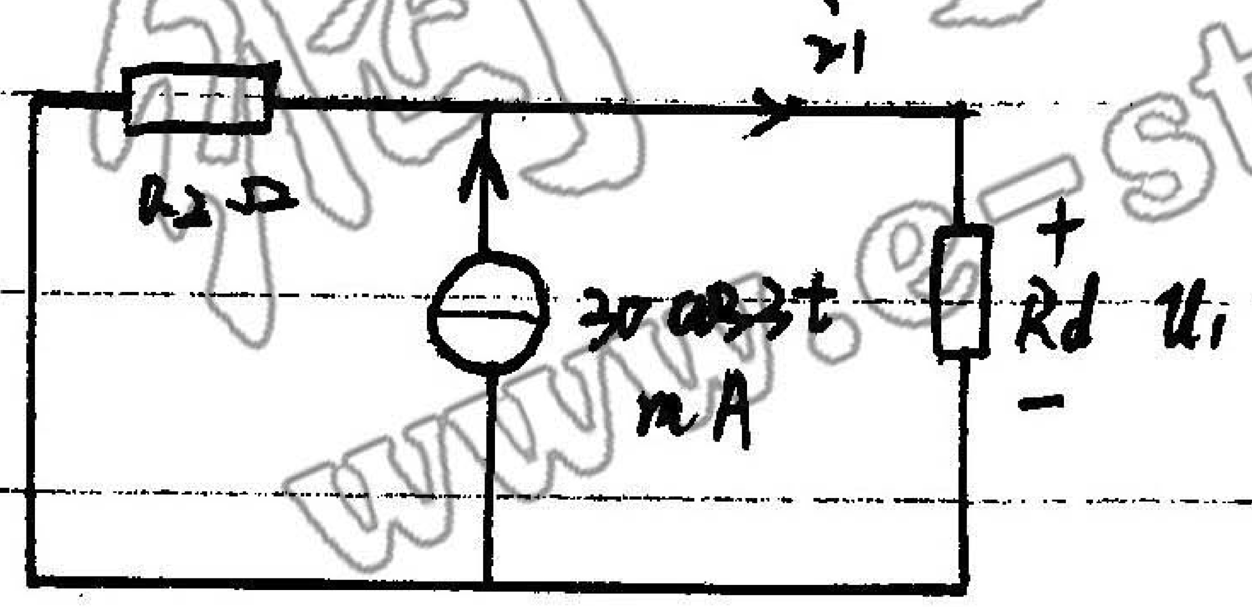
依KVL得 $0.1 I_Q^2 + 0.2 I_Q = 0.8$

解得： $I_Q = -4A$ 或 $I_Q = 2A$，又 $i > 0$ 所以 $I_Q = 2A$

代入非线性电阻伏安特性 得 $U_Q = 0.4V$

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

等效电路如图示，并可解得



$i_1 = \frac{0.2}{0.6} \times 30\cos 3t \ mA = 10\cos 3t \ mA$

$u_1 = 4\cos 3t \ mV$

$\therefore i = I_Q + i_1 = (2000 + 10\cos 3t)\ mA$

$u = U_Q + u_1 = (400 + 4\cos 3t)\ mV$