2008年西南交大电路分析考研

2008年答案：

一.1 解：$3A + I - 5A - 2A = 0 \Rightarrow I = 4A$

$$\begin{cases} I_1 + I_2 = 3A \\ I_1 - 2A - I_3 = 0 \\ 10V + 2I_2 - 2V - 8I_3 - 5I = 0 \end{cases} \Rightarrow \begin{cases} I_1 = 1A \\ I_3 = -1A \\ I_2 = 2A \end{cases}$$

一.2 解：结点电压法：

$$\left(\frac{1}{6} + \frac{1}{4} + \frac{1}{12}\right)U_- - \frac{1}{12}U_0 = \frac{U_S}{6} - \frac{8V}{4}$$

又 $U_- = U_+ = 0$，$\Rightarrow \therefore U_0 = 24 - 2U_S$. 即：$6V < U_S < 18V$.

二. 解：结点电压法：

$$\begin{cases} a: \left(1 + \frac{1}{2} + \frac{1}{6}\right)U_a - U_c - \frac{1}{2}U_d = 0 \\ b: U_b = 4I \\ c: U_c = 10V \\ d: \left(\frac{1}{6} + \frac{1}{3}\right)U_d - \frac{1}{6}U_b - \frac{1}{3}U_a = 1A + 2A \end{cases} \Rightarrow \text{又知：} U_c - U_a = I$$

$\therefore U_a = 8V$，$U_b = 8V$

$U_c = 10V$，$U_d = 14V$.

三.1 解：$\because \dot{I} = 10\angle 60°A$，$\cos\varphi = \frac{\sqrt{2}}{2}$，$P = 500W$. $\Rightarrow Q = P \cdot \tan\varphi = 500\,var$.

又 $P = UI\cos\varphi \Rightarrow \dot{U} = 50\sqrt{2}\angle 105°V$.

$\therefore P = 500W = \frac{U^2}{R} = U_R \cdot I_R \Rightarrow I_R = \frac{500}{50\sqrt{2}} = 5\sqrt{2}A$

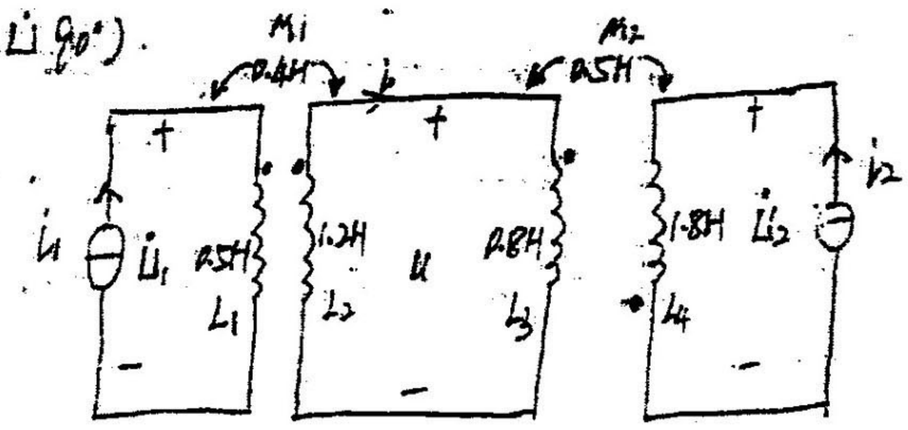
$Q_L = 500\,var = \frac{U^2}{X_L} = U_L \cdot I_L \Rightarrow I_L = 10\sqrt{2}A$

$Q_C = Q - Q_L = -500\,var = -\frac{U^2}{X_C} = -U_C \cdot I_C \Rightarrow I_C = 5\sqrt{2}A$.

故：$\begin{cases} \dot{I}_R = 5\sqrt{2}\angle 105°A \quad (\text{与 } \dot{U} \text{ 同相位}) \\ \dot{I}_L = 10\sqrt{2}\angle 15°A \quad (\dot{I}_L \text{ 滞后 } \dot{U}\ 90°) \\ \dot{I}_C = 5\sqrt{2}\angle 195°A \quad (\dot{I}_C \text{ 超前 } \dot{U}\ 90°) \end{cases}$

三.2 解：$\dot{I}_1 = \frac{5}{\sqrt{2}}\angle 0°A$，$\dot{I}_2 = \frac{2}{\sqrt{2}}\angle 0°A$.

端口电压电流关系：



$$\begin{cases}\dot{U}_1 = j\omega L_1 \dot{I}_1 - j\omega M_1 \dot{I} \\ \dot{U} = -j\omega L_2 \dot{I} + j\omega M_1 \dot{I}_1 \\ \dot{U} = j\omega L_3 \cdot \dot{I} - j\omega M_2 \dot{I}_2 \\ \dot{U}_2 = j\omega L_4 \dot{I}_2 - j\omega M_2 \cdot \dot{I}\end{cases} \Rightarrow \begin{cases}\dot{U} = -j480\dot{I} + j400\sqrt{2}\angle 0^\circ \\ \dot{U} = j320\dot{I} - j200\sqrt{2}\angle 0^\circ\end{cases} \Rightarrow \begin{matrix}\dot{U} = 40\sqrt{2}\angle 90^\circ \text{ V} \\ \dot{I} = \frac{3}{4}\sqrt{2}\angle 0^\circ \text{ A}.\end{matrix}$$

故 $i(t) = \frac{3}{2}\cos 400t$ A

$u(t) = 40\cos(400t + 90^\circ)$ V.

四

解：K闭合时，A相电路：

$\dot{I}_A = \dot{U}_A / \frac{Z}{3} = \dfrac{220\angle 30^\circ}{\frac{50}{3}\angle -37^\circ} = 13.2\angle 67^\circ$ A.

$\dot{I}_B = 13.2\angle -53^\circ$ A，$\dot{I}_C = 13.2\angle -173^\circ$ A

电源发出 $P = 3U_A I_A \cos\varphi = 3\times 220\times 13.2\times\cos(-37^\circ) = 6969.6$ W.

K打开时，$\dot{I}_A = \dot{U}_{AB}/Z = \dfrac{\sqrt{3}\times 220\angle 60^\circ}{50\angle -37^\circ} = 7.62\angle 97^\circ$ A

$\dot{I}_C = -\dot{U}_{BC}/Z = -\dfrac{\sqrt{3}\times 220\angle 120^\circ - 120^\circ + 30^\circ}{50\angle -37^\circ} = -7.62\angle -23^\circ$ A

$\dot{I}_B = -\dot{I}_A - \dot{I}_C = 13.2\angle 53^\circ$ A.

电源发出 $P = P_A + P_B + P_C = 5667.2$ W.

五

解：$i_{S1} = 10$A单独作用，C断开，L短路，$i = 0$，i_{S2}断开 $\Rightarrow \begin{cases}U_{R1} = 10\text{A}\times 20\Omega = 200\text{V} \\ P_1 = U_{R1}\cdot i_{S1} = 2000\text{W}.\end{cases}$

$\dot{I}_{S2} = \frac{5}{\sqrt{2}}\angle 30^\circ$A；$i_{S1}$断开时，L、C发生串联谐振，相当于一段导线：

$\dot{I} = \dot{I}_{S2} = \frac{5}{\sqrt{2}}\angle 30^\circ$ A；$\dot{U}_R = -5\dot{I} = -25\angle 30^\circ$ V；$P_2 = 0$.

故：$\begin{cases}u_R(t) = u_{R1} + u_{R2} = 200 - 25\cos(200t + 30^\circ) \text{ V}. \\ P = P_1 + P_2 = 2\text{KW}\end{cases}$

六

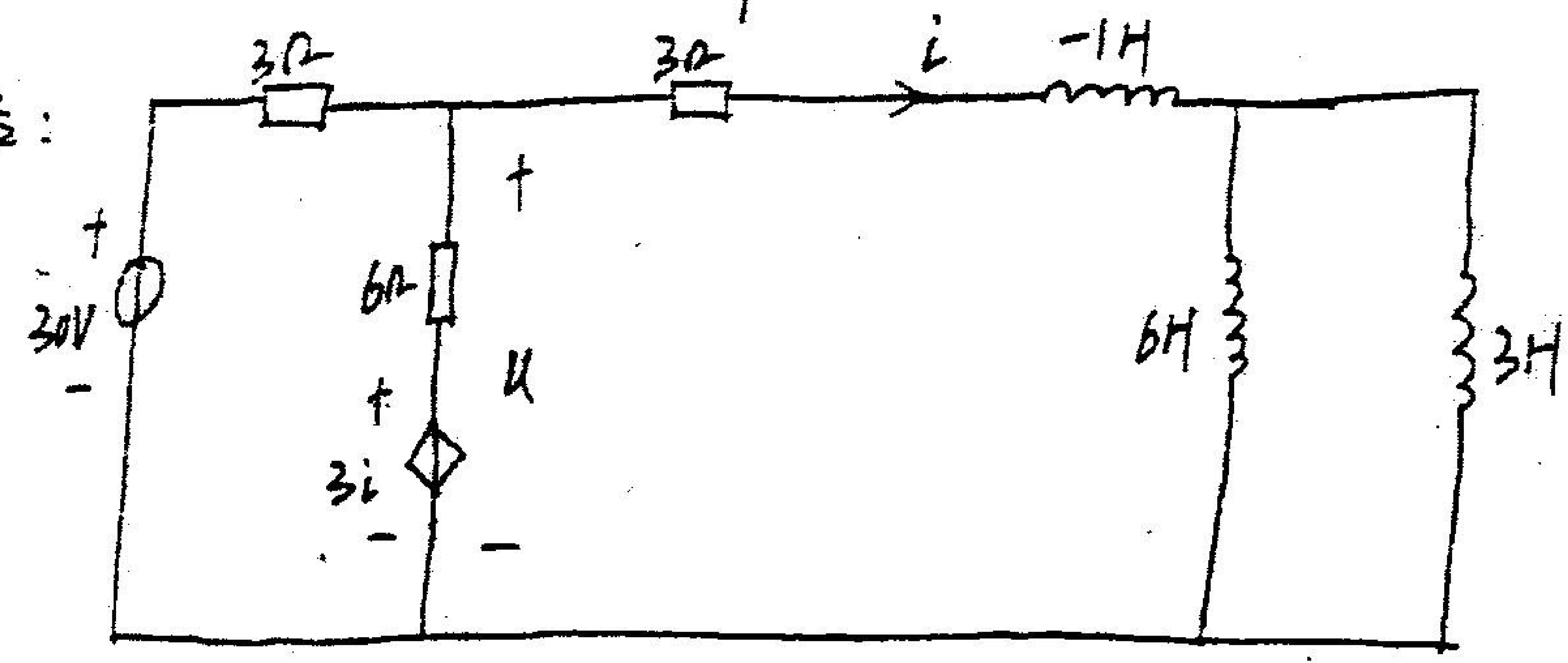
解：$\begin{cases}\dot{U}_1 = Z_{11}\cdot\dot{I}_1 + Z_{12}\cdot\dot{I}_2 \\ \dot{U}_2 = Z_{12}\cdot\dot{I}_1 + Z_{22}\cdot\dot{I}_2\end{cases}$ $\Rightarrow$ 当 $Z_L = \infty$ 时，即 $\dot{I}_2 = 0$，$\begin{cases}48\angle 0^\circ = Z_{11}\cdot\dot{I}_1 \\ 32\angle 0^\circ = Z_{12}\cdot\dot{I}_1\end{cases}$

当 $Z_L = 0$ 时，即 $\dot{U}_2 = 0$，$\begin{cases}48\angle 0^\circ = Z_{11}\cdot 6\angle 0^\circ + Z_{12}\cdot 3\angle 180^\circ \\ 0 = Z_{12}\cdot 6\angle 0^\circ + Z_{22}\cdot 3\angle 180^\circ\end{cases}$ $\Rightarrow$ $Z_{12} = 8\Omega$，$Z_{11} = 12\Omega$，$Z_{22} = 16\Omega$

Z参数矩阵：$Z = \begin{bmatrix}12 & 8 \\ 8 & 16\end{bmatrix}\Omega$.

七解 $t<0$时，$i(0_-)=0$，$u(0_-)=30\times\frac{6}{9}=20V$.

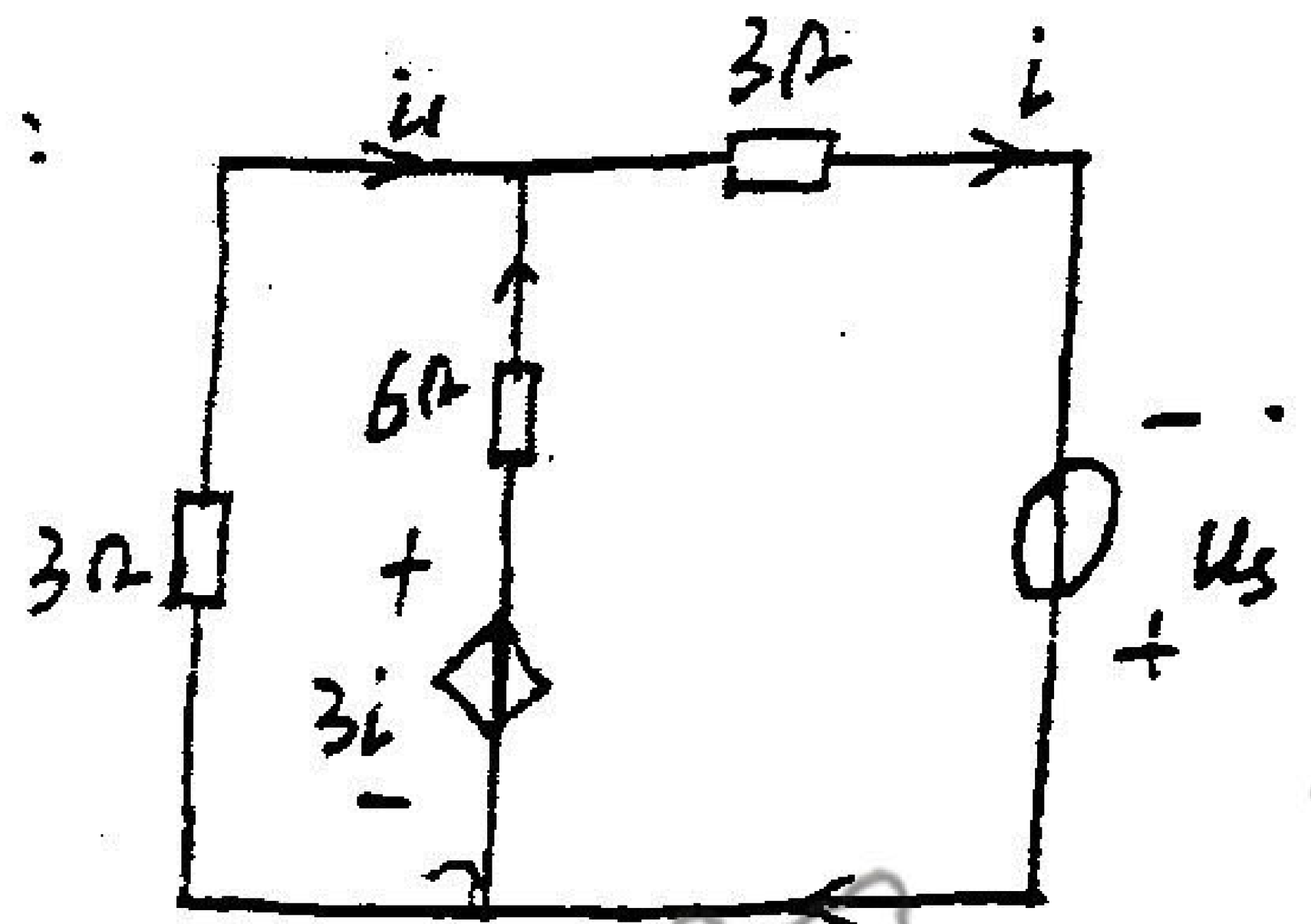
$t\geq 0$换路：



$i(\infty)=\frac{30V}{3+3}=5A$

$\tau=\frac{L}{R_0}=\frac{1}{4}S$.

外接电源法求R_0：



$$\begin{cases}3i_1+3i=u_s\\3i_1=6(i-i_1)-3i\end{cases}\Rightarrow 4i=u_s\ ,\ R_0=4\Omega.$$

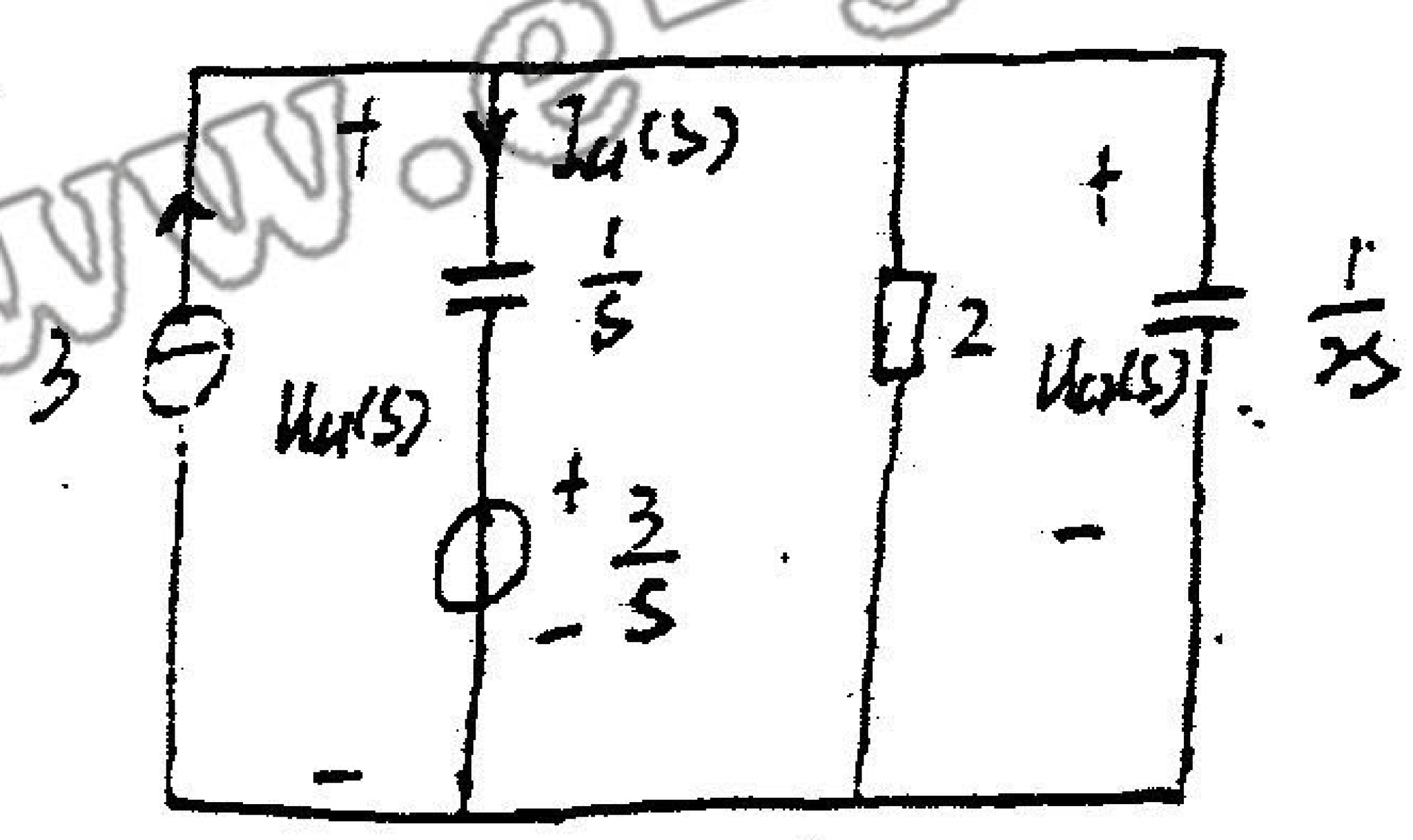
故 $i(t)=5-5e^{-4t}$，$t\geq 0$.

回原电路求$u(t)$：

KVL:
$$\begin{cases}3i+1H\cdot\frac{di}{dt}=6i_2+3i\\3(i+i_2)+3i+1H\cdot\frac{di}{dt}=30\end{cases}\Rightarrow 2i+3i_2=10\Rightarrow i_2=\frac{10-2i}{3}$$

故 $u(t)=6i_2+3i=20-4i+3i=20-i=15+5e^{-4t}$，$t\geq 0$.

八.解：s域运算电路：



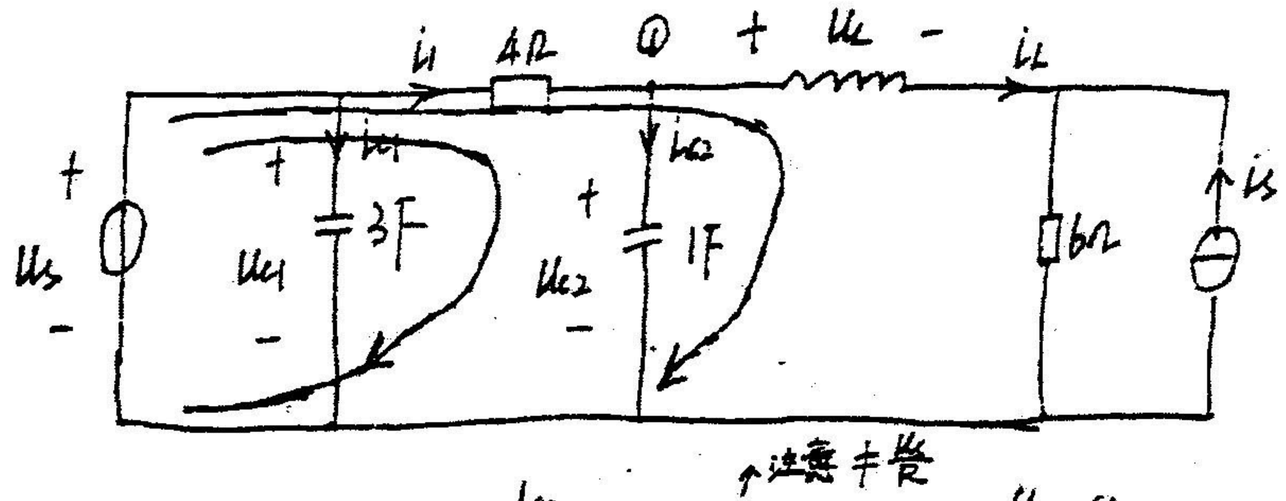
KVL：$\frac{1}{s}\cdot I_{c1}(s)+\frac{3}{s}=\frac{2\cdot\frac{1}{2s}}{2+\frac{1}{2s}}\cdot(3-I_{c1}(s))$

$\Rightarrow I_{c1}(s)=\frac{2(3s-1)}{4s+1}-3=-\frac{3}{2}-\frac{7}{8}\cdot\frac{1}{s+\frac{1}{4}}$

$\therefore\ i_{c1}(t)=L^{-1}[I_{c1}(s)]=-\frac{3}{2}\delta(t)-\frac{7}{8}e^{-\frac{1}{4}t}\cdot\varepsilon(t)$

九.解：选u_{c2}，i_L为状态变量.

$\because$ u_{c1}与u_s并联，则作为多余元件先处理掉：



注：C_1 非独立变量

结点①：$i_{C2} = C_2 \cdot \frac{du_{C2}}{dt} = i_1 - i_L = \frac{u_S - u_{C2}}{R} - i_L$

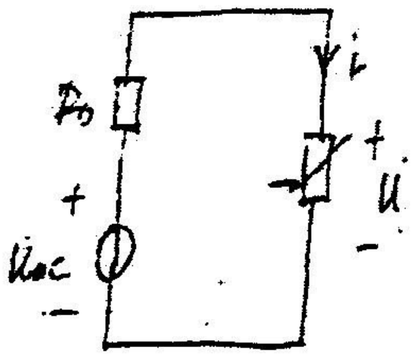
即：$\dot{u}_{C2} = \frac{1}{4}u_S - \frac{1}{4}u_{C2} - i_L$ ①

回路有：$Ri_1 + L\cdot\frac{di_L}{dt} + 6(i_S + i_L) = u_S \rightarrow 2\dot{i}_L = u_S - 6i_S - 6i_L - 4\cdot\frac{u_S - u_{C2}}{4}$

$\therefore \dot{i}_L = -3i_S - 3i_L + \frac{1}{2}u_{C2}$ ②

①② 联立：$\begin{bmatrix}\dot{u}_{C2}\\ \dot{i}_L\end{bmatrix} = \begin{bmatrix}-\frac{1}{4} & -1\\ \frac{1}{2} & -3\end{bmatrix}\begin{bmatrix}u_{C2}\\ i_L\end{bmatrix} + \begin{bmatrix}\frac{1}{4} & 0\\ 0 & -3\end{bmatrix}\begin{bmatrix}u_S\\ i_S\end{bmatrix}$

十.解：a.b 左端戴维南化简：$u_{oc} = 15V$，$R_0 = 2\Omega$



KVL：$2i + u = 15V$ ③

非线性R伏安特性：AB段：$u = i+3$，$i \le 3A$ ④

BC段：$u = 4i - 6$，$i > 3A$ ⑤

③④ 联立：$u = 7V$，$i = 4A$（不在AB段上 ~~舍去~~）

③⑤ 联立：$u = 8V$，$i = \frac{7}{5}A$（落在BC段上，符合题意）