2011年《电路分析二》试题标准答案

一、解：$I_3 = 3I_1 - I_1 = 2I_1$，$I_2 = 2 - I_1$

KVL：$10I_1 = 4I_2 + 3I_3 = 4\times(2 - I_1) + 3\times 2I_1 = 8 + 2I_1$

$\therefore$ $I_1 = 1A$

$I_3 = 2A$

$I_2 = 1A$　　　$I = 1A$

二、解：以(下)为参考结点，(左)为1，(右)为2结点，

结点电压方程为：

$$\begin{cases} (1+\frac{1}{2}+\frac{1}{4})U_1 - (\frac{1}{2}+\frac{1}{4})U_2 = 2 - \frac{1}{2}I \\ -(\frac{1}{2}+\frac{1}{4})U_1 + (\frac{1}{2}+\frac{1}{4}+\frac{1}{3}+\frac{1}{6})U_2 = \frac{1}{2}I + \frac{18}{3} \\ I = \frac{1}{2}(U_2 - U_1) \end{cases}$$

整理，得：

$$\begin{cases} 7U_1 - 3U_2 = 8 - 2I \\ -9U_1 + 15U_2 = 6I + 72 \\ 2I = U_2 - U_1 \end{cases} \qquad \begin{cases} 6U_1 - 2U_2 = 8 \\ -6U_1 + 12U_2 = 72 \end{cases}$$

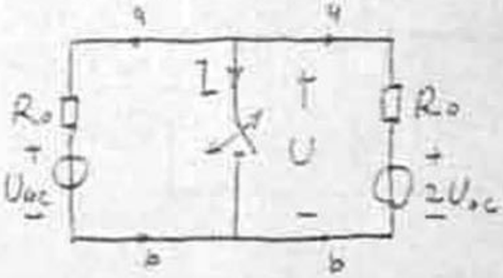
解得：$U_1 = 4V$，$U_2 = 8V$　　$I = \frac{1}{2}(8 - 4) = 2A$

$\therefore$ 电流源发出的功率为：$P = 2\times(U_1 + 2\times 5)$

$= 2\times(4 + 10)$

$= 28(W)$

三、解：由戴维南定理及齐次性，图(a)可等效为：



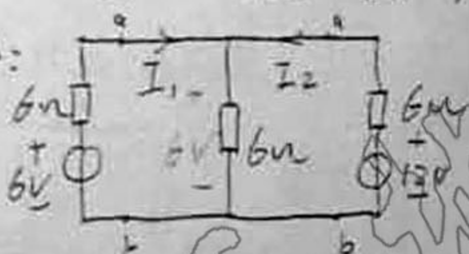
K闭合时：$I=\frac{U_{oc}}{R_0}+\frac{2U_{oc}}{R_0}=\frac{3U_{oc}}{R_0}=3$ (A)

K断开时：$U=U_{oc}+R_0\times\frac{2U_{oc}-U_{oc}}{2R_0}$

$=U_{oc}+\frac{1}{2}U_{oc}=9$ (V)

$\therefore U_{oc}=6V$，$R_0=6\Omega$

∴图(b)可等效为：



可得：$I_1=0$ (A)

$I_2=1$ (A)

四、解：开关K闭合时，有 $R_1I^2=P_1$ $\therefore R_1=\frac{P_1}{I^2}=\frac{1936}{11^2}=16\Omega$

$|Z|=\frac{U}{I}=\frac{220}{11}=20=\sqrt{R_1^2+X_L^2}$

$\therefore X_L=\sqrt{|Z|^2-R_1^2}=\sqrt{20^2-16^2}=12\Omega=100\pi L$

$L=\frac{12}{100\pi}=38.2mH$

K断开时，$S=UI=220\times11=2420=P$，$\cos\varphi=1$

电路发生谐振，$\therefore X_C=X_L=12\Omega=\frac{1}{100\pi C}$

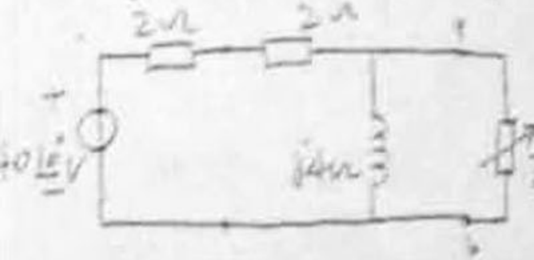
$C=\frac{1}{1200\pi}(F)=265.26\mu F$

$(R_1+R_2)I^2=P_2=2420W$

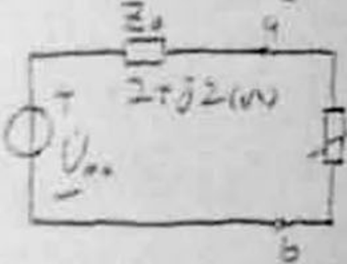
$R_1+R_2=\frac{P_2}{I^2}=\frac{2420}{11^2}=20\Omega$

$R_2=20-R_1=20-16=4\Omega$

、解：将原边电路折算到副边，电路可等效为：



$\Rightarrow$

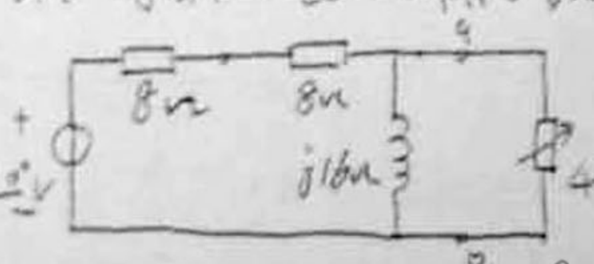


$\dot{U}_{oc} = 20\sqrt{2}\angle 45^\circ (V)$

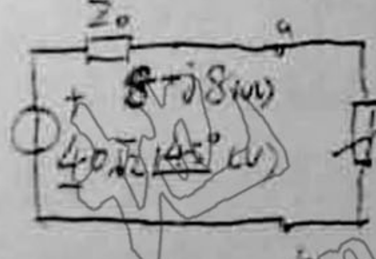
$Z_0 = 2 + j2(\Omega)$

∴ 当 $Z_L = \overset{*}{Z}_0 = 2 - j2(\Omega)$ 时，有 $P_{max} = \frac{U_{oc}^2}{4R_0} = \frac{(20\sqrt{2})^2}{4\times 2} = 100W$

或：将副边电路折算到原边：



$\Rightarrow$



结果相同

六、解：设负载为Y接，$P_p = \frac{P}{3} = 1000(W)$，$\dot{U}_{A'} = 220\angle 0^\circ (V)$

又 $P_p = U_p^2 / R_L$

∴ 负载电阻 $R_L = U_p^2 / P_p = 220^2/1000 = 48.4(\Omega)$

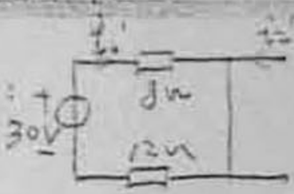
则 $\dot{U}_{AB} = \frac{Z_l + R_L}{R_L} \times \dot{U}_{A'B'} = \frac{2 + j10 + 48.4}{48.4} \times 380\angle 30^\circ$

$= \frac{51.38\angle 11.21^\circ}{48.4} \times 380\angle 30^\circ = 403.42\angle 41.22^\circ (V)$

或：$\dot{U}_A = \frac{Z_l + R_L}{R_L}\dot{U}_{A'} = \frac{51.38\angle 11.21^\circ}{48.4} \times 220\angle 0^\circ = 233.55\angle 11.21^\circ (V)$

$\dot{U}_{AB} = \sqrt{3}\dot{U}_A\angle 30^\circ = 404.53\angle 41.22^\circ (V)$

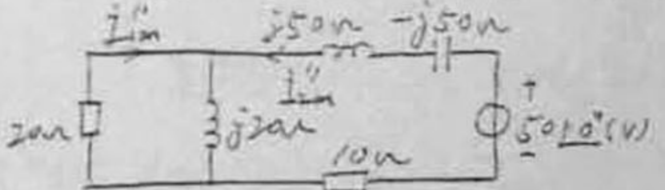
七. 解：直流 U_{S1} 单独作用：



$$i_1' = \frac{30}{8+12} = 1.5\,(A)$$

$$i_2' = 0$$

交流 U_{S2} 单独作用：令 $\dot{U}_{S2m} = 50\angle 0^\circ\,(V)$



$$\dot{I}_{2m}'' = \frac{50\angle 0^\circ}{10 + j\dfrac{20\times 20}{20+j20}} = \frac{50\angle 0^\circ}{20+j10} = \frac{50\angle 0^\circ}{22.36\angle 26.57^\circ} = 2.236\angle -26.57^\circ\,(A)$$

$$\dot{I}_{1m}'' = -\frac{j20}{20+j20}\times \dot{I}_{2m}'' = -\frac{j1}{1+j1}\times 2.236\angle -26.57^\circ = -1.581\angle 18.43^\circ\,(A)$$

$\therefore\ i_1'' = -1.581\sin(10^3 t + 18.43^\circ)\,(A)$　　$i_2'' = 2.236\sin(10^3 t - 26.57^\circ)\,(A)$

$i_1 = 1.5 - 1.581\sin(10^3 t + 18.43^\circ)\,(A)$.　　$i_2 = 2.236\sin(10^3 t - 26.57^\circ)\,(A)$

$P_{U_{S1}} = U_{S1}\times i_1' = 30\times 1.5 = 45\,(W)$

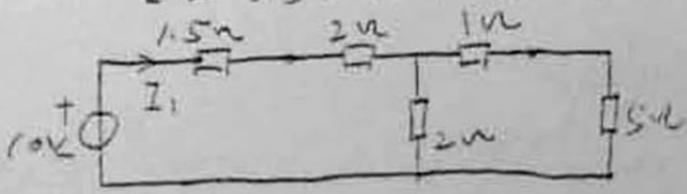
八. 解：由传输方程 $U_1 = 2U_2 - 4I_2$ 得 Z参数方程：$U_1 = 4I_1 + 2I_2$

$i_1 = 1.5 - 1.58\sin(10^3 t + 18.43^\circ)\,(A)$.　　$i_2 = 2.236\sin(10^3 t - 26.57^\circ)\,(A)$

$P_{U_{S1}} = U_{S1}\times i_1' = 30\times 1.5 = 45\,(W)$

八. 解：由传输方程 $\begin{cases} U_1 = 2U_2 - 4I_2 \\ I_1 = 0.5U_2 - 1.5I_2 \end{cases}$ 得 Z参数方程：$\begin{cases} U_1 = 4I_1 + 2I_2 \\ U_2 = 2I_1 + 3I_2 \end{cases}$

$Z = \begin{bmatrix} 4 & 2 \\ 2 & 3 \end{bmatrix}$. $\therefore$ 原电路等效为：



$$R = 1.5 + 2 + \frac{2\times 6}{2+6} = 5\Omega$$

$$I_1 = \frac{10}{5} = 2\,(A)$$

$$\therefore P = 10\times 2 = 20\,(W)$$

或：由 $\begin{cases} U_1 = 2U_2 - 4I_2 \\ I_1 = 0.5U_2 - 1.5I_2 \\ U_1 = 10 - 1.5I_1 \\ U_2 = -5I_2 \end{cases}$　　解得 $I_1 = 2A$，　$P = 20W$

电路分析二

九. 解：当 $u_S(t)=10\varepsilon(t)$ (V)，$C=0.1F$ 时，$i(t)=8+(5-8)e^{-\frac{t}{\tau_1}}$ (A)

有：$i(\infty)=8$ (A) (C开路时)，$i(0_+)=5$ (A) (C短路时)

$\tau_1=R_0C=\frac{1}{5}$，∴ $R_0=\frac{\tau_1}{C}=\frac{1}{5\times 0.1}=2(\Omega)$

∴ 当 $u_S(t)=20\varepsilon(t)$ V，$L=0.2H$ 时，

$\tau_2=\frac{L}{R_0}=\frac{0.2}{2}=0.1(s)$

而 $t\to\infty$ 时 L短路，相当于C在 $t=0_+$ 时的情况 ∴ 此时 $i(\infty)=10A$

$t=0_+$ 时，L开路，相当于C在 $t\to\infty$ 时的情况 ∴ 此时 $i(0_+)=16A$

∴ 此时 $i(t)=[10+(16-10)e^{-10t}]\varepsilon(t)=[10+6e^{-10t}]\varepsilon(t)$ (A)

十. 解：$i_L(0_-)=1A$，$u_C(0_-)=6V$

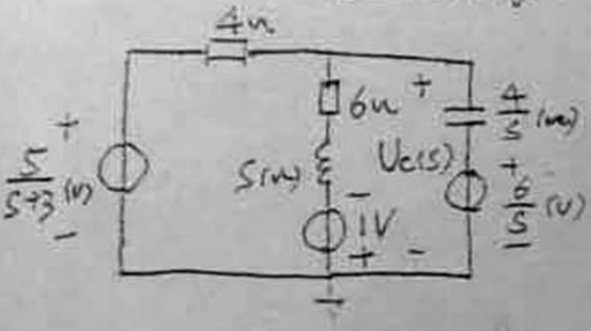
而 $t\to\infty$ 时 L短路，相当于C在 $t=0_+$ 时的情况 ∴ 此时 $i(\infty)=10A$

$t=0_+$ 时，L开路，相当于C在 $t\to\infty$ 时的情况 ∴ 此时 $i(0_+)=16A$

∴ 此时 $i(t)=[10+(16-10)e^{-10t}]\varepsilon(t)=[10+6e^{-10t}]\varepsilon(t)$ (A)

十. 解：$i_L(0_-)=1A$，$u_C(0_-)=6V$

$t\geq 0$ 时运算电路为：



列节点方程.

$$\left(\frac{1}{4}+\frac{1}{s+6}+\frac{s}{4}\right)U_C(s)=\frac{5}{4(s+3)}+\frac{3}{2}-\frac{1}{s+6}$$

两边同乘以 $4(s+6)(s+3)$

$$[(s+6)(s+3)+4(s+3)+s(s+6)(s+3)]U_C(s)$$
$$=5(s+6)+6(s+6)(s+3)-4(s+3)$$

$$(s+3)(s+2)(s+5)U_C(s)=6s^2+55s+126$$

$$\therefore U_C(s)=\frac{6s^2+55s+126}{(s+3)(s+2)(s+5)}=\frac{-\frac{15}{2}}{s+3}+\frac{\frac{40}{3}}{s+2}+\frac{\frac{1}{6}}{s+5}$$

$$\therefore u_C(t)=\mathscr{L}^{-1}[U_C(s)]=-\frac{15}{2}e^{-3t}+\frac{40}{3}e^{-2t}+\frac{1}{6}e^{-5t}\ (V)$$

$$=-7.5e^{-3t}+13.3e^{-2t}+0.17e^{-5t}\ (V)$$

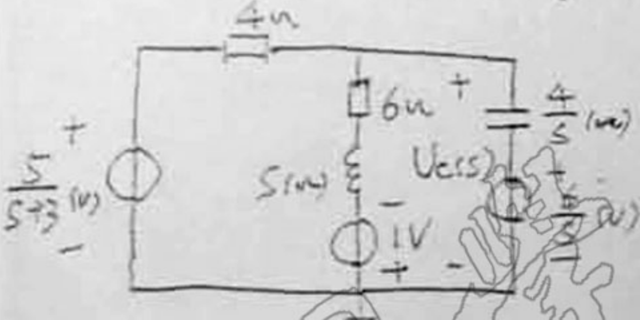
$(t\geq 0)$

…时，…相当于C在 $t\to\infty$ 时的情况：∴此时 $i(\infty)=16A$

∴ 此时 $i(t)=[10+(16-10)e^{-10t}]\varepsilon(t)=[10+6e^{-10t}]\varepsilon(t)$ (A)

十、解：$i_L(0_-)=1A$，$U_C(0_-)=6V$

$t\geq 0$ 时运算电路为：



列结点方程

$$\left(\frac{1}{4}+\frac{1}{s+6}+\frac{s}{4}\right)U_C(s)=\frac{5}{4(s+3)}+\frac{3}{2}-\frac{1}{s+6}$$

两边同乘以 $4(s+6)(s+3)$

$$[(s+6)(s+3)+4(s+3)+s(s+6)(s+3)]U_C(s)$$

$$=5(s+6)+6(s+6)(s+3)-4(s+3)$$

$$(s+3)(s+2)(s+5)U_C(s)=6s^2+55s+126$$

$$\therefore U_C(s)=\frac{6s^2+55s+126}{(s+3)(s+2)(s+5)}=\frac{-\frac{15}{2}}{s+3}+\frac{\frac{40}{3}}{s+2}+\frac{\frac{1}{6}}{s+5}$$

$$\therefore u_C(t)=\mathcal{L}^{-1}[U_C(s)]=-\frac{15}{2}e^{-3t}+\frac{40}{3}e^{-2t}+\frac{1}{6}e^{-5t}\ (V)$$

$$=-7.5e^{-3t}+13.3e^{-2t}+0.17e^{-5t}\ (V)$$

$(t\geq 0)$