2011（电32）

一、解：KCL：$I_3 = 3I_1 - I_1 = 2I_1 \qquad I_2 = 2 - I_1$

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

$\therefore\ I_1 = 1A \quad I_2 = 1A \quad I_3 = 2A \quad I = 1A$

二、解：以（下）为参考结点，（左）为1结点（右）为2结点。

列结点电压方程为

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

整理得：

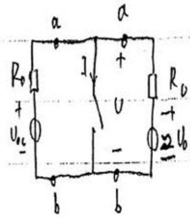
$$\begin{cases} 7U_1 - 3U_2 = 8 - 2I \\ -9U_1 + 15U_2 = 6I + 72 \\ 2I = U_2 - U_1 \end{cases}$$

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

$P = 2\times(U_1 + 2\times 5)$

$= 28W$

三、解：由戴维南定理及对称性，图a可等效为：



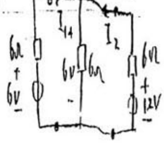
K闭合时：$I = \frac{U_{oc}}{R_0} + \frac{2U_{oc}}{R_0} = \frac{3U_{oc}}{R_0} = 3$

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

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

$\therefore\ U_{oc} = 6V \quad R_0 = 6\Omega.$

∴ 图b可等效为



可得 $I_1 = 0A$

$I_2 = 1A$

四、解：K闭合时有：$R_1 I^2 = P_1$ ∴ $R_1 = \frac{P_1}{I^2} = \frac{1936}{11^2} = 16\Omega$

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

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

∴ $L = \frac{12}{100\pi} = 38.2mH$

K断开时 $S = UI = 220 \times 11 = 2420 = P_2$

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

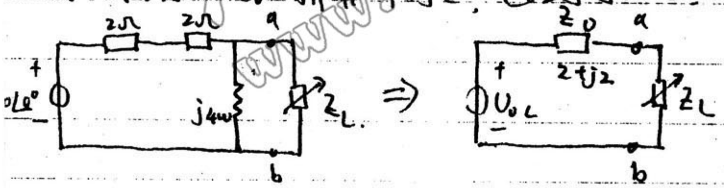
$C = \frac{1}{120\pi} = 265.26\mu F$

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

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

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

五、解：将原边电路折算到副边，电路可等效为：



$U_{oc} = 20\sqrt{2}\angle45° V$

$Z_0 = 2 + j2\ \Omega$.

∴ 当 $Z_L = Z_0^* = 2 - j2\ \Omega$ 时有 $P_{max} = \frac{U_{oc}^2}{4R_0} = \frac{(20\sqrt{2})^2}{4\times2} = 100W$

六、解：设负载为Y接，$P_P = \frac{P}{3} = 1000W$，$\dot{U}_{A'} = 220\angle0° (V)$

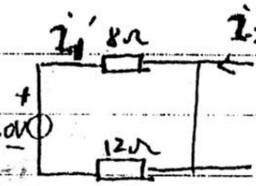
又 $P_P = U_P^2 / R_L$

∴ 负载电阻 $R_L = U_P'^2 / P_P = \frac{220^2}{1000} = 48.4\Omega$.

则 $\dot{U}_{AB} = \frac{Z_L + R_L}{R_L} \times \dot{U}_{A'B'} = \frac{2+j10+48.4}{48.4} \times 380\angle30°$

$= \frac{51.38\angle11.22°}{48.4} \times 380\angle30° = 403.42\angle41.23° V$

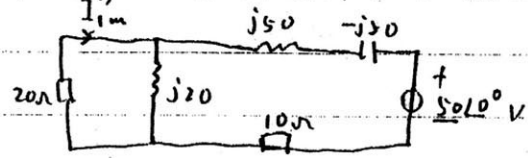
10、解：直流 U_{s1} 单独作用：



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

$i_2' = 0\ A$

交流 U_{s2} 单独作用：令 $\dot U_{s2m} = 50\angle 0°\ V$



$$\dot I_{2m}'' = \frac{\frac{50}{\sqrt2}\angle 0°}{10+j\frac{20\times 20}{20+j20}} = \frac{\frac{50}{\sqrt2}\angle 0°}{20+j10} = \frac{2.236\angle -26.57°}{\sqrt2}\ A$$

$$\dot I_{1m}'' = -\frac{j20}{20+j20}\times \dot I_{2m}''$$

$$= -\frac{j1}{1+j1}\times\frac{2.236\angle -26.57°}{\sqrt2} = \frac{-1.581\angle 18.43°}{\sqrt2}\ A$$

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

$i_1 = 1.5 - 1.581\sin(10^3t+18.43°)\ A$

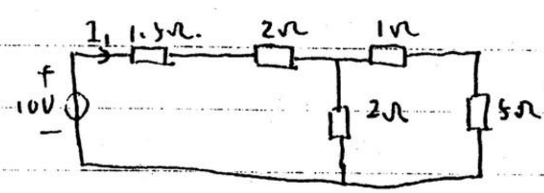
$i_2 = 2.236\sin(10^3t-26.57°)\ A$

$P_{us1} = U_{s1}\times i_1' = 30\times 1.5 = 45\ W$

11. 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：$\begin{cases} U_1 = 4I_1 + 2I_2 \\ U_2 = 2I_1 + 3I_2 \end{cases}$

$Z = \begin{bmatrix} 4 & 2 \\ 2 & 3 \end{bmatrix}$

等效电路为：



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

$I_1 = \frac{10}{5} = 2\ A$

$\therefore\ P = 10\times 2 = 20\ W$

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）

$\tau_1=R_0C=\frac{1}{5}$ ∴ $R_0=\frac{\tau_1}{C}=\frac{1}{5\times0.1}=2\Omega$

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 $t=0_+$ 时的情形。

∴此时 $i(\infty)=10$A

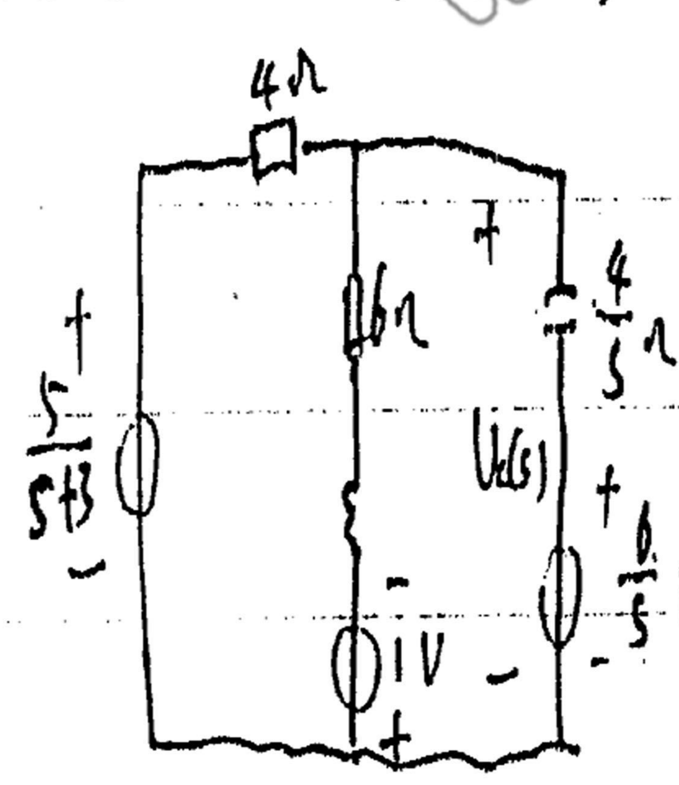
$t=0_+$ 时，L开路，相当于C在 $t\to\infty$ 时的情形。

∴此时 $i(0_+)=16$A

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

十.解：$i_L(0_-)=1$A，$u_C(0_-)=6$V

$t>0$ 时运算电路为



列结点电压方程

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

两边同乘 $4(5s+6)(s+3)$

$$[(5s+6)(s+3)+4(s+3)+s(5s+6)(s+3)]U_c(s)$$

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

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

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

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

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

$(t>0)$