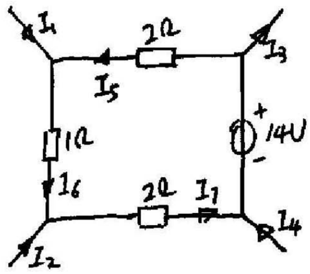
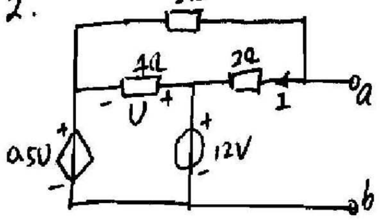
2003年

一、1. 解：



$$\begin{cases} I_1 + I_2 - I_3 + I_4 = 0 \\ I_1 + I_5 - I_6 = 0 \\ I_2 + I_6 - I_7 = 0 \\ 2I_5 + I_6 + 2I_7 = 14 \end{cases} \Rightarrow \begin{cases} I_4 = 2A \\ I_5 = 2A \\ I_6 = 4A \\ I_7 = 3A \end{cases}$$

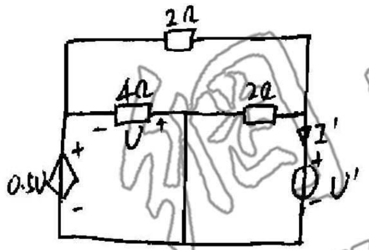
2.



解：①求开路电压 U_{ab}

$$\begin{cases} (2+2)I + U = 0 \\ U + 0.5U = 12 \end{cases} \Rightarrow \begin{cases} I = -2A \\ U = 8V \end{cases}$$

$\therefore U_{ab} = 12 + (-2)\times 2 = 8V$

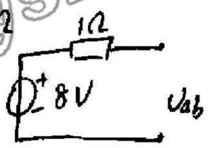


② 用外加电源法求 R_{ab}

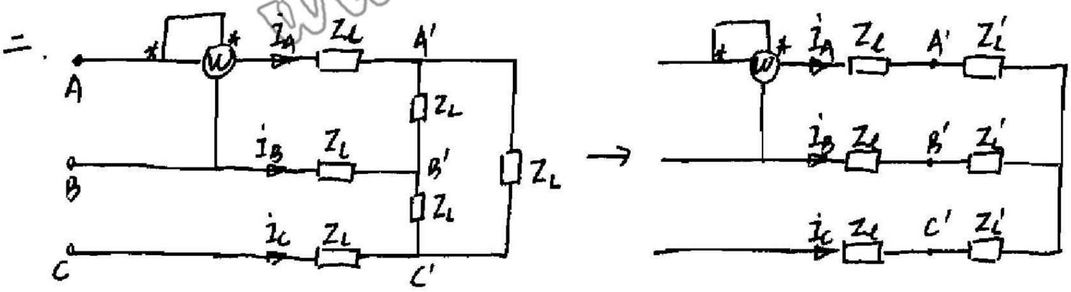
$0.5U = -U \Rightarrow U = 0V$

$\therefore \frac{U'}{I'} = R_{ab} = 1\Omega$

∴ 等效电路为



二、



解：(1) $Z_L' = \frac{1}{3} Z_L = 14 + j12\,\Omega$

$\dot U_{AB} = 380\angle 0^\circ (V)$ ∴ $\dot U_A = 220\angle -30^\circ (V)$

$$\dot I_A = \frac{\dot U_A}{Z_l + Z_L'} = \frac{220\angle -30^\circ}{16 + j12} = \frac{220\angle -30^\circ}{20\angle 36.87^\circ} = 11\angle -66.87^\circ \ (A)$$

$\dot I_B = 11\angle -186.87^\circ (A)$ $\dot I_C = 11\angle 53.13^\circ (A)$

(2) $P = 3U_A I_A \cos\varphi = 3\times 220\times 11\times\cos(36.87^\circ) = 5.808\ KW$

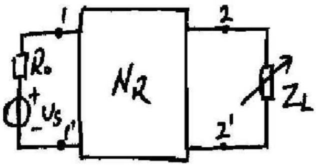
$Q = 3U_A I_A \sin\varphi = 3\times 220\times 11\times\sin(36.87^\circ) = 4.356\ KVar$

$S = \sqrt{P^2 + Q^2} = 7.26\ KVA$

(3) $\bar{S} = \dot{U}_{AB}\dot{I}_A^* = 380\angle0° \cdot 11\angle66.87° = 4180\angle66.87°$

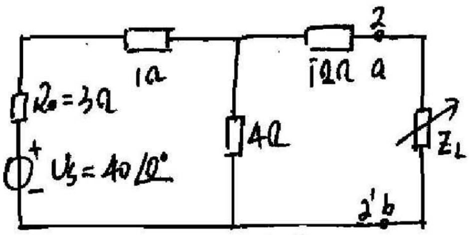
∴ $P = Re[\dot{U}_{AB}\dot{I}_A^*] = 1.642KW$.

三.



解: $Z = \begin{bmatrix}5 & 4\\ 4 & 4+j2\end{bmatrix} \Rightarrow$ 互易

求 2-2' 的等效电路



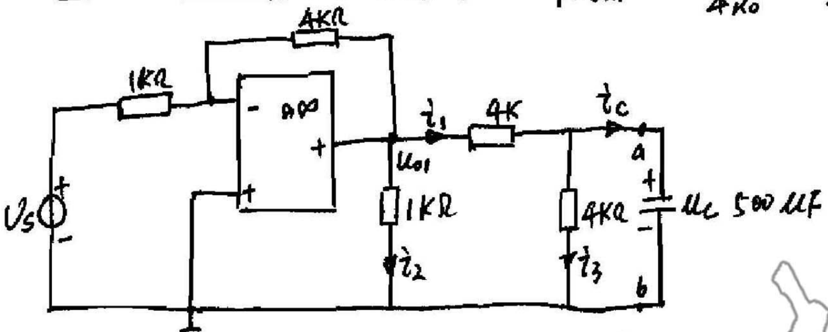
$Z_{ab} = 2+j2\Omega$

开路电压 $\dot{U}_{ab} = \frac{\dot{U}_S}{8}\times4 = \frac{1}{2}\dot{U}_S = 20\angle0° V$

∴当 $Z_L = 2-j2\Omega$ 时获得最大功率

$P_{max} = \frac{U_{ab}^2}{4R_0} = \frac{20^2}{4\times2} = 50W$

四.



解: 求 a.b 点等效电路

① 开路电压: $\frac{0-U_S}{1K} = \frac{u_{01}-0}{4K} \Rightarrow u_{01} = -4U_S$

∴ $U_{ab} = \frac{1}{2}u_{01} = -2U_S = -4\varepsilon(t)V$

② 短路电流 $i_{SC} = \frac{u_{01}}{4K} = -2\times10^{-3}\varepsilon(t)A$

∴ $R_{ab} = \frac{U_{ab}}{i_{SC}} = \frac{-4\varepsilon(t)}{-2\times10^{-3}\varepsilon(t)} = 2K\Omega$

$\tau = RC = 2K\times500uF = 1S$

$u_C(0+) = u_C(0-) = 0V$ $\quad u_C(+\infty) = U_{ab} = -4\varepsilon(t)V$

∴ $u_C(t) = -4\varepsilon(t) + 4\varepsilon(t)e^{-t} = (-4+4e^{t})\varepsilon(t)V$

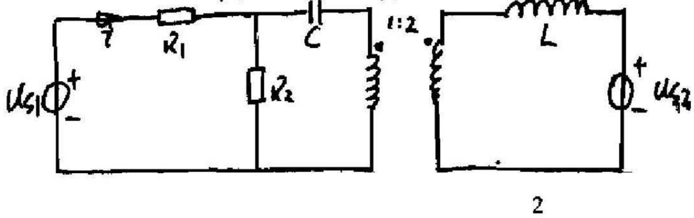
$i_C(t) = C\frac{du_C(t)}{dt} = 2e^{t}\varepsilon(t)\,mA$

$i_3(t) = \frac{u_C(t)}{4K} = (-1+e^{t})\varepsilon(t)\,mA$

∴ $i_1(t) = i_C(t) + i_3(t) = (-1+3e^{t})\varepsilon(t)\,mA$

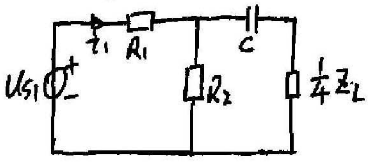
$i_2(t) = \frac{u_{01}}{1K} = \frac{-4\times2\varepsilon(t)}{1K} = -8\varepsilon(t)\,mA$

五.



解：应用叠加定理

① 当 u_{S1} 单独作用，原边等效电路为：



当 $u_{S1}=10V$ 时，$i_1(0)=\frac{10}{R_1+R_2}=1A$

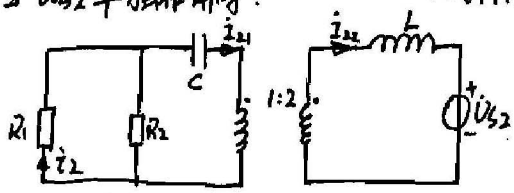
当 $\dot{U}_{S1}=10\angle -90^\circ$ 时

$\frac{1}{j\omega C}+\frac{1}{4}Z_L=-10j+\frac{1}{4}\times j\times 1000\times 40\times 10^{-3}=0\Omega$

$\therefore \dot{I}_{1(1)}=\frac{\dot{U}_{S1}}{R_1}=2\angle -90^\circ$ A

$\therefore i_1(t)=1+2\sqrt{2}\sin(1000t)$ A

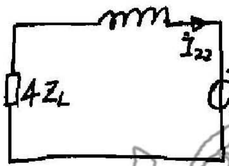
② 当 u_{S2} 单独作用时：



$Z_L=2.5+\frac{1}{j\omega C}=2.5-j10\Omega$

$4Z_L=10-j40\Omega$

副边等效电路如下：



$\dot{U}_{S2}=20\angle 0^\circ$

$\dot{I}_{22}=-\frac{\dot{U}_{S2}}{10-j40+j40}=-2\angle 0^\circ$ A

$\dot{I}_{21}=2\dot{I}_{22}=-4\angle 0^\circ$ A

$\therefore \dot{I}_2=-2\angle 0^\circ$ A

$\therefore i_2(t)=-2\sqrt{2}\cos(1000t)$ A

$\therefore i(t)=i_1(t)+i_2(t)=1+2\sqrt{2}\sin(1000t)-2\sqrt{2}\cos(1000t)$

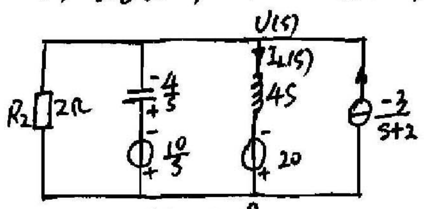
$=1+2\sqrt{2}\cdot\sqrt{2}\sin(1000t-\frac{\pi}{4})=1+4\sin(1000t-\frac{\pi}{4})$ A

$\therefore I_{rms}=\sqrt{1^2+8^2}=3A$

$P_1=I_{rms}^2R=9\times 5=45W$

六、解：(1) $u_C(0-)=10V$　$i_L(0-)=\frac{10}{2}=5A$

(2)



$(t\geq 0)$

(3) $(\frac{1}{2}+\frac{s}{4}+\frac{1}{4s})U(s)=\frac{-3}{s+2}-2.5-\frac{20}{4s}$

$U(s)=\frac{-10s^2-52s-40}{(s+1)^2(s+2)}\Rightarrow U_C(s)=\frac{10s^2+52s+40}{(s+1)^2(s+2)}$

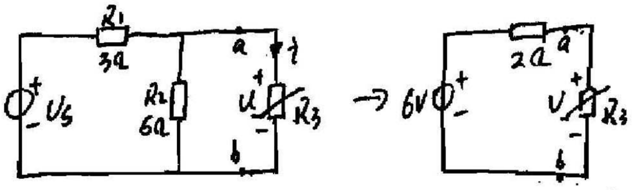
$=\frac{K_{11}}{(s+1)^2}+\frac{K_{12}}{(s+1)}+\frac{K_2}{s+2}$

$K_{11}=[(s+1)^2U_C(s)]|_{s=-1}=-2$

$K_{12}=\frac{d}{ds}(s+1)^2U_C(s)|_{s=-1}=34$　　$K_3=(s+2)U_C(s)|_{s=-2}=-24$

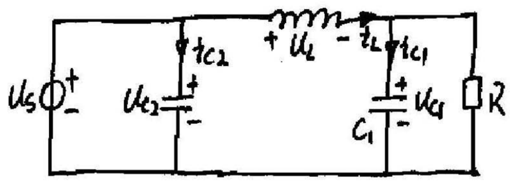
$\therefore u_C(t)=-2te^{-t}+34e^{-t}-24e^{-2t}$ V $(t\geq 0)$

七1.解：



$$\begin{cases} i = \frac{1}{2}u - 1 \\ u + 2i = 6 \end{cases} \Rightarrow \begin{cases} u = 4V \\ i = 1A \end{cases}$$

2. 解：



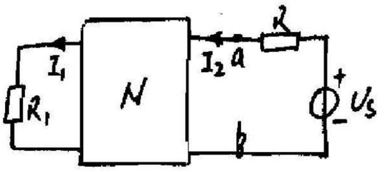
取 u_{C1}，i_L 为状态变量

$$u_L = u_S - u_{C1} \Rightarrow \frac{di_L}{dt} = \frac{1}{L}u_S - \frac{1}{L}u_{C1} = -\frac{1}{L}u_{C1} + \frac{1}{L}u_S$$

$$i_{C1} = i_L - \frac{u_{C1}}{R} \Rightarrow \frac{du_{C1}}{dt} = -\frac{1}{C}\frac{u_{C1}}{R} + \frac{1}{C}i_L$$

$$\therefore \begin{bmatrix} \dot{u}_{C1} \\ \dot{i}_L \end{bmatrix} = \begin{bmatrix} -\frac{1}{RC} & \frac{1}{C} \\ -\frac{1}{L} & 0 \end{bmatrix} \begin{bmatrix} u_{C1} \\ i_L \end{bmatrix} + \begin{bmatrix} 0 \\ \frac{1}{L} \end{bmatrix} u_S$$

八



解：当 $U_S = 8V$，$R = 2\Omega$，$I_2 = 1A$，$I_1 = 1A$　$U_{ab} = 6V$

当 $U_S = 13V$，$R = 4\Omega$，$I_2 = 1.5A$，$I_1 = 1.2A$　$U_{ab} = 7V$

令 $I_2 = K_1 U_{ab} + K_2 U_N$（因为N为内部含有独立电源的线性网络）

$$\therefore \begin{cases} 6K_1 + K_2 U_N = 1 \\ 7K_1 + K_2 U_N = 1.5A \end{cases} \quad \begin{cases} K_1 = 0.5 \\ K_2 U_N = -2 \end{cases}$$

$\therefore I_2 = 0.5U_{ab} - 2$　当 $U_S = 14V$ 时　$I_2 = 0.5(14 - 3I_2) - 2 \Rightarrow I_2 = 2A$

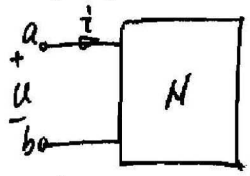
令 $I_1 = K_1 U_{ab} + K_2 U_N$

$$\begin{cases} 6K_1 + K_2 U_N = 1 \\ 7K_1 + K_2 U_N = 1.2 \end{cases} \quad \begin{cases} K_1 = 0.2 \\ K_2 = -0.2 \end{cases}$$

$\therefore I_1 = 0.2U_{ab} - 0.2$

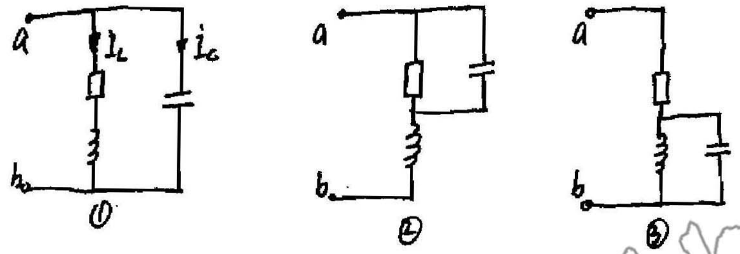
$\therefore$ 当 $U_S = 14V$　$R = 3\Omega$ 时．$I_1 = 0.2 \times (14 - 6) - 0.2 = 1.4A$

九．



解：黑匣子问题，当取直流分量时 $R=\frac{20}{2}=10\Omega$

有以下几种可能的情况.

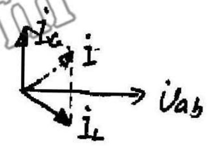


(1) 又∵交流作用时：

$$Z_{ab}=\frac{\frac{10}{\sqrt{2}}\angle -90^\circ}{\frac{2}{\sqrt{2}}\angle -90^\circ}=5\angle 0^\circ$$ 表明发生谐振 ⇒ 第三种情况不符.

(2) 针对第一种情况画出相量图，

$\dot{U}_{ab}$ 与 $\dot{I}$ 必然有夹角，不符题意，舍去.



(3) 对第二种情况画出相量图.

$$\frac{10\cdot jX_C}{10+jX_C}+jX_L=5$$

$$\frac{100jX_C+10X_C^2}{10^2+X_C^2}+jX_L=5$$

$$\frac{10X_C^2}{10^2+X_C^2}=5\Rightarrow X_C=10\Rightarrow C=1000uF$$

$$\frac{100X_C}{10^2+X_C^2}+X_L=0\Rightarrow X_L=5\Rightarrow L=50mH$$