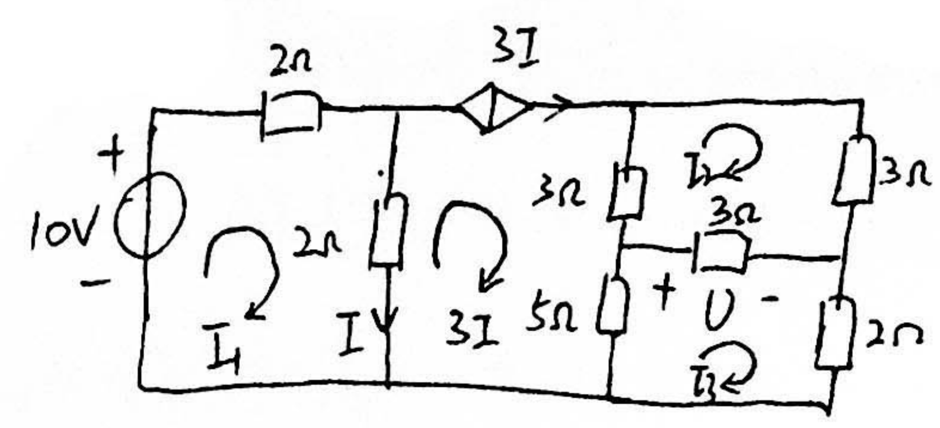
2011年电路

一、解：~~对~~



列网孔电流方程得：

$(2+2)I_1-2\times3I-10=0$ ①

$-3\times3I+(3+3+3)I_2-3I_3=0$ ②

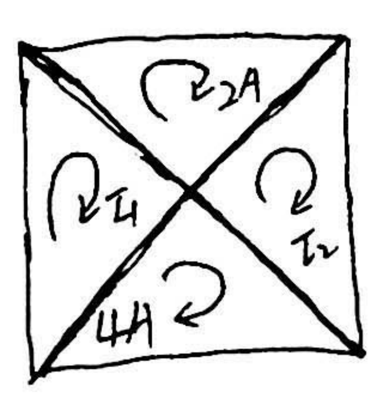
$-5\times3I-3I_2+(5+3+2)I_3=0$ ③

又 $I_1-3I=I$ ④

①②③④联立可得：

$\begin{cases}I_1=4A\\ I_2=\frac{5}{3}A\\ I_3=2A\\ I=1A\end{cases} \Rightarrow U=3\times(I_3-I_2)=1(V)$

二、解：



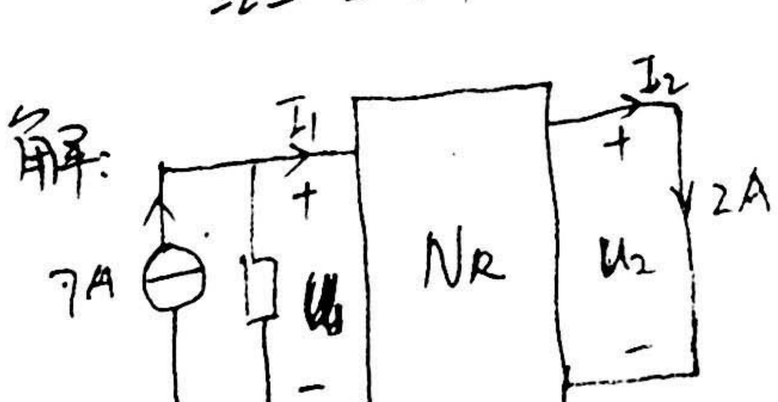
列回路方程可得：

$\begin{cases}2\times(I_1-2)+2+2\times(I_1-4)+6\times I_1=0\\ -4I_1+2\times(I_2-2)+4I_2+2\times(I_2-4)=0\end{cases}$

解得：$I_1=1(A)$

$I_2=2(A)$

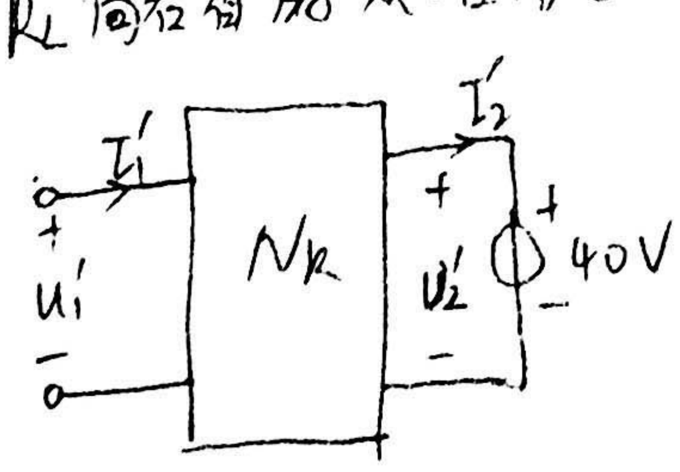
三、解：



求 $u_1=20V$ $I_1=7-\frac{20}{10}=5(A)$

$U_2=0$ $I_2=2A$

求 R_L 向右看的戴维南等效电路.



$u_1'=U_{oc}$ $I_1'=0$ $u_2'=40$.

由特勒根定理知 $\begin{cases}\sum_{i=1}^{k}U_iI_i'=\cancel{\sum_{i=1}^{k}U_i'I_i}=0\\ \sum_{i=1}^{k}U_i'I_i=0\end{cases}$

即 $\begin{cases}U_1(-I_1')+U_2I_2'\cancel{=0}+\sum_{i=2}^{k}U_iI_i'=0\\ U_1'(-I_1)+U_2'I_2+\sum_{i=2}^{k}U_i'I_i=0\end{cases}$

又 $\sum_{i=2}^{k}U_iI_i'=\sum_{i=2}^{k}I_iR_iI_i'=\sum_{i=2}^{k}I_iU_i'$

故有：$U_1(-I_1')+U_2I_2'=U_1'(-I_1)+U_2'I_2$

即 $-5U_{oc}+40\times2=0 \Rightarrow U_{oc}=16(V)$

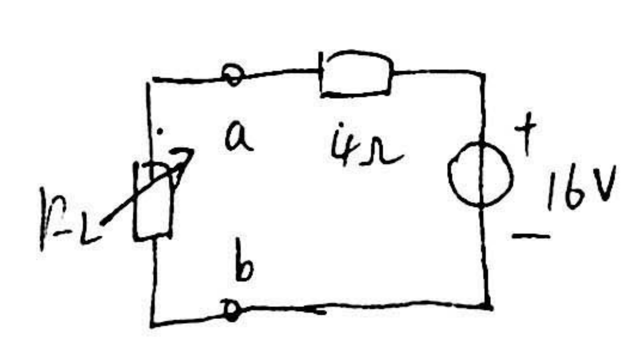
$U_1''=0$ $I_1''=-I_{sc}$ $U_2''=40$.

(由特勒根定理知 $\begin{cases}\sum_{i=1}^{k}U_iI_i''=0\\ \sum_{i=1}^{k}U_i''I_i=0\end{cases}$

即 $\{U_1(-I_1')+)$ X

由互易定理知：$\frac{I_{sc}}{40}=\frac{2}{20} \Rightarrow I_{sc}=4(A)$

故图(b)等效为 $R_0=\frac{U_{oc}}{I_{sc}}=4(\Omega)$



~~当 $R_L=4\Omega$~~ $P=\left(\frac{16}{4+R_L}\right)^2\times R_L$

当 $R_L=4\Omega$ 时 ~~P最大~~ R_L 可获得最大功率 P_{max}.

$P_{max}=\frac{16^2}{4\times4}=16(W)$

四、解：由题知 $\dot U$ 与 $\dot I$ 同相.

故电路发生了谐振.

$Z=jX_L+\frac{R\times(-jX_C)}{R-jX_C}=\frac{RX_C^2}{R^2+X_C^2}+j(X_L-\frac{R^2X_C}{R^2+X_C^2})$

$\Rightarrow\begin{cases}\frac{RX_C^2}{R^2+X_C^2}=\frac{U}{I}\\ X_L-\frac{R^2X_C}{R^2+X_C^2}=0\end{cases}$

$\frac{X_C}{R^2+X_C^2} = 20$ ①

$X_L = \frac{R^2 X_C}{R^2+X_C^2}$ ②

$R = X_C$ ③

①②联立可得：$R = X_C = 40(\Omega)$ $X_L = 20(\Omega)$

设 $\dot{I}_R = I_R\angle 0^\circ$

则 $\dot{I}_C = \frac{R I_R\angle 0^\circ}{-jX_C} = I_R\angle 90^\circ$

$\dot{I} = \dot{I}_R + \dot{I}_C = \sqrt{2} I_R\angle 45^\circ$

又 $I = 5A$. 故 $I_R = \frac{5}{\sqrt{2}}(A)$.

即 $\dot{I} = 5\angle 45^\circ$ (A)

$\dot{U} = 100\angle 45^\circ$ (V)

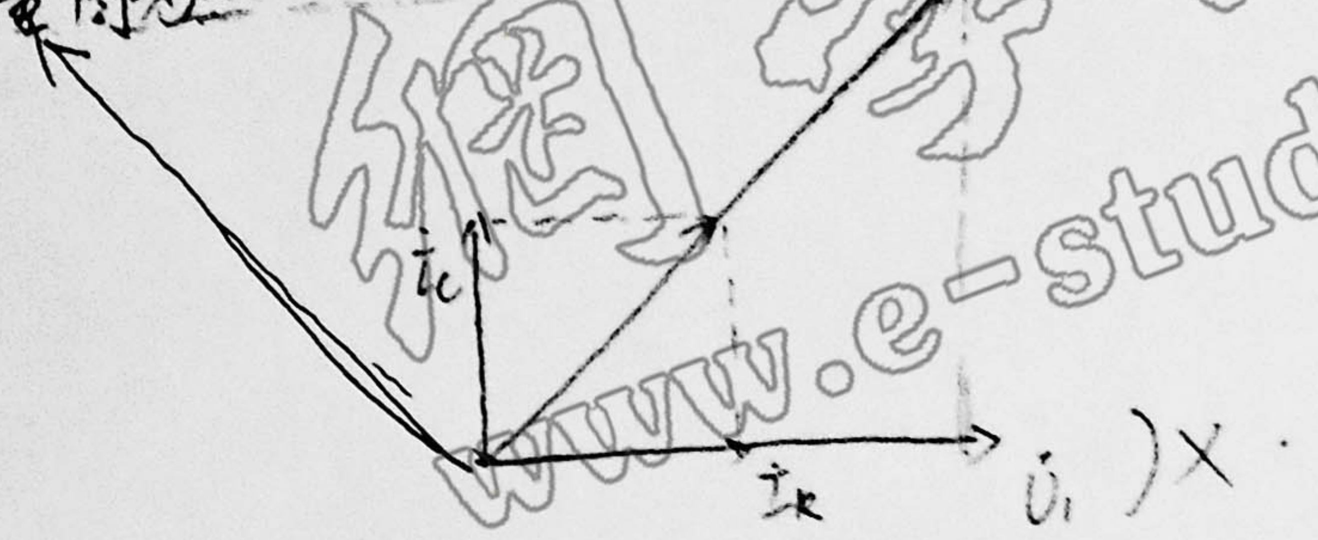
$\dot{I}_C = \frac{5}{\sqrt{2}}\angle 90^\circ$

$\dot{U}_1 = -40j \times \frac{5}{\sqrt{2}}\angle 90^\circ = 141.42\angle 0^\circ$ (V)

$\dot{I}_R = \frac{5}{\sqrt{2}}\angle 0^\circ$ (A)

$\dot{U}_L = j20 \times 5\angle 45^\circ = 100\angle 135^\circ$ (V)

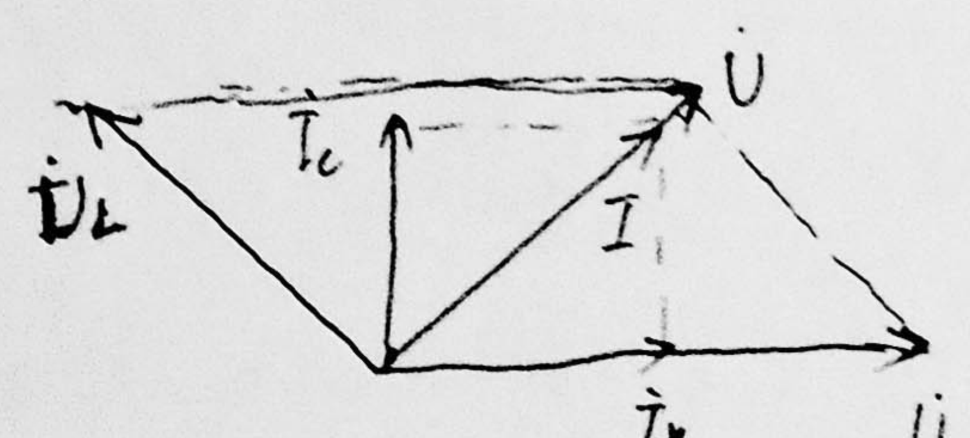
相量图为：



留意相量加式

$\dot{I} = \dot{I}_1 + \dot{I}_R$，即以 $\dot{I}_1$

$\dot{I}_R$ 之长度叠加

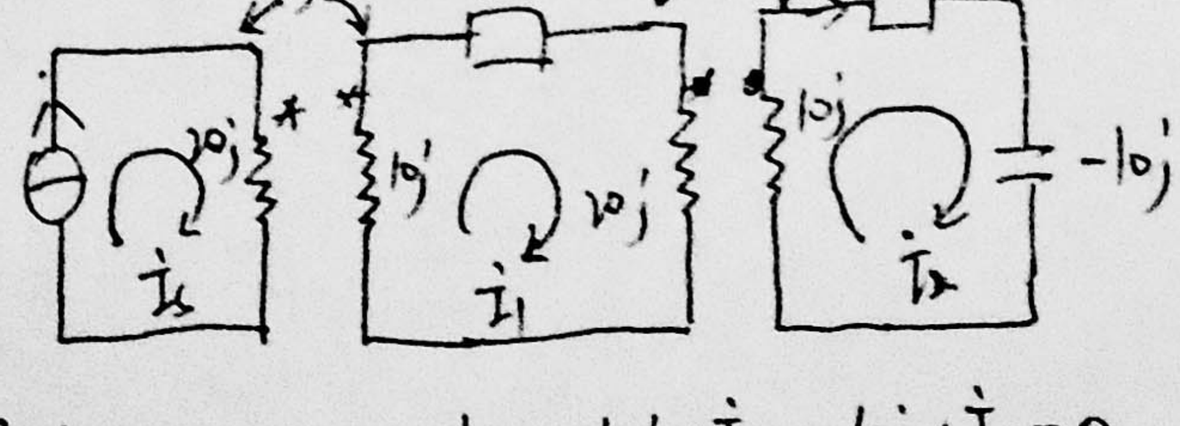


理想变压器电流方向

与电压同流向的端子

五、解：$\dot{I}_S = 25\sqrt{2}\angle 0^\circ$ A

相量图为：



列KVL方程可得：

$$\begin{cases} (30+10j+20j)\dot{I}_1 - 10j\times\dot{I}_S - 10j\times\dot{I}_2 = 0 \\ (10+10j-10j)\dot{I}_2 - 10j\times\dot{I}_1 = 0 \end{cases}$$

解得：$\dot{I}_1 = 5\sqrt{2}\angle 53.13^\circ$ (A) $\dot{I}_2 = 5\sqrt{2}\angle 143.13^\circ$ (A)

$i_1(t) = 10\cos(1000t + 53.13^\circ)$ (A)

$i_2(t) = 10\cos(1000t + 143.13^\circ)$ (A)

六解：$\dot{U}_{A'N'} = 300\angle 0^\circ$ (V) $I_P = I_{线} = 2A$

$Q = 900 var$

$Q = 3U_P I_P \sin\varphi$

故 $\sin\varphi = \frac{Q}{3U_P I_P} = \frac{900}{3\times 300\times 2} = \frac{1}{2}$

又 Q 为 Z 吸收的无功功率.

且 $Q>0$. 故 Z 为感性负载.

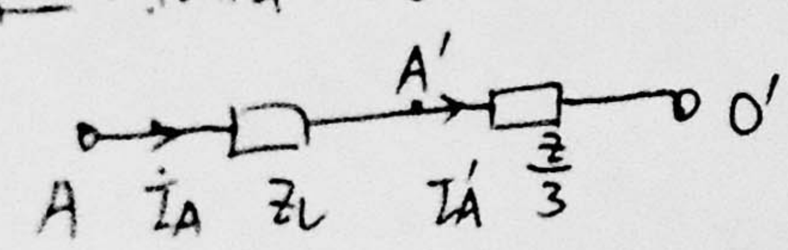
$\varphi = 30^\circ$

$|Z| = \frac{U_P}{I_P} = \frac{300}{2} = 150(\Omega)$

故 $Z = |Z|\cos\varphi + j|Z|\sin\varphi = 75\sqrt{3} + 75j$ (Ω)

$\dot{I}_{A'B'} = \frac{\dot{U}_{A'B'}}{Z} = 2\angle -30^\circ$ (A)

A相单相电路为：



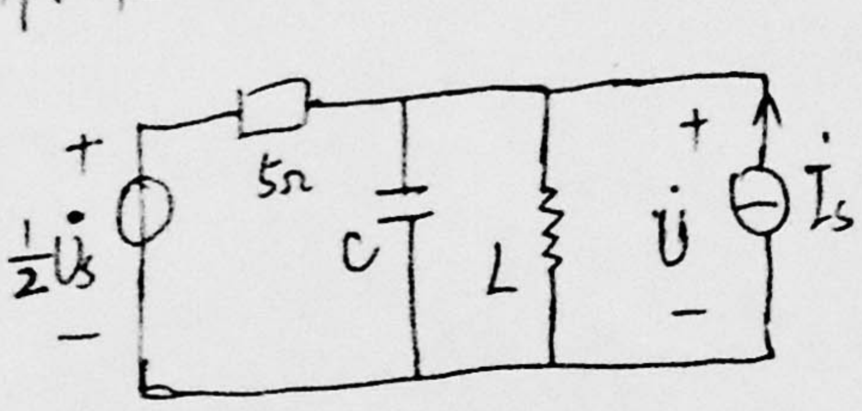
$\dot{I}_A = \dot{I}_A' = \sqrt{3}\angle -30^\circ \cdot \dot{I}_{A'B'} = 2\sqrt{3}\angle -60^\circ$ (A)

$\dot{U}_{AO'} = \dot{I}_A(Z_L + \frac{Z}{3}) = 212\angle -30.63^\circ$ (V)

$\dot{U}_{AB} = 366.98\angle -0.63^\circ$ (V)

$\dot{U}_{BC} = 366.98\angle -120.63^\circ$ (V)

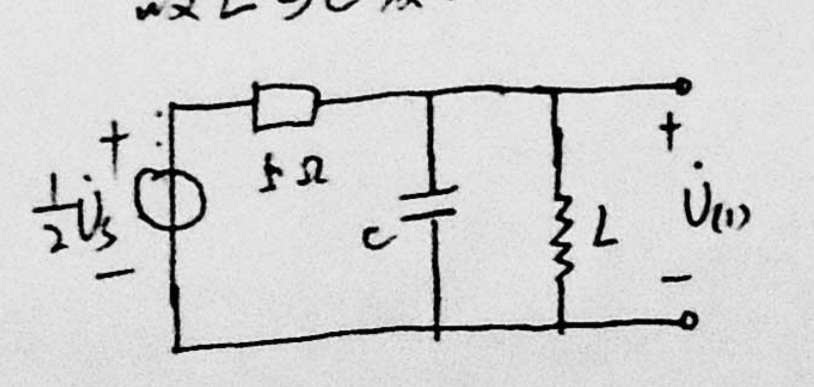
七、解：原电路可等效为：



当 $\frac{1}{2}\dot{U}_S = 20\sqrt{2}\angle 0^\circ$ V 单独作用时.

$2\omega L = 10\Omega$ $\frac{1}{2\omega C} = 10(\Omega)$

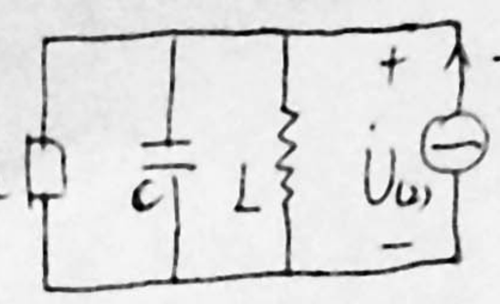
故 L 与 C 发生谐振.



$\dot{U}_{(1)} = \frac{1}{2}\dot{U}_S = 20\sqrt{2}\angle 0^\circ$ V

$u_{(1)} = 20\sqrt{2}\cos 2\omega t$ (V)

当 $\dot{I}_s = 2\angle 0^\circ (A)$ 单独作用时.



~~$\dot{U}_{(1)} = \dot{I}_s$~~ $\omega L = 5\Omega$

$\frac{1}{\omega C} = 20\Omega$

$Y = \frac{1}{5} + \frac{1}{5j} + \frac{1}{20}j = \frac{1}{5} - \frac{3}{20}j$

$\dot{U}_{(1)} = \frac{\dot{I}_s}{Y} = 8\angle 36.87^\circ (V)$

$u_{(1)}(t) = 8\sqrt{2}\cos(\omega t + 36.87^\circ)(V)$

~~$P = Re(\dot{U}_{(1)}$~~

故 $u(t) = u_{(1)}(t) + u_{(2)}(t)$

$= 20\sqrt{2}\cos 2\omega t + 8\sqrt{2}\cos(\omega t + 36.87^\circ)(V)$

$P = Re(\dot{U}_{(1)} \cdot \dot{I}_s^*) = 12.8(W)$

即 i_s 发出的有功功率为 12.8 W

八.解：由题意知

$I(s) = \frac{1}{s}$ 时，$U(s) = \frac{6}{s} - \frac{2}{s+100}$

故 $H(s) = \frac{U(s)}{I(s)} = 6 - \frac{2s}{s+100} = 6 - \frac{20 \times 0.1s}{10 \times 0.1s + 100}$

$sL = 0.1s$

故 $H(sL) = 6 - \frac{20 \times sL}{10 \times sL + 100}$

若将 L 换为 $C = 0.05F$ 的电容

则 sL 将换为 $\frac{1}{sC}$

即 $H(\frac{1}{sC}) = 6 - \frac{20 \times \frac{1}{sC}}{\frac{10}{sC} + 100}$

即 $H'(s) = 6 - \frac{20 \times \frac{1}{0.05s}}{\frac{10}{0.05s} + 100} = 6 - \frac{4}{s+2}$

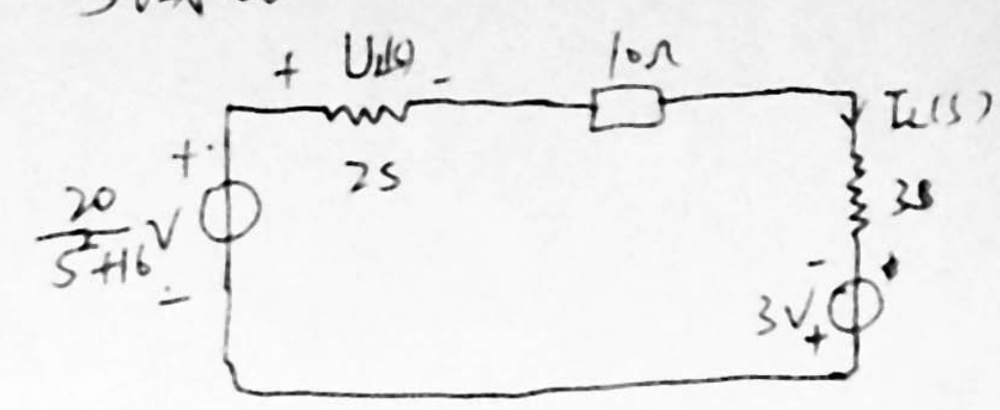
故当 $i_s(t) = 5\delta(t)$ A 即 $I_s(s) = 5$ 时

$U'(s) = H'(s) \cdot I_s(s) = 30 - \frac{20}{s+2}$

$u(t) = 30\delta(t) - 20e^{-2t}\varepsilon(t)$ (V)

九.解：$t<0$ 时 $i_L(0_-) = \frac{10}{10} = 1(A)$

S域电路为：



$U_L(s) = \frac{\frac{20}{s^2+16} + 3}{2s + 10 + 3s} \times 2s = \frac{(3s^2+68) \times 2s}{(5s+10)(s^2+16)} = \frac{4}{s+2} + \frac{-s+2}{s^2+16}$

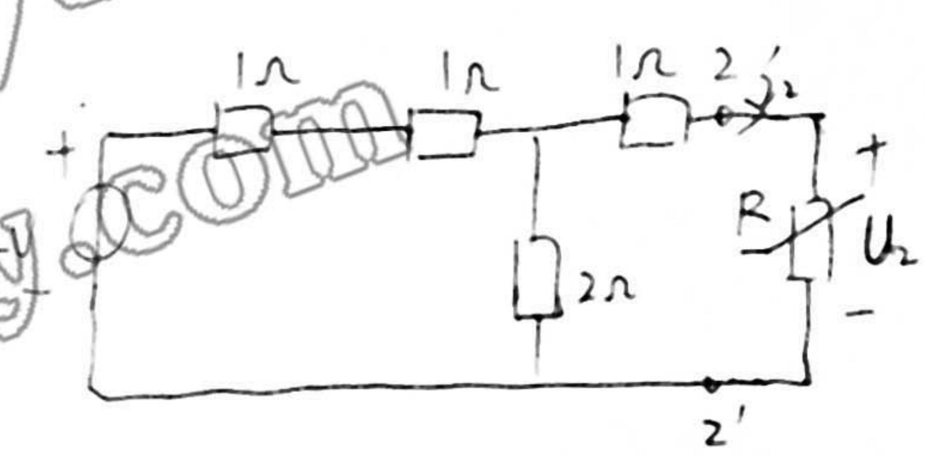
$= \frac{4}{s+2} - \frac{s}{s^2+16} + \frac{1}{2}\frac{4}{s^2+4^2}$

故 $u_L(t) = 4e^{-2t} - \cos(4t) + \frac{1}{2}\sin 4t$ (V) $(t>0)$

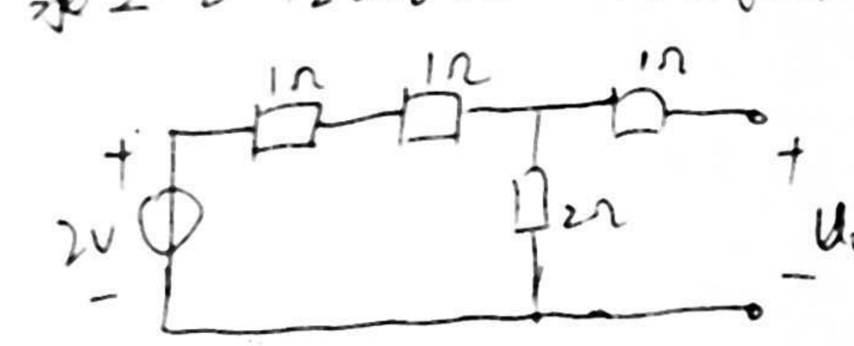
十.解：由双口网络的Z参数为 $\begin{bmatrix} 3 & 2 \\ 2 & 3 \end{bmatrix}\Omega$ 知 $(t\geq 0)$

N为纯阻性网络，满足互易性.

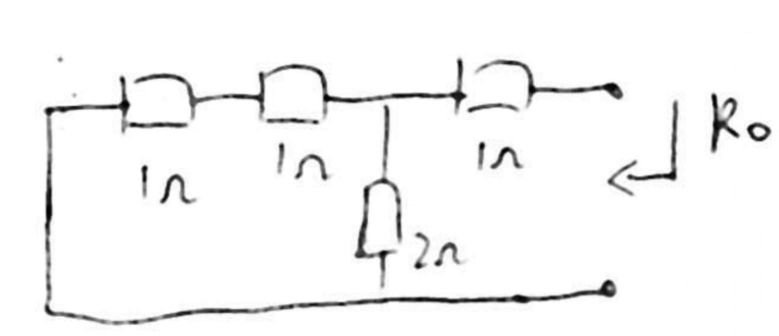
图(a)电路可等效为：



求 2-2' 左端电路的戴维南等效电路.

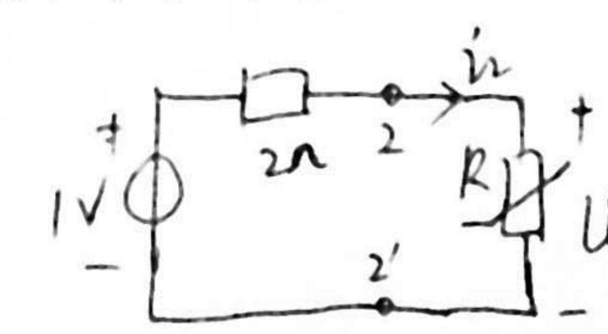


$u_{oc} = 2 \times \frac{2}{2+1+1} = 1(V)$



$R_0 = 1 + \frac{2 \times 2}{2+2} = 2(\Omega)$

故图(a)电路等效为：



列KVL方程：$u_2 = 1 - 2i_2$ ①

当 $u_2 < 3V$ 时 $i_2 = 0$ 代入①式得：$u_2 = 1$

当 $u_2 = 3$ 时，由①式知 $i_2 = -1(A)$ 不合题意，应舍去. 综上知：$u_2 = 1V$ $i_2 = 0A$