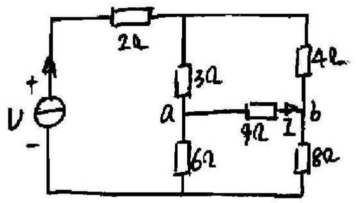
西南交通大学电路分析历年考研真题参考答案

2006

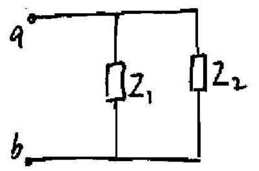
一. 1. 解：



a.b等电位. ∴ $I=0A$

$$V=7\times\left(\frac{3\times4}{3+4}+\frac{6\times8}{6+8}+2\right)=50V$$

2. 解：



$Q_1=UI_1\sin\varphi_1=-180\,Var$

$Q_2=UI_2\sin\varphi_2$

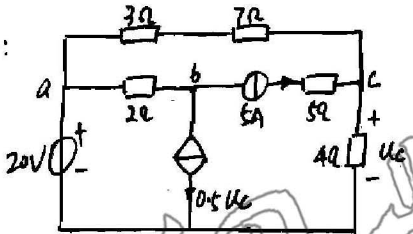
$Q_1+Q_2=U(I_1\sin\varphi_1+I_2\sin\varphi_2)=Q=300Var$

$\therefore Q_2=U_1I_2\sin\varphi_2=480Var$

$\therefore \sin\varphi_1<0 \quad \sin\varphi_2>0$

∴ Z_1呈容性，Z_2呈感性

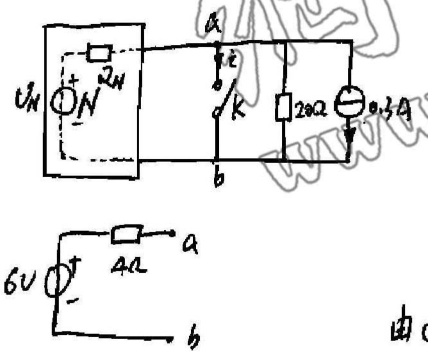
二. 解：



$$\begin{cases}U_a=20V\\ -\frac{1}{2}U_a+\frac{1}{2}U_b=-0.5U_c-5\\ -\frac{1}{10}U_a+(\frac{1}{4}+\frac{1}{10})U_c=5\end{cases}\Rightarrow\begin{cases}U_a=20V\\ U_b=-10V\\ U_c=20V\end{cases}$$

$\therefore U_{ab}=U_a-U_b=30V$

三.



解：K打开时 $U_{ab}=4V$

$$I=-\frac{U_N+6}{R_N+20}=\frac{-6-4}{20}=-0.5A$$

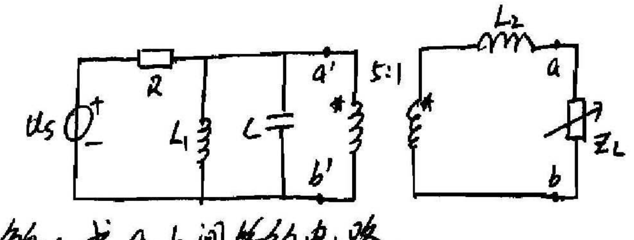
$U_N+6=0.5R_N+10 \quad \cdots ①$

当K闭合时 $i=1.2A$

$\therefore \frac{U_N}{R_N}-\frac{6}{20}=1.2 \quad U_N=1.5R_N \quad \cdots ②$

由①②得. $U_N=6V \quad R_N=4\Omega$

四



解：求a.b间等效电路.

① R_{ab}：原边等效导纳为 $Y=\frac{1}{R}+\frac{1}{j\omega L_1}+j\omega C=\frac{1}{200}-\frac{1}{20}j+0.05j=\frac{1}{200}S$

对应阻抗为200Ω，等效到副边

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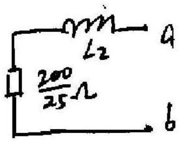


$\therefore R_{ab} = \frac{200}{25} + j\omega L_2 = 8 + 20j\ \Omega$

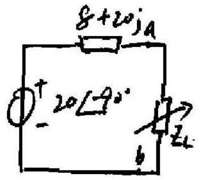
② 求 U_{oc}.

由于 $I_2 = 0A$，又 ∵ L C 发生并联谐振，相当于开路.

$\therefore U_{a'b'} = U_s = 100\sqrt{2}\sin 1000t\ (V)$

$U_{ab} = 20\sqrt{2}\sin 1000t\ (V)$

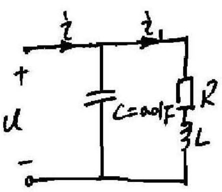
∴ 等效电路如左图：



当 $Z_L = 8 - j20\ \Omega$ 时获得最大功率.

$P_{max} = \frac{U_{oc}^2}{4R} = \frac{20^2}{4\times 8} = 12.5W$

五.

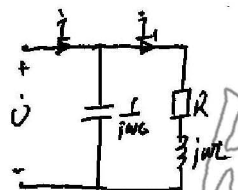


解：(1) 当直流作用时：

$R = \frac{100}{10} = 10\Omega$

当交流作用时：

$Z_1 = \frac{\dot U}{\dot I} = \frac{100\angle 0°}{\frac{10}{\sqrt{2}}\angle -45°} = 10 + 10j\ \Omega$



$R + j\omega L = 10 + 10j \Rightarrow L = 1H$

$Z = \frac{(10+10j)\times(-10j)}{(10+10j)-10j} = 10\sqrt{2}\angle -45°\ \Omega$

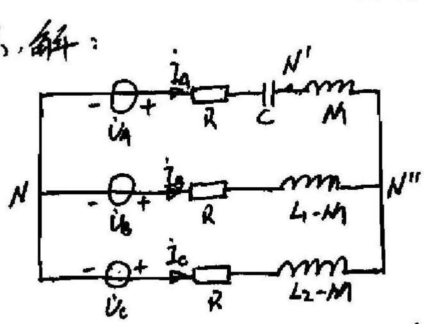
$\therefore \dot I = \frac{\dot U}{Z} = \frac{100\angle 0°}{10\sqrt{2}\angle -45°} = 5\sqrt{2}\angle 45°\ A$

直流 $I_0 = \frac{100}{10} = 10A$

$\therefore i(t) = 10 + 10\cos(10t + 45°)\ A$

$I_{rms} = \sqrt{10^2 + (\frac{10}{\sqrt{2}})^2} = \sqrt{100 + 50} = 5\sqrt{3}\ A$

六、解：



$R + \frac{1}{j\omega C} + j\omega M = 8 - 4j + 10j = 8 + 6j\ \Omega$

$R + j\omega(L_2 - M) = 8 + 6j\ \Omega$

$\therefore U_{NN''} = 0\ V$

$\dot I_A = \frac{\dot U_A}{Z} = \frac{220\angle 0°}{10\angle 36.87°} = 22\angle -36.87°\ A$

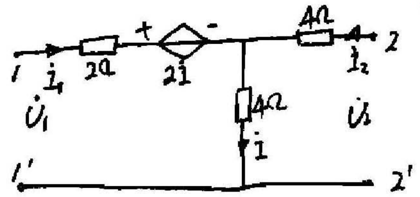
$\dot I_B = 22\angle -156.87°\ A \qquad \dot I_C = 22\angle 83.13°\ A$

$U_{N'N} = U_{NN''} = \dot I_A\, 10\angle 90° = 220\angle 53.13°\ V$

$P = 3U_A I_A\cos\varphi = 3\times 220\times 22\times\cos 36.87° = 11.62KW$

$p(t) = u(t)i(t) = P = 11.62KW$

七、



解：
$$\begin{cases} \dot{U}_1 = Z_{11}\dot{I}_1 + Z_{12}\dot{I}_2 \\ \dot{U}_2 = Z_{21}\dot{I}_1 + Z_{22}\dot{I}_2 \end{cases}$$

$$Z_{11} = \frac{\dot{U}_1}{\dot{I}_1}\Big|_{\dot{I}_2=0} = \frac{2\dot{I}+2\dot{I}+4\dot{I}}{\dot{I}} = 8\Omega$$

$$Z_{21} = \frac{\dot{U}_2}{\dot{I}_1}\Big|_{\dot{I}_2=0} = \frac{4\dot{I}}{\dot{I}} = 4\Omega$$

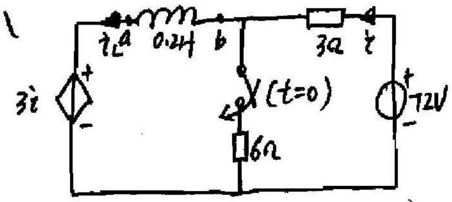
$$Z_{22} = \frac{\dot{U}_2}{\dot{I}_2}\Big|_{\dot{I}_1=0} = 8\Omega$$

$$Z_{12} = \frac{\dot{U}_1}{\dot{I}_2}\Big|_{\dot{I}_1=0} = \frac{4\dot{I}+2\dot{I}}{\dot{I}} = 6\Omega$$

$$\therefore Z = \begin{bmatrix} 8 & 6 \\ 4 & 8 \end{bmatrix}$$

$$Y = \frac{1}{40}\begin{bmatrix} 8 & -6 \\ -4 & 8 \end{bmatrix} = \begin{bmatrix} \frac{1}{5} & -\frac{3}{20} \\ -\frac{1}{10} & \frac{1}{5} \end{bmatrix}$$

八、



解：$i_L(0+) = i_L(0-) = 12A$，$i_L(+\infty) = 6A$

求 $t \geq 0$ 时 a, b 两点等效电路。

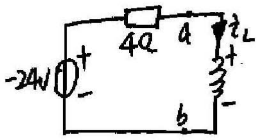
①开路电压：$i = \frac{72}{9} = 8A$

$\therefore U_{ab} = 24 - 48 = -24V$

②短路电流 i_{SC}：

$3i + 3i = 72V$　$i = 12A$

$i_L = \frac{36}{6} = 6A$　$\therefore i_{SC} = 6A$

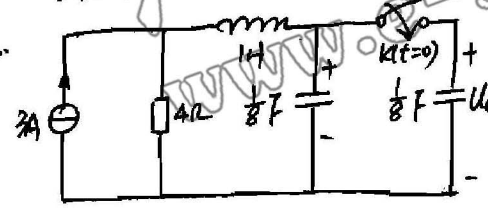


$$\tau = \frac{L}{R} = \frac{0.2}{4} = 0.05s$$

$$\therefore i_L(t) = 6 + (12-6)e^{-t/\tau} = 6 + 6e^{-20t}\ (A)\quad (t \geq 0)$$

$$3i(t) + 6(i(t) - i_L(t)) = 72 \Rightarrow i(t) = 12 + 4e^{-20t}\ (A)\quad (t \geq 0)$$

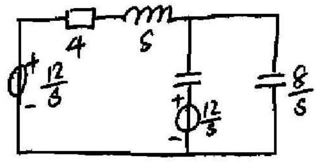
九、



解：$u_{C2}(0-) = 0V$

$u_{C1}(0-) = 12V$

$i_L(0-) = 0A$



$$\left(\frac{1}{4+s} + \frac{s}{8} + \frac{s}{8}\right)U_C(s) = \frac{\frac{12}{s}}{4+s} + \frac{12}{8}$$

$$U_C(s) = \frac{6(s^2+4s+8)}{s(s+2)^2} = \frac{K_{11}}{(s+2)^2} + \frac{K_{12}}{s+2} + \frac{K_2}{s}$$

$$K_{11} = \frac{6(s^2+4s+8)}{s}\Big|_{s=-2} = -12 \qquad K_{12} = \left(\frac{6(s^2+4s+8)}{s}\right)'\Big|_{s=-2} = -6$$

$$K_2 = \frac{6(s^2+4s+8)}{(s+2)^2}\Big|_{s=0} = 12 \qquad \therefore U_C(s) = \frac{-12}{(s+2)^2} + \frac{-6}{s+2} + \frac{12}{s}$$

$$\therefore u_C(t) = -12te^{-2t} - 6e^{-2t} + 12\ (V)\quad (t \geq 0)$$

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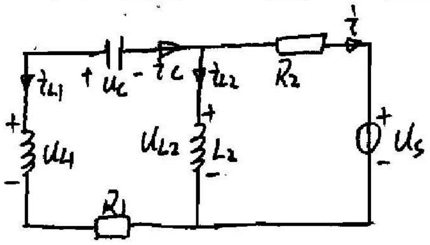

解：取 u_C，i_{L1}，i_{L2} 为参数变量

$i_C = -i_{L1} \Rightarrow \frac{du_C(t)}{dt} = -\frac{1}{C} i_{L1}$ ①

$-u_C + u_{L1} - R_1 i_C - u_S - R_2 i = 0$

$\Rightarrow u_{L1} = u_C + R_1 i_C + u_S + R_2 i = u_C - (R_1+R_2) i_{L1} - R_2 i_{L2} + u_S$

$\Rightarrow \frac{di_{L1}}{dt} = \frac{1}{L_1} u_C - \frac{(R_1+R_2)}{L_1} i_{L1} - \frac{R_2}{L_1} i_{L2} + \frac{1}{L_1} u_S$ ②

$u_{L2} - u_S - R_2(-i_{L1} - i_{L2}) = 0$

$\Rightarrow \frac{di_{L2}}{dt} = -\frac{R_2}{L_2} i_{L1} - \frac{R_2}{L_2} i_{L2} + \frac{1}{L_2} u_S$ ③

$$\therefore \begin{pmatrix} \frac{du_C}{dt} \\ \frac{di_{L1}}{dt} \\ \frac{di_{L2}}{dt} \end{pmatrix} = \begin{pmatrix} 0 & -\frac{1}{C} & 0 \\ \frac{1}{L_1} & -\frac{R_1+R_2}{L_1} & -\frac{R_2}{L_1} \\ 0 & -\frac{R_2}{L_2} & -\frac{R_2}{L_2} \end{pmatrix} \begin{pmatrix} u_C \\ i_{L1} \\ i_{L2} \end{pmatrix} + \begin{pmatrix} 0 \\ \frac{1}{L_1} \\ \frac{1}{L_2} \end{pmatrix} u_S$$