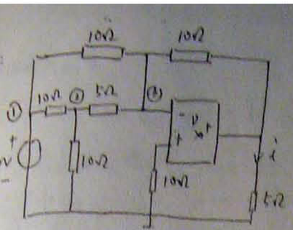
2002年电路分析(426) key

一、解



设输出端对参考点的电压为 U_0，$U_1 = 10V$，$U_3 = 0$（理想运放性质）

$$\begin{cases}\left(\frac{1}{10}+\frac{1}{10}+\frac{1}{5}\right)U_2-\frac{1}{10}U_1-\frac{1}{5}U_3=0\\ \left(\frac{1}{5}+\frac{1}{10}+\frac{1}{10}\right)U_3-\frac{1}{5}U_2-\frac{1}{10}U_1-\frac{1}{10}U_0=0\end{cases} \Rightarrow \begin{cases}U_0=-15V\\ i=\frac{U_0}{5}=-3A\end{cases}$$

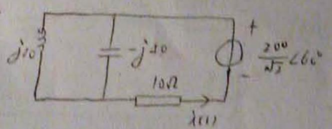
二、解 将负载进行 Δ-Y 变换，$Z_L' = \frac{1}{3}Z_L = (6+j6)\Omega$，又 $\dot U_A = 220\angle -30^\circ V \Rightarrow \dot I_A = \frac{\dot U_A}{Z_1+Z_L'} = 22\angle -67^\circ A$

$\therefore \dot I_{A'B'} = \frac{22}{\sqrt3}\angle -37^\circ A$，于是 $P = 3\times\left(\frac{22}{\sqrt3}\right)^2\times 18W = 8712W$，$Q = 3\times\left(\frac{22}{\sqrt3}\right)^2\times 18Var = 8712Var$

$S = \sqrt{P^2+Q^2} = 12321VA$，又 $\dot I_B = 22\angle -187^\circ A$，$\therefore \dot U_{A'B'} = 380\angle 0^\circ + \dot I_B Z_1 - \dot I_A Z_1 = 322\angle 8^\circ V$

三、解 ① U_0 单独作用时，$I_0 = -\frac{U_0}{R} = -\frac{50}{10}A = -5A$

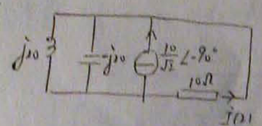
② u_s 单独作用时，



$$\dot I(1) = \frac{\frac{200}{\sqrt2}\angle 60^\circ}{10+\frac{400}{-j30}} = \frac{12}{\sqrt2}\angle 7^\circ$$

$\therefore i(1) = 12\cos(10t+7^\circ)$

③ i_s 单独作用时，



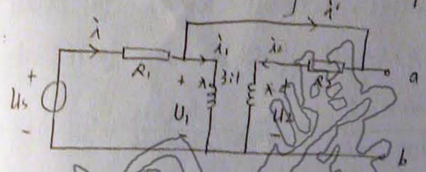
电路并联谐振，视为断路，$\dot I(2) = -\frac{10}{\sqrt2}\angle -90^\circ$

$\therefore i(2) = -10\sin 20t\ A$

$\therefore i = -5 + 12\cos(10t+7^\circ) + 10\cos(20t+90^\circ)$

$P_R = \left[(-5)^2 + \left(\frac{12}{\sqrt2}\right)^2 + \left(\frac{10}{\sqrt2}\right)^2\right]\times 10W = 1470W$

四、解

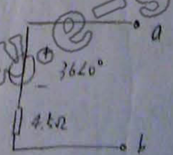


求a、b端开路电压 U_{oc}，$\frac{\dot U_1}{\dot U_2} = 3$，$\frac{\dot I_1}{\dot I_2} = -\frac{1}{3}$

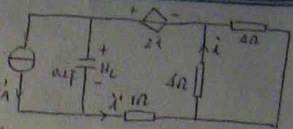
$$\begin{cases}\dot U_1 = \left(\frac{\dot U_s-\dot U_1}{R_1} - \dot I_1\right)R_2 + \dot U_2\\ \dot U_1 = \dot I R_2 + \dot U_2\end{cases} \Rightarrow \begin{cases}\dot U_2 = 12\angle 0^\circ V\\ \dot I_2 = 6\angle 0^\circ A\\ \dot U_1 = 36\angle 0^\circ V\end{cases}$$

求 R_0，外加电源法，$R_0 = 4.5\Omega$。

戴维南等效电路



五. 解：(1) 电流源单独作用下，等效电路如下图示

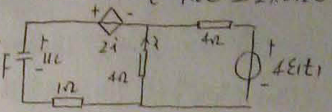


流过1Ω的电流i′,

由KCL得 $2\delta(t)+C\cdot\frac{du_C}{dt}=i' \Rightarrow$ 积分得 $u_C(0_+)=-10V$，$u_C(\infty)=0$

外加电源法求等效电阻，$R_0=2\Omega$，$\tau=R_0C=2\times0.2S=0.4S$，$u_C(t)=-10e^{-2.5t}\varepsilon(t)\ V$

(2) 电压源单独作用时，

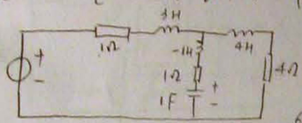


$i=-\frac{1}{2}A$，$u_C(\infty)=-2i$

$\therefore u_C(\infty)=1V$

$R_0=2\Omega$，$\tau=0.4S$，$u_C(t)=(1-e^{-2.5t})\varepsilon(t)V$ 故 $u_C(t)=(1-11e^{-2.5t})\varepsilon(t)\ V$

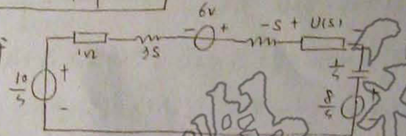
六.



$t<0$时，$i_{L1}(0_-)=i_{L2}(0_-)=\frac{10}{5}A=2A$

$u_C=4\times2V=8V$

$t=0$时K打开



设电流为$I(s)$，$\frac{10}{S}=(2+2S+\frac{1}{S})I(s)-6+\frac{8}{S}$

$\Rightarrow U(s)=\frac{2+6S}{2S^2+2S+1} \Rightarrow u(t)=\sqrt{10}e^{-\frac{1}{2}t}\cos(\frac{1}{2}t+tg^{-1}\frac{1}{3})$

七. 解：以u_C、i_L为状态变量

$$\begin{cases} C\frac{du_C}{dt}=i_1-i_L \\ i_1=\frac{f(t)-u_C(t)}{R_1} \end{cases} \qquad L\cdot\frac{di_L}{dt}=u_C-R_2 i_L$$

$$\begin{bmatrix}\dot{u}_C\\ \dot{i}_L\end{bmatrix}=\begin{bmatrix}-\frac{1}{R_1C} & -\frac{1}{C}\\ \frac{1}{L} & -\frac{R_2}{L}\end{bmatrix}\begin{bmatrix}u_C\\ i_L\end{bmatrix}+\begin{bmatrix}\frac{1}{R_1C}\\ 0\end{bmatrix}f(t)$$

输出方程

$$\begin{bmatrix}i_1\\ i_C\end{bmatrix}=\begin{bmatrix}-\frac{1}{R_1} & 0\\ -\frac{1}{R_1} & -1\end{bmatrix}\begin{bmatrix}u_C\\ i_L\end{bmatrix}+\begin{bmatrix}\frac{1}{R_1}\\ \frac{1}{R_1}\end{bmatrix}f(t)$$

八. ① u负半轴时，$i=-1A$，$u=2\times1+(2+1)\times2=8V>0$ 显然不成立

② u正半轴时，$u=i+1$（由图），$u=-2i+(2-i)\times2 \Rightarrow \begin{cases}u=1.6V\\ i=0.6A\end{cases}$ $\quad u_1=2\times2+(2-i)\times2=6.8V$

九. 解：① $Z=\frac{20\times j\omega L}{20+j\omega L}-j\frac{1}{\omega C}=\frac{j20\times100L}{20+j100L}-j\cdot\frac{1}{100C}=10 \Rightarrow \begin{cases}L=0.2H\\ C=0.001F\end{cases}$

（电路谐振）

② $I_3=I_2+I_2\cdot\frac{R_1}{R_2}=I_2(1+\frac{R_1}{R_2})=1+\frac{R_1}{R_2}$

$u_s=R_1I_1+R_2(I_1-I_3)=4R_1+(4R_2-R_2-R_1)=3(R_1+R_2)$

断开后，$I_1=\frac{u_s}{R_1+R_2}=3A$

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