$u_C=(k_1'+k_2't)e^{-t}$

$u_C(0_+)=k_1'=6$

$\frac{du_C}{dt}|_{0^+}=-k_1'+k_2'=\frac{i_C(0_+)}{C}=\frac{-(i_L+\frac{u_C(0_+)}{1})}{0.5}=-13$

$\therefore k_2'=-7$

$\therefore u_C=(6-7t)e^{-t}\varepsilon(t)V \quad (t>0)$

[法2] 电源为 $2\varepsilon(t)A$ 、$u_C(0^-)=0$

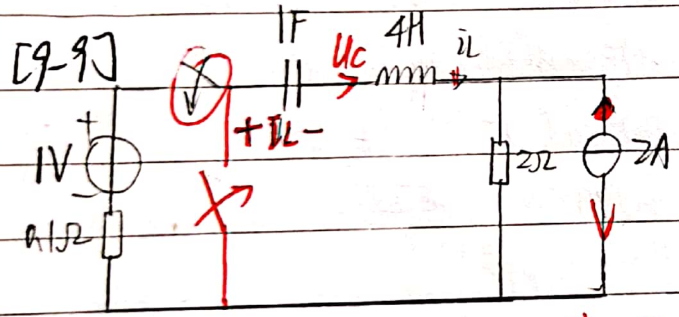
$t>0$时 $i_L+0.5\frac{du_C}{dt}+u_C=2$.

$\frac{di_L}{dt}+0.5\frac{d^2u_C}{dt^2}+\frac{du_C}{dt}=0$

$\frac{di_L}{dt}=\frac{1}{L}u_L=\frac{1}{2}u_C$ $\therefore \frac{d^2u_C}{dt^2}+2\frac{du_C}{dt}+u_C=0$

由 $\begin{cases} u_C(0_+)=6 \\ \frac{du_C}{dt}|_{0^+}=-13 \end{cases}$ 得 ?

[9-9]




开关闭合对偶于开关打开 串→并

习题9

[9-5] (1) $\omega_0=\frac{1}{\sqrt{LC}}=600s^{-1}$, $\alpha=\frac{G}{2C}=1000s^{-1}$

$s_1=-\alpha+\sqrt{\alpha^2-\omega_0^2}=-200s^{-1}$, $s_2=-\alpha-\sqrt{\alpha^2-\omega_0^2}=-1800s^{-1}$

(2) $\because \alpha>\omega_0$ $\therefore$为过阻尼状态

(3) $i_R=(k_1e^{-200t}+k_2e^{-1800t})A$

(4) $\omega_d=\sqrt{\omega_0^2-\alpha^2}=300rad/s$ $\therefore \alpha'=300\sqrt{3}=\frac{1}{2RC}$

$\therefore R=\frac{500}{3\sqrt{3}}\Omega$

(5) $s_1=(-300\sqrt{3}+300j)s^{-1}$, $s_2=(-300\sqrt{3}-300j)s^{-1}$

(6) 临界阻尼状态 $\alpha=\omega_0$ $\therefore R=\frac{250}{3}\Omega$

[9-7] 知 $s_1=-10$, $s_2=-20$

$\therefore \alpha=-\frac{s_1+s_2}{2}=15$, $\sqrt{\alpha^2-\omega_0^2}=5$ $\therefore \omega_0=10\sqrt{2}$

$\therefore \frac{1}{\sqrt{LC}}=\omega_0=10\sqrt{2}$, $\alpha=\frac{1}{2RC}=15$

又 $u_L=L\frac{di_L}{dt}$

$(30e^{-10t}-40e^{-20t})=L(600e^{-10t}-800e^{-20t})\times10^{-3}$

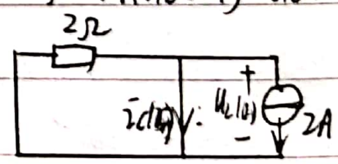
$\therefore L=50H$

$\therefore C=0.1mF$ $\quad R=\frac{1000}{3}\Omega$

[9-9] $t<0$时, $i_L(0_-)=2A$, $u_C(0_-)=0$

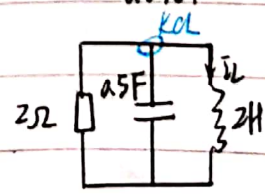
$i_L(0_+)=i_L(0_-)=2A$, $u_C(0_+)=u_C(0_-)=0$

$t=0_+$时刻




$i_C(0_+)=-i_L(0_+)=-2A$, $u_L(0_+)=u_C(0_+)=0$

$\therefore \frac{di_L}{dt}|_{0^+}=\frac{u_L(0_+)}{L}=0$




由KCL: $i_L+0.5\frac{du_C}{dt}+\frac{u_C}{2}=0$

又 $u_C=u_L=2\frac{di_L}{dt}$

$\therefore \frac{d^2i_L}{dt^2}+\frac{di_L}{dt}+i_L=0$

$\alpha=\frac{G}{2C}=0.5$  $\omega_0=\frac{1}{\sqrt{LC}}=1<\alpha$ ∴为欠阻尼状态

$\omega_d=\sqrt{\omega_0^2-\alpha^2}=0.5\sqrt{3}$  $s_{1,2}=-0.5\pm0.5\sqrt{3}j$

∴ $i_L=Ke^{-0.5t}\sin(0.5\sqrt{3}t+\theta)$

$$\begin{cases} i_L(0_+)=K\sin\theta=2 \\ \frac{di_L}{dt}\Big|_{0_+}=-0.5K\sin\theta+0.5\sqrt{3}K\cos\theta=0 \end{cases}$$

解得 $\tan\theta=3$ ∴ $\theta=60^\circ$. $K=\frac{4}{\sqrt{3}}$

∴ $i_L=\frac{4}{\sqrt{3}}e^{-0.5t}\sin(0.5\sqrt{3}t+60^\circ)$

$u_0=u_L=2\frac{di_L}{dt}=-\frac{8}{\sqrt{3}}e^{-0.5t}\sin(\frac{\sqrt{3}}{2}t)\,V$

[9-12] $t<0$时, $i_L(0_-)=2A$, $u_C(0_-)=0$

连续换路, $i_L(0_+)=i_L(0_-)=2A$, $u_C(0_+)=u_C(0_-)=0$

$t=0_+$时刻: $u_L(0_+)=10-5i_L(0_+)-u_C(0_+)=0$

∴ $\frac{di_L}{dt}\Big|_{0_+}=\frac{u_L(0_+)}{L}=0$  $\frac{du_C}{dt}\Big|_{0_+}=\frac{i_C(0_+)}{C}=\frac{i_L(0_+)}{C}=18V/s$

RLC串联: $\alpha=\frac{R}{2L}=10s^{-1}$ $\omega_0=\frac{1}{\sqrt{LC}}=6s^{-1}$

$\alpha>\omega_0$, 过阻尼 ∴ $S_1=-2s^{-1}$, $S_2=-18s^{-1}$

又 $i_L(\infty)=0$, $u_C(\infty)=10V$

∴ $u_C=K_1e^{-2t}+K_2e^{-18t}+10$

又 $$\begin{cases} u_C(0_+)=K_1+K_2+10=0 \\ \frac{du_C}{dt}\Big|_{0_+}=-2K_1-18K_2=18 \end{cases}$$ ∴ $$\begin{cases} K_1=-\frac{81}{8} \\ K_2=\frac{1}{8} \end{cases}$$

∴ $u_C=\left(-\frac{81}{8}e^{-2t}+\frac{1}{8}e^{-18t}+10\right)V$

自由分量: $(-\frac{81}{8}e^{-2t}+\frac{1}{8}e^{-18t})V$

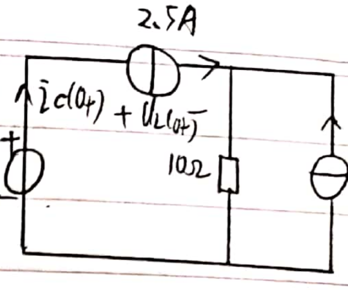
强制分量: $10V$

[9-13] $t<0$时, $u_C(0_-)=30V\times\frac{1}{2}+2A\times5\Omega=25V$

$i_L(0_-)=\frac{20V}{20\Omega}-2A\times\frac{10}{10+10}=0.5A$ (由叠加定理)

$u_C(0_+)=u_C(0_-)=25V$, $i_L(0_+)=i_L(0_-)=0.5A$

$t=0_+$时刻:




$i_C(0_+)=i_L(0_+)=0.5A$

$u_L(0_+)=25-10(0.5+2)=0$

$\frac{di_L}{dt}\Big|_{0_+}=\frac{u_L(0_+)}{L}=0$

$t>0$时, R、L、C串联. $\alpha=\frac{R}{2L}=5s^{-1}$, $\omega_0=\frac{1}{\sqrt{LC}}=4s^{-1}$

$S_1=-2s^{-1}$, $S_2=-8s^{-1}$

又 $i_L(\infty)=0$

∴ $i_L=K_1e^{-2t}+K_2e^{-8t}$

$$\begin{cases} i_L(0_+)=K_1+K_2=0.5 \\ \frac{di_L}{dt}\Big|_{0_+}=-2K_1-8K_2=0 \end{cases}$$ ∴ $$\begin{cases} K_1=\frac{2}{3} \\ K_2=-\frac{1}{6} \end{cases}$$

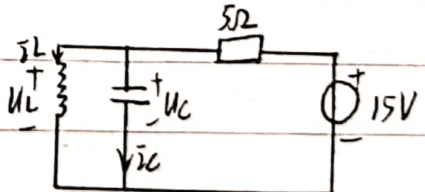
∴ $t>0$时, $i_L=(\frac{2}{3}e^{-2t}-\frac{1}{6}e^{-8t})A$

[9-15] $t<0$时, 由叠加定理,

$i_L(0_-)=3A+\frac{15V}{5\Omega}=6A$, $u_C(0_-)=0$ 连续换路

$u_C(0_+)=u_C(0_-)=0$, $i_L(0_+)=i_L(0_-)=6A$

$t>0$时,




$u_L(0_+)=u_C(0_+)=0$  $\frac{di_L}{dt}\Big|_{0_+}=\frac{u_L(0_+)}{L}=0$

$i_L(\infty)=3A$

R、L、C并联. $\alpha=\frac{G}{2C}=2\ s^{-1}$, $\omega_0=\frac{1}{\sqrt{LC}}=2s^{-1}$

∴ $S_1=S_2=-2$. $i_L=(K_1+K_2t)e^{-2t}+3$

$$\begin{cases} i_L(0_+)=K_1+3=6 \\ \frac{di_L}{dt}\Big|_{0_+}=-2K_1+K_2=0 \end{cases}$$ ∴ $$\begin{cases} K_1=3 \\ K_2=6 \end{cases}$$

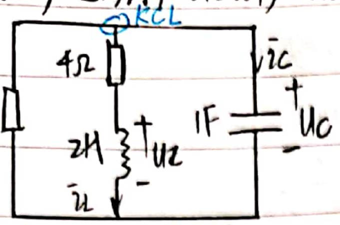
∴ $i_L=[(3+6t)e^{-2t}+3]A$

[9-19] $t<0$时, $i_L(0_-)=\frac{15}{1+\frac{4\times4}{4+4}}\times\frac{4}{4+4}=2.5A$

$u_C(0_-)=\frac{2}{2+1}\times15V=10V$

$i_L(0_+)=i_L(0_-)=2.5A$, $u_C(0_+)=u_C(0_-)=10V$

$t>0$时:




$i_C(0_+)=-\left(i_L(0_+)+\frac{u_C(0_+)}{4}\right)=-5A$

$\therefore \frac{du_C}{dt}\Big|_{0_+}=\frac{i_C(0_+)}{C}=-5V/s$ $\quad u_C(\infty)=0$

KCL: $\frac{u_C}{4}+i_L+\frac{du_C}{dt}=0$ ①

KVL: $4i_L+2\frac{di_L}{dt}=u_C$ ②

$u_C=-4\left(\frac{du_C}{dt}+i_L\right)$

由①②, $i_L+\frac{1}{2}\frac{di_L}{dt}+i_L+4\frac{di_L}{dt}+2\frac{d^2i_L}{dt^2}=0$

$\frac{d^2i_L}{dt^2}+\frac{9}{4}\frac{di_L}{dt}+i_L=0$

$\therefore s_1=-1.64 \quad s_2=-0.61$

$u_C$与$i_L$特征根相同

$\therefore$设 $u_C=k_1e^{-1.64t}+k_2e^{-0.61t}$

$$\begin{cases} u_C(0_+)=k_1+k_2=10 \\ \frac{du_C}{dt}\Big|_{0_+}=-1.64k_1-0.61k_2=-5 \end{cases} \therefore \begin{cases} k_1=-1.07 \\ k_2=11.07 \end{cases}$$

$\therefore u_C=(-1.07e^{-1.64t}+11.07e^{-0.61t})V$

[9-1] (1) $\alpha=\frac{R}{2L}=2000$, $\omega_0=\frac{1}{\sqrt{LC}}=1000$

$\therefore s_1=-\alpha-\sqrt{\alpha^2-\omega_0^2}=(-200-100\sqrt{3})s^{-1}$

$s_2=-\alpha+\sqrt{\alpha^2-\omega_0^2}=(-200+100\sqrt{3})s^{-1}$

(2) $\alpha>\omega_0$. 过阻尼

(3) $\omega_d=\sqrt{\omega_0^2-\alpha^2}=800$ $\quad \alpha=600$. $R=150\Omega$

(4) $s_{1,2}=(600\pm800j)s^{-1}$

(5) $\frac{R}{2L}=\frac{1}{\sqrt{LC}}$ $\therefore R=250\Omega$

[9-2]. $\alpha=7s^{-1}$. $\sqrt{\alpha^2-\omega_0^2}=1$ $\therefore \omega_0=4\sqrt{3}s^{-1}$

$=\frac{R}{2L}$ $\qquad =\frac{1}{\sqrt{LC}}$

$\therefore L=15H$, $C=1.39mF$

[9-3]. $\alpha=100$, $\omega_d=200$ $\therefore \omega_0=\frac{1}{\sqrt{LC}}=100\sqrt{5}s^{-1}$

$\therefore L=0.2H$, $R=40\Omega$

[9-4] $s_1=s_2=-50$ $\therefore \alpha=\frac{R}{2L}=50=\omega_0=\frac{1}{\sqrt{LC}}$

$\therefore R=50\Omega$, $C=0.8mF$

[9-8] (1) $u_C(0_+)=u_C(0_-)=18V$,

$i_L(0_+)=i_L(0_-)=3A$

(2) $u_L(0_+)=u_C(0_+)-10i_L(0_+)=-12V$

$\frac{di_L}{dt}\Big|_{0_+}=\frac{u_L(0_+)}{L}=-6A/s$

(3) $\alpha=\frac{(6+4)\Omega}{2\times2H}=2.5s^{-1}$, $\omega_0=\frac{1}{\sqrt{LC}}=1.5s^{-1}$

$\therefore s_1=-4.5s^{-1}$, $s_2=-0.5s^{-1}$

(4) $i_L=k_1e^{-4.5t}+k_2e^{-0.5t}$

$$\begin{cases} i_L(0_+)=k_1+k_2=3 \\ \frac{di_L}{dt}\Big|_{0_+}=-4.5k_1-0.5k_2=-6 \end{cases} \therefore \begin{cases} k_1=\frac{9}{8} \\ k_2=\frac{15}{8} \end{cases}$$

$\therefore i_L=\left(\frac{9}{8}e^{-4.5t}+\frac{15}{8}e^{-0.5t}\right)A$