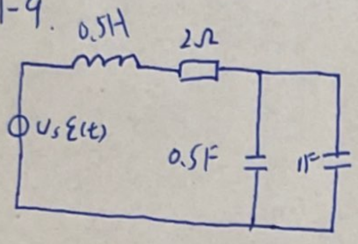
（科目：　　）清华大学数学作业纸

4120238

编号：H9.　　班级：　　姓名：　　第　　页

11-9.



$L=0.5H$

$C_{eq}=1.5F$

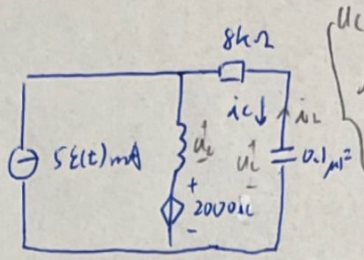
$p^2+2\alpha p+\omega_0^2=0$

$p^2+\frac{R}{L}p+\frac{1}{LC_{eq}}=0$

$p^2+4p+\frac{4}{3}=0$

$4^2-4\times\frac{4}{3}>0$

为过阻尼非振荡衰减



$$\begin{cases} u_C=-8000i_C+u_L+2000i_C \\ i_C=C\frac{du_C}{dt} \\ i_L=-i_C \end{cases}$$

⇓

$u_L=L\frac{di_L}{dt}=-L\frac{di_C}{dt}=-LC\frac{d^2u_C}{dt^2}$

$LC\frac{d^2u_C}{dt^2}+6000C\frac{du}{dt}+u_C=0$

$10^{-7}p^2+6\times10^{-4}p+1=0$

$p^2+6000p+10^7=0$

$6000^2-4\times10^7<0$

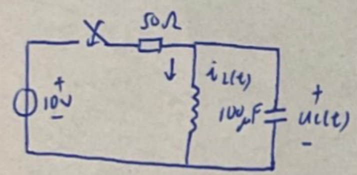
为欠阻尼衰减振荡

$p_{1,2}=-3000\pm1000j$

$\delta=3000s^{-1}$, $\omega=1000$ rad/s

11-10.

求下列情况 $i_L(t)$，并画出波形 (1) $L=\frac{4}{3}H$ (2) $L=0.1H$



(1) $L=\frac{4}{3}H$

$p^2+2\alpha p+\omega_0^2=0$

$p^2+\frac{1}{RC}p+\frac{1}{LC}=0$

$p^2+200p+7500=0$

$200^2-4\times7500>0$ 过阻尼

$p_1=-150$　$p_2=-50$

$i_L(t)=Ae^{p_1t}+Be^{p_2t}$

$=Ae^{-150t}+Be^{-50t}$

∵电路无初始储能

$i_L(0^-)=i_L(0^+)=0$, $u_C(0^-)=u_C(0^+)=0$

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

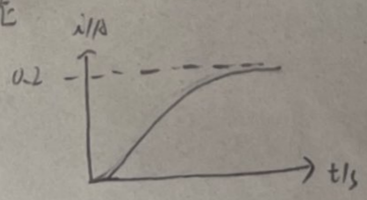
$i_L(\infty)=\frac{10}{50}=0.2A$

$i_L(t)=Ae^{-150t}+Be^{-50t}+0.2$

$$\begin{cases} i_L(0^+)=A+B+0.2=0 \\ i_L'(0^+)=-150A-50B=0 \end{cases}$$

$\Rightarrow\begin{cases} A=0.1 \\ B=-0.3 \end{cases}$

$i_L(t)=0.1e^{-150t}-0.3e^{-50t}+0.2$. $(t>0^+)$



(2) $L=0.1H$.

$p^2+2\alpha p+\omega_0^2=0$

$p^2+\frac{1}{RC}p+\frac{1}{LC}=0$

$p^2+200p+100000=0$.

$200^2-400000<0$. 欠阻尼

$p_1=-100+300j \quad p_2=-100-300j$

$i_L(t)=ke^{-\alpha t}\sin(\omega_d t+\theta)$

$=ke^{-100t}\sin(300t+\theta)$

$i_L(0^+)=0$.

$\frac{di_L}{dt}\Big|_{0^+}=0$.

$i_L(\infty)=0.2A$,

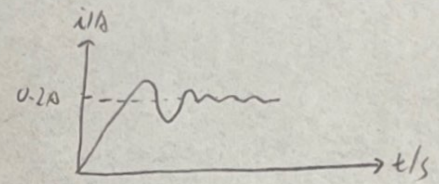
$i_L(t)=ke^{-100t}\sin(300t+\theta)+0.2$

$\begin{cases} i_L(0^+)=k\sin\theta+0.2=0 \\ i_L'(0^+)=-100k\sin\theta+300k\cos\theta=0 \end{cases}$

$\tan\theta=3$

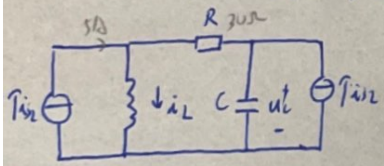
$\Rightarrow \begin{cases} k=-0.21 \\ \theta=71.56^\circ \end{cases}$

$i_L(t)=-0.21e^{-100t}\sin(300t+71.56^\circ)+0.2 \quad (t>0^+)$

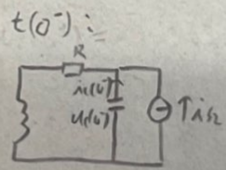


11-17

已知 $i_{s1}=5A$, $i_{s2}=4\varepsilon(t)A$, $R=30\Omega$, $L=3H$, $C=\frac{1}{27}F$, 求 $u_c(t)$ $\quad \varepsilon(t)=\begin{cases} 0 & (t<0) \\ 1 & (t>0) \end{cases}$



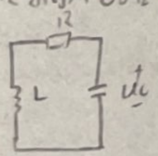
$t(0^-)$:



$u_c(0^-)=150V$

$u_c(0^+)=u_c(0^-)=150V$.

零输入电路：



$p^2+2\alpha p+\omega_0^2=0$

$p^2+\frac{R}{L}p+\frac{1}{LC}=0$.

$p^2+10p+9=0$

$10^2-4\times9>0$ 过阻尼

$p_1=-1,\ p_2=-9$.

$u_c(\infty)=5\times30=150V$.

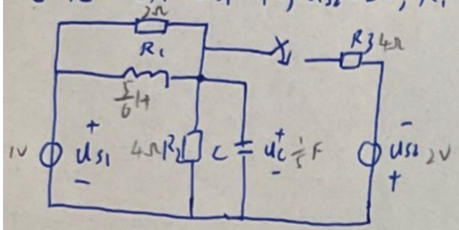
$u_c(t)=Ae^{-t}+Be^{-9t}+150$.

$\begin{cases} u_c(t)=A+B+150=150 \\ u_c'(t)=-A-9B=\frac{5+4-5}{\frac{1}{27}}=108 \end{cases}$

$\Rightarrow \begin{cases} A=13.5 \\ B=-13.5 \end{cases}$

$u_c(t)=13.5e^{-t}-13.5e^{-9t}+150. \quad (t>0^+)$

8-18. 已知 $u_{s1}=1V$, $u_{s2}=2V$, $R_1=2\Omega$, $R_2=R_3=4\Omega$, $L=\frac{5}{6}H$, $C=\frac{1}{5}F$. 求 $u_C(t)$.

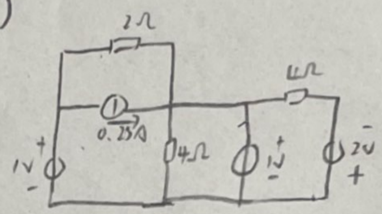


(0^-)

$i_L(0^-)=\frac{1}{4}=0.25A=i_L(0^+)$

$u_C(0^-)=1V=u_C(0^+)$

(0^+)



$i_C(0^+)=-\frac{2+1}{4}=-0.75A$.

$u_C(\infty)=1V$.

$R_{eq}=2//4//4=1\Omega$.

$2\alpha=\frac{1}{R_{eq}C}=5$

$\omega_0^2=\frac{1}{LC}=6$.

$p^2+5p+6=0$ 过阻尼

$P_1=-2,\ P_2=-3$.

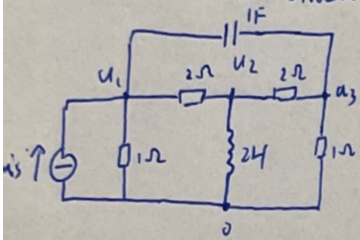
$u_C(t)=Ae^{-2t}+Be^{-3t}+1$

$$\begin{cases} u_C(0^+)=A+B+1=1 \\ u_C'(0^+)=-2A-3B=\frac{-i_C(0^+)}{C}=-3.75 \end{cases}$$

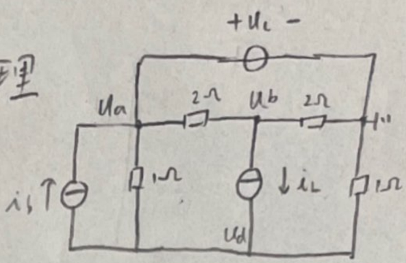
$$\Rightarrow\begin{cases} A=-3.75 \\ B=-3.75 \end{cases}$$

$u_C(t)=-3.75e^{-2t}-3.75e^{-3t}+1\quad(t>0^+)$

15-5. 列写状态方程和输出方程



替代定理



節点法

$$\begin{cases} u_a = u_c \\ (\frac{1}{2}+\frac{1}{2})u_b - \frac{1}{2}u_a = -i_L \\ (1+1)u_d - u_a = i_L - i_s \end{cases} \Rightarrow \begin{cases} u_a = u_c \\ u_b = 0.5u_c - i_L \\ u_d = 0.5u_c + 0.5i_L - 0.5i_s \end{cases}$$

$$i_c = i_s + \frac{u_d - u_a}{1} + \frac{u_b - u_a}{2} = -0.75u_c + 0.5i_s$$

$$u_L = u_b - u_d = -1.5i_L + 0.5i_s \qquad i_c = C\frac{du_c}{dt} \quad u_L = L\frac{di_L}{dt}$$

$$\therefore \begin{bmatrix} \dot{u}_c \\ \dot{i}_L \end{bmatrix} = \begin{bmatrix} -0.75 & 0 \\ 0 & -0.75 \end{bmatrix} \begin{bmatrix} u_c \\ i_L \end{bmatrix} + \begin{bmatrix} 0.5 \\ 0.25 \end{bmatrix} i_s$$

$$\begin{cases} u_1 = u_a - u_d = 0.5u_c - 0.5i_L + 0.5i_s \\ u_2 = u_b - u_d = -1.5i_L + 0.5i_s \\ u_3 = -u_d = -0.5u_c - 0.5i_L + 0.5i_s \end{cases}$$

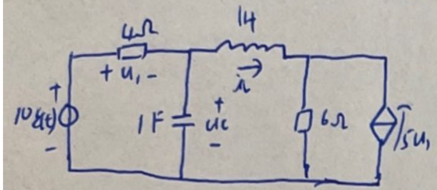
$$\Downarrow$$

$$\begin{bmatrix} u_1 \\ u_2 \\ u_3 \end{bmatrix} = \begin{bmatrix} 0.5 & -0.5 \\ 0 & -1.5 \\ -0.5 & -0.5 \end{bmatrix} \begin{bmatrix} u_c \\ i_L \end{bmatrix} + \begin{bmatrix} 0.5 \\ 0.5 \\ 0.5 \end{bmatrix} i_s$$

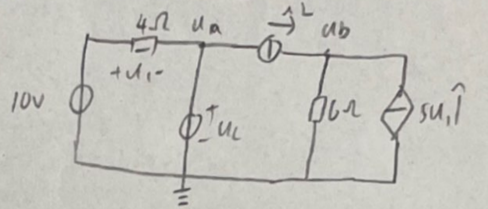
（科目：　　　）清华大学数学作业纸 4120238

编号：　　　班级：　　　姓名：　　　第　　页

15-12. 列写换路后状态方程 $\varepsilon(t) = \begin{cases} 1 & t>0 \\ 0 & t<0 \end{cases}$



替代定理



$$\begin{cases} u_a = u_C \\ \frac{1}{6} u_b = i_L + 5u_1 \\ u_1 = 10 - u_a \end{cases} \Rightarrow \begin{cases} u_a = u_C \\ u_b = -30u_C + 6i_L + 300 \end{cases}$$

$$u_L = u_a - u_b = 31u_C - 6i_L - 30$$

$$\begin{bmatrix} \dot{u}_C \\ \dot{i}_L \end{bmatrix} = \begin{bmatrix} -0.25 & -1 \\ 31 & -6 \end{bmatrix} \begin{bmatrix} u_C \\ i_L \end{bmatrix} + \begin{bmatrix} 2.5 \\ -300 \end{bmatrix}.$$