不要求：8.5，8.6.4

第8章作业

[8-2] (1) 令 $u_S=\varepsilon(t)$，$R_{eq}=22.5\Omega+10\Omega=32.5\Omega$

知 $u_C(0_+)=u_C(0_-)=0$　$\tau=R_{eq}C=0.65s$

$u_C(\infty)=\frac{3}{4}u_S$

$\therefore u_C=u_C(\infty)+[u(0_+)-u(\infty)]e^{-\frac{t}{0.65}}$

$=\frac{3}{4}(1-e^{-\frac{t}{0.65}})\varepsilon(t)\,V$

(2) 求 $h(t)=\frac{d s(t)}{dt}=\frac{15}{13}e^{-\frac{t}{0.65}}\varepsilon(t)+\frac{3}{4}(1-e^{-\frac{t}{0.65}})\delta(t)$

$=\frac{15}{13}e^{-\frac{t}{0.65}}\varepsilon(t)\,V$

(3) $i_C(0)=\frac{9}{10}\cdot\frac{1}{39}\delta(t)\,A$ (?)

$u_C(0_+)=u_C(0_-)+\frac{1}{C}\int_{0_-}^{0_+}i_C(0)dt$

$=0+\frac{3}{0.02\times10\times13}\int_{0_-}^{0_+}\delta(t)dt=\frac{15}{13}V$

$\therefore h(t)=\frac{15}{13}e^{-\frac{t}{0.65}t}\varepsilon(t)\,V$

[8-22] (1) 令 $u_S=\varepsilon(t)$

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

$i_L(\infty)=\frac{1}{4+4}\times\frac{2}{3}=\frac{1}{12}A$

$R_{eq}=(12\Omega//4\Omega)+6\Omega=9\Omega$

$\tau=\frac{L}{R_{eq}}=\frac{1}{45}s$

$\therefore i_L=i_L(\infty)+[i_L(0_+)-i_L(\infty)]e^{-45t}\varepsilon(t)$

$=\frac{1}{12}(1-e^{-45t})\varepsilon(t)\,A$

(2) $h(t)=\frac{d s(t)}{dt}=\frac{15}{4}e^{-45t}\varepsilon(t)\,A$

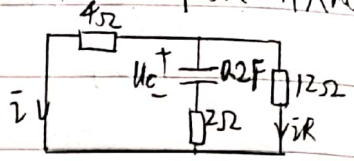
(3) 令 $u_S=\delta(t)$ 则 $u_L(0)=\frac{3}{4}\delta(t)$

$i_L(0_+)=i_L(0_-)+\frac{1}{L}\int_{0_-}^{0_+}u_L(0)dt$

$=\frac{15}{4}\int_{0_-}^{0_+}\delta(t)dt=\frac{15}{4}$

$\therefore h(t)=\frac{15}{4}e^{-45t}\varepsilon(t)\,A$

[8-2] ① 确定时间常数，开关闭合后，



$R_{eq}=(4\Omega//12\Omega)+2\Omega=5\Omega$

$\tau=CR_{eq}=1s$

② $t<0$ 时，$u_C(0_-)=\frac{12}{12+8+4}\times24V=12V$

$u_C(0_+)=u_C(0_-)=12V$

$\therefore u_C=12e^{-t}V$

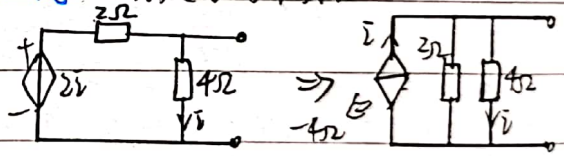
$i'=\frac{u_C}{(4//12)+2}\times\frac{12}{4+12}A=1.8e^{-t}A$

$i_R=\frac{u_C}{(4//12)+2}\times\frac{4}{4+12}A=0.6e^{-t}A$

$i''=\frac{24V}{8\Omega}=3A$ ←(易漏!)

由叠加定理 $i=i'+i''=(3+1.8e^{-t})A$

[8-4] ① 确定时间常数



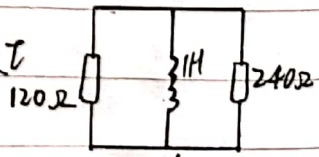
$\therefore R_{eq}=2\Omega$

$\tau=R_{eq}C=1s$

② $u_C(0_+)=u_C(0_-)=10V$　$\therefore u_C=10e^{-t}V$

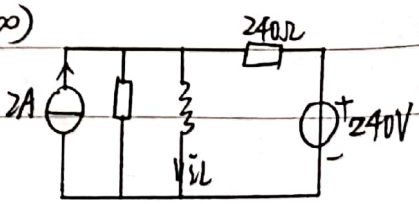
$i=\frac{1}{2}\frac{u_C}{R_{eq}}=2.5e^{-t}A$

[8-13] ① 确定 τ



$\therefore R_{eq}=80\Omega$　$\tau=\frac{L}{R_{eq}}=\frac{1}{80}s$

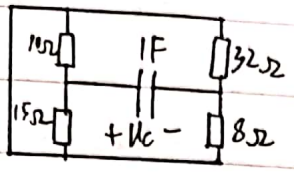
② 确定 $i_L(\infty)$



由叠加定理 $i_L(\infty)=2A+\frac{240V}{240\Omega}=3A$

$\therefore i_L=3(1-e^{-80t})\,A$

[8-18] ① 确定时间常数.



$R_{eq}=(10\Omega//15\Omega)+(32\Omega//8\Omega)$

$=12.4\Omega$ $\therefore \tau=R_{eq}C=12.4s$

② $u_C(0_+)=u_C(0_-)=0$

③ 稳态: $u_C(\infty)=\frac{20}{25//40}\times\left(-\frac{8}{13}\times10+\frac{5}{13}\times32\right)=8V$

$\therefore u_C=8(1-e^{-\frac{5}{52}t})\varepsilon(t)\,V$

[8-31] $C=2F$ 时, 时间常数 $\tau=R_{eq}C=4s$

∴从电容元件两端看进去的等效电阻 $R_{eq}=2\Omega$

∴电容换成电感时 R_{eq} 不变

$\tau'=\frac{L}{R_{eq}}=\frac{1}{2}s$

接电容时. $u_0(0_+)=\frac{5}{8}V$, $u_0(\infty)=\frac{1}{2}V$

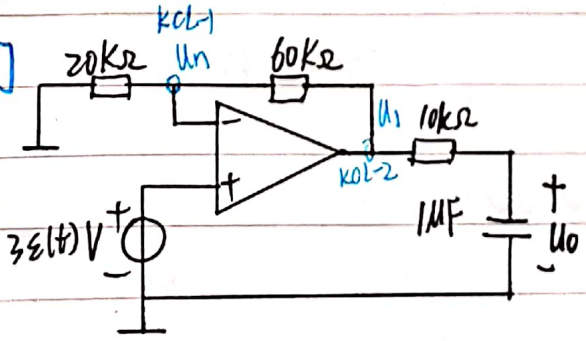
达稳态时, 电容相当于断路, 电流为0, 相当于电感刚接入, 电流为0的状态 $\therefore u_0'(0_+)=\frac{1}{2}V$

电容刚接入时其两端电压为0相当于被短路, 即电感接入达稳态的情况 $\therefore u_0'(\infty)=\frac{5}{8}V$

$\therefore u_0'=u_0'(\infty)+[u_0'(0_+)-u_0'(\infty)]e^{-\frac{t}{\tau}}$

$=(\frac{5}{8}-\frac{1}{8}e^{-t})\varepsilon(t)\,V$

[8-37]



KCL-1: $\frac{u_n}{20K}+\frac{u_n-u_1}{60K}=0$ $\because u_n=u_p=3\varepsilon(t)V$

KCL-2: $\frac{u_1-u_0}{10K}=1\times10^{-6}\frac{du_0}{dt}$

$\therefore \frac{du_0}{dt}+100u_0=1200$

特征方程 $s+100=0$ $\therefore s=-100$ 特解 $y_h=\frac{1200}{100}=12$

$\therefore u_0=12(1-e^{-100t})\varepsilon(t)\,V$

(2) $\because u_1=12\varepsilon(t)V$ $\therefore |U_{cc}|\geq12V$

[8-41] ① 令 $u_s=\varepsilon(t)V$ 则 $u_C=s(t)$ 单位阶跃响应

② 单位冲激响应 $h(t)=\frac{ds(t)}{dt}=e^{-t}\varepsilon(t)V$

$u_C=(1-e^{-t})\varepsilon(t)V$ $i_C=C\frac{du_C}{dt}=e^{-t}\varepsilon(t)A$

当 $u_s=-1(t-1)[\varepsilon(t)-\varepsilon(t-1)]V$ 时,

$u_C=\int_{0_-}^{t}u_C(\tau)h(t-\tau)\,d\tau$

$=\int_{0_-}^{t}-(\tau-1)[\varepsilon(\tau)-\varepsilon(\tau-1)]e^{-(t-\tau)}\varepsilon(t-\tau)d\tau$

$=\int_{0_-}^{t}-(\tau-1)e^{-(t-\tau)}\varepsilon(\tau)\varepsilon(t-\tau)d\tau-$

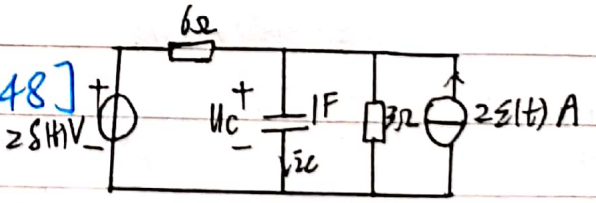
$\int_{0_-}^{t}-(\tau-1)e^{-(t-\tau)}\varepsilon(\tau-1)\varepsilon(t-\tau)\,d\tau$

$=[\int_{0}^{t}-(\tau-1)e^{-(t-\tau)}d\tau]\varepsilon(t)-[\int_{1}^{t}-(\tau-1)e^{-(t-\tau)}d\tau]\varepsilon(t-1)$

$=(-2e^{-t}-t+2)\varepsilon(t)-[-e^{-(t-1)}+(1-t)+1]\varepsilon(t-1)\,V$

$i_C=C\frac{du_C}{dt}=[(2e^{-t}-1)\varepsilon(t)+(-e^{-(t-1)}+1)\varepsilon(t-1)]A$

[8-48]



$R_{eq}=6\Omega//3\Omega=2\Omega$ $\tau=CR_{eq}=2s$

知 $u_C(0_-)=0$, $u_C(\infty)=2\times\frac{6\times3}{6+3}=4V$

$i_C(0)=\frac{1}{3}\delta(t)$

$u_C(0_+)=u_C(0_-)+\frac{1}{C}\int_{0_-}^{0_+}i_C(0)\,dt=\frac{1}{3}\varepsilon(t)\,V$

$\therefore u_C=u_C(\infty)+[u_C(0_+)-u_C(\infty)]e^{-\frac{t}{\tau}}=(4-\frac{11}{3}e^{-\frac{t}{2}})\varepsilon(t)V$

~~t>0时~~, $i_C=C\frac{du_C}{dt}=[\frac{11}{6}e^{-\frac{t}{2}}\varepsilon(t)+\frac{1}{3}\delta(t)]A$

[8-43] ① $\tau = RC = 1s$. 令 $i_S = \varepsilon(t)$ A

则 $u_C = \varepsilon(t)(1-e^{-t})\varepsilon(t)\ V = s(t)$

② $h(t) = \frac{ds(t)}{dt} = e^{-t}\varepsilon(t)\ V$

③ $i_S = \sin t\,[\varepsilon(t) - \varepsilon(t-\pi)]\ A$

④ $u_C = \int_{0_-}^{t} u_C(\tau)\,h(t-\tau)\,d\tau$

$= \int_{0_-}^{t} \sin\tau\,[\varepsilon(\tau) - \varepsilon(\tau-\pi)]\,e^{-(t-\tau)}\,\varepsilon(t-\tau)\,d\tau$

$= \left[\int_0^t \sin\tau\, e^{-(t-\tau)}\,d\tau\right]\varepsilon(t)$

$\quad - \left[\int_\pi^t \sin\tau\, e^{-(t-\tau)}\,d\tau\right]\varepsilon(t-\pi)$

$= \left(\frac{(\sin t - \cos t) + e^{-t}}{2}\varepsilon(t) - \frac{(\sin t - \cos t) - e^{-(t-\pi)}}{2}\varepsilon(t-\pi)\right)V$

[8-44] $S(t) = 0.5e^{-2t}\varepsilon(t)$

$h(t) = \frac{ds(t)}{dt} = -e^{-2t}\varepsilon(t) + 0.5e^{-2t}\delta(t)$

$= -e^{-2t}\varepsilon(t) + 0.5\delta(t)$

$u_S = 2e^{-2t}\varepsilon(t)\ V$ 时

$u_0 = \int_{0_-}^{t} u_S(\tau)\,h(t-\tau)\,d\tau$

$= \int_{0_-}^{t} 2e^{-2\tau}\varepsilon(\tau)\,[-e^{-2(t-\tau)} + 0.5\delta(\tau)]\,d\tau$

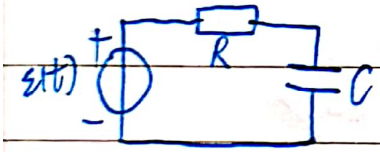
$= \left[\int_{0_-}^{t} -2e^{-2\tau}e^{-2(t-\tau)}\,d\tau\right]\varepsilon(t) + \int_{0_-}^{t} 2e^{-2\tau}\cdot 0.5\delta(\tau)\,d\tau$

$= -2te^{-2t}\varepsilon(t) - 0.5(e^{-2t}-1)\varepsilon(t)$

$te^{-2t}\varepsilon(t)\ V$

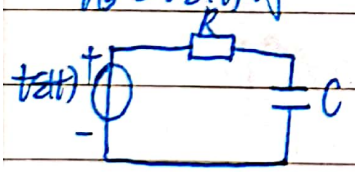
[8-41] 法2：叠加定理

$u_C = \varepsilon(t)(1-e^{-t})V$ 时，电路零效



其中 $RC = \tau = 1$

$u_S = t\varepsilon(t)$ 时　　$t>0$ 时



$C\frac{du_C}{dt}R + u_C = t$

$\Rightarrow u_C = t + e^{-t}$

$\Rightarrow i = C\frac{du_C}{dt} = 1 - e^{-t}$

$\therefore u_S = (1-t)[\varepsilon(t) - \varepsilon(t-1)]$

$= \varepsilon(t) - t\varepsilon(t) + (t-1)\varepsilon(t-1)$ 时

$i = e^{-t}\varepsilon(t) - (1-e^{-t})\varepsilon(t) + (1-e^{-(t-1)})\varepsilon(t-1)$

$= (2e^{-t}-1)\varepsilon(t) + (1-e^{-(t-1)})\varepsilon(t-1)$

[8-46] $R_{eq} = 40\Omega$　$\tau = \frac{L}{R_{eq}} = \frac{1}{40}s$

$i_L(0) = \frac{1}{\Omega} \times \frac{2}{5} = \frac{1}{80}A$

$\therefore i_L = \frac{1}{80}e^{-40t}\varepsilon(t)\ A$

冲激响应计算：

$u_C(0_+) = u_C(0_-) + \frac{1}{C}\int_{0_-}^{0_+} i_C(0)\,dt$

将电容视为短路求 $i_C(0)$ → 表达式中含 $\delta(t)$

⇒ Step1. C → 求 $i_C(0)$　L → 求 $u_L(0)$

2. $i_C(0) \to u_C(0_+)$，$u_L(0) \to i_L(0_+)$

$u_L(0) = 0.5\delta(t)V$，$i_L(0_-) = 0$

$i_L(0_+) = i_L(0_-) + \frac{1}{L}\int_{0_-}^{0_+} u_L(0)\,dt = 0.5\varepsilon(t)\ A$

$R_{eq} = 40\Omega$.　$\tau = \frac{L}{R_{eq}} = \frac{1}{40}s$.　$i_L(\infty) = 0$

$\therefore i_L = 0.5e^{-40t}\varepsilon(t)\ A$

⇒ 若令 $u_S = \varepsilon(t)V$

则 $i_L(0_+) = i_L(0_-) = 0$，$i_L(\infty) = \frac{1}{80}A$

$S(t) = i_L = \frac{1}{80}(1-e^{-40t})\varepsilon(t)\ A$

$h(t) = \frac{ds(t)}{dt} = 0.5e^{-40t}\varepsilon(t)\ A$

$\therefore u_{o2}=(2.4+2.12e^{-1.25\times10^5(t-3\times10^{-6})})V\ (t>3\mu s)$

[8-57] $\tau=RC=10^{-2}s=10ms \quad 5\tau>T$

$u_1=\frac{1}{1+e^{-\frac{T}{\tau}}}u_s=7.3V$

$u_2=\frac{e^{-\frac{T}{\tau}}}{1+e^{-\frac{T}{\tau}}}u_s=2.7V$

$\therefore u_o=\begin{cases}(10-7.3e^{-100t})V, & 0<t<0.01s\\ 7.3e^{-100(t-0.01)}V, & 0.01s<t<0.02s\end{cases}$

[8-58] (1) $\frac{u_{o1}}{25K}+\frac{u_o}{100K}+1\times10^{-6}\frac{du_o}{dt}=0$ ①

$\therefore 40u_{o1}+10u_o+\frac{du_o}{dt}=0$

(2) $\frac{u_s}{100K}+\frac{u_{o1}}{500K}+1\times10^{-7}\frac{du_{o1}}{dt}=0$

$\therefore 100u_s+20u_{o1}+\frac{du_{o1}}{dt}=0$

$u_s=250mV \quad \therefore \frac{du_{o1}}{dt}+20u_{o1}+25=0$

$u_{o1}=(1.25e^{-20t}-1.25)V$

$\therefore 50e^{-20t}-50+10u_o+\frac{du_o}{dt}=0$

$y'+10y=-50e^{-20t}+50$

~~$y_{h1}=5\cdot y_{h2}$~~

$y=e^{\int-10dt}\left(\int(50e^{-20t}+50)e^{\int10dt}dt+c\right)$

$=e^{-10t}(50\int(e^{-10t}+e^{10t})dt+c)$

$=e^{-10t}(5e^{-10t}+5e^{10t}+c)$

$=5e^{-20t}+ce^{-10t}+5$

又 $u_o(0)=0 \quad \therefore u_o=(5e^{-20t}-10e^{-10t}+5)V$

(3) $|u_s|_{max}\le300mV$

[8-60](a) 存在电容有跳变

$u_c(0-)=-7i_L=-17.5V$

$u_c(0+)+5i_L(0+)=0 \quad \therefore u_c(0+)=-12.5V$

$-12.5=-17.5-\frac{1}{C}\int_{0-}^{0+}i_L(0)dt \quad \therefore i_L(0)=-10\delta(t)A$

[8-59] (1) $\tau=R_{ab}C=0.1 \quad \therefore R_{ab}=10^5\Omega$

(2) $u_o(0-)=u_o(0+)=5V$

(3) 将 u_s 置零 则仅在 i_s 作用下

$u_o(0+)-u_o(\infty)=-8V \quad 又 u_o(0+)=5V$

$\therefore u_o(\infty)=13V \quad \therefore K=u_o(\infty)=13$

(4) 知 i_s 单独作用时, $u_{o1}(\infty)=13V$

又 u_s, i_s 共同作用时 $u_o(\infty)=20V$

$\therefore u_s$ 单独作用时, $u_{o2}(\infty)=7V$

$\therefore u_o=(7-2e^{-10t})V$

(5) $W=\frac{1}{2}Cu^2 \quad \therefore u_o'(0+)=\sqrt{5}u_o(0+)=5\sqrt{5}V$

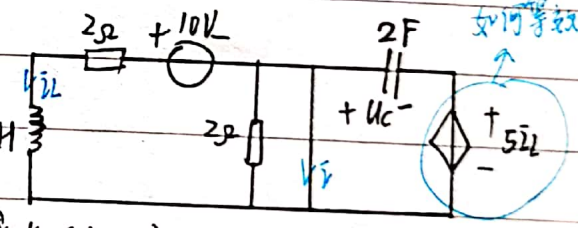
$u_o'(\infty)=7V-13V=-19V \quad -6V$ 这里不用 K

$\therefore u_o'=[-19+(5\sqrt{5}+19)e^{-10t}]V$ 题意, u_o' 变为原来的二倍

$(-6+16e^{-10t})V$?

考试有不到这个难度

[8-60]



电容电感在两个独立回路

(1) $t<0$ 时, $i_L=\frac{10V}{4\Omega}=2.5A \quad u_c+5i_L=-2i_L \quad \therefore u_c=-17.5$

$i_L(0+)=i_L(0-)=2.5A \quad u_c(0+)=u_c(0-)=-17.5V$

$t>0$ 时:

L 回路 $R_{eq}=2\Omega \quad \tau_1=\frac{L}{R_{eq}}=1s \quad i_L(\infty)=\frac{10V}{2\Omega}=5A$

$\therefore i_L=(5-2.5e^{-t})A \ (t>0)$

(2) C 回路 $u_c+5i_L=0$

$i=-(i_L+C\frac{du_c}{dt})=-(i_L+2\frac{d(-5i_L)}{dt})$

$=2.5e^{-t}-5+10\times2.5e^{-t}=(27.5e^{-t}-5)A$

(3) ~~$i(0)=22.5A$~~ $-10\delta(t)A$?

$u_c=-5i_L=(2.5e^{-t}-25)\varepsilon(t)$

$i_c=C\frac{du_c}{dt}=-25e^{-t}\varepsilon(t)+(25e^{-t}-50)\delta(t)$