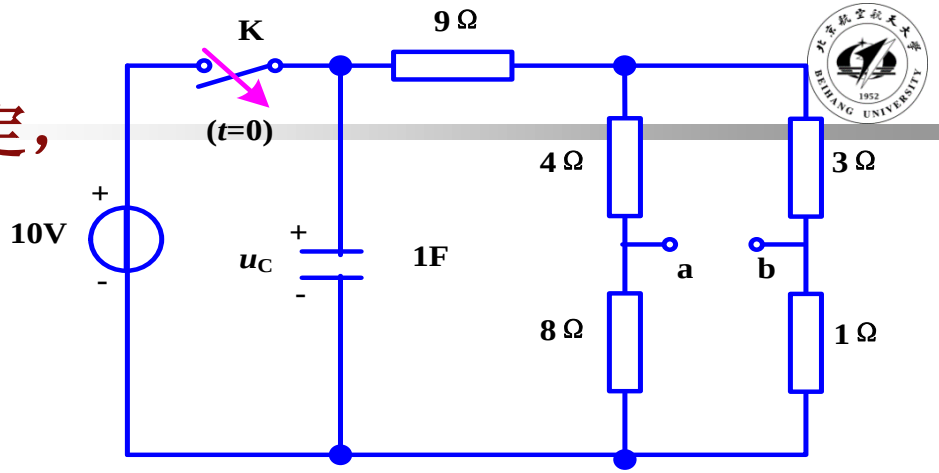
一阶电路习题

【题1】已知t<0时电路处于稳定，

t=0时开关打开。

求t>0时的$u_{ab}(t)$ 。



解：用三要素法 $u_C(0_-)=10\,\mathrm{V}$

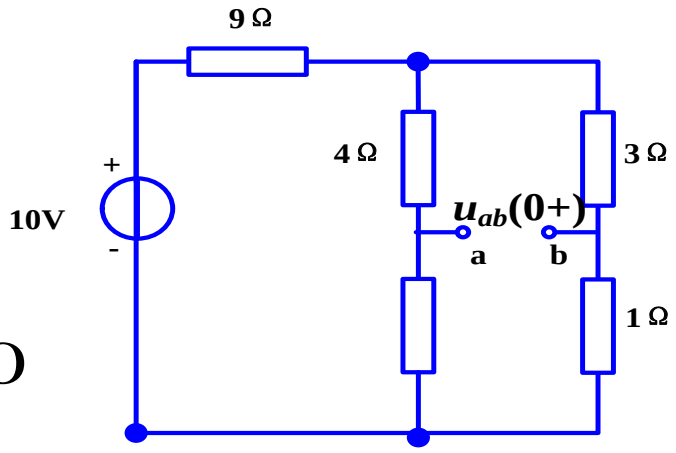
由换路定理 $u_C(0_+)=u_C(0_-)=10\,\mathrm{V}$

由0_+电路

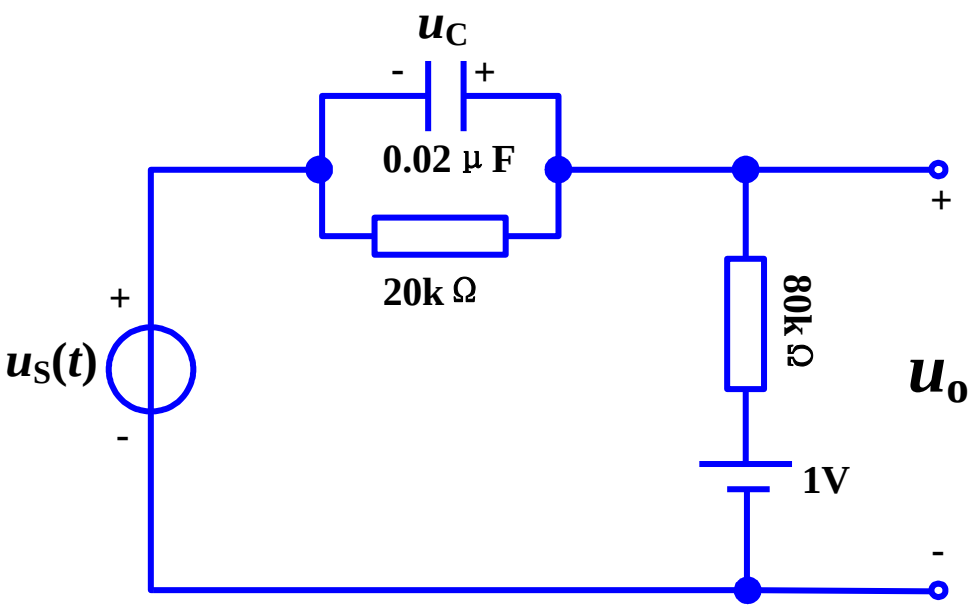
$$u_{ab}(0_+)=\frac{u_C(0_+)}{9+\dfrac{(4+8)\times(3+1)}{4+8+3+1}}\times\frac{(4+8)\times(3+1)}{4+8+3+1}\times\left(\frac{3}{3+1}-\frac{4}{4+8}\right)=\frac{25}{24}\,\mathrm{V}$$

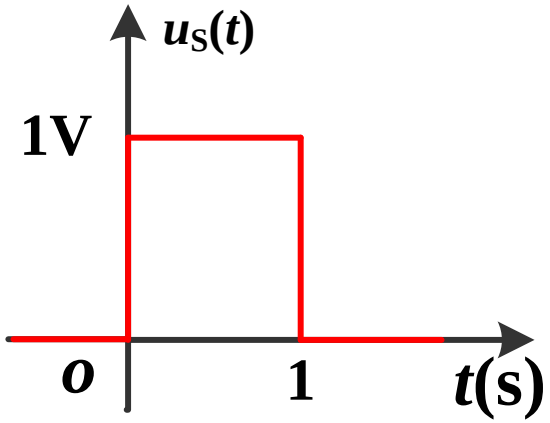
$$\tau=R_{eq}C=12(\text{秒})\quad u_{ab}(\infty)=0$$

$$\therefore u_{ab}(t)=\frac{25}{24}\mathrm{e}^{-\frac{1}{12}t}(\mathrm{V}),t>0$$

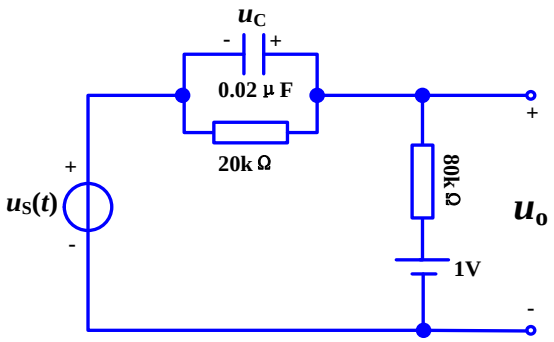


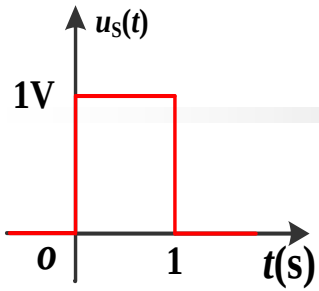
【题2】

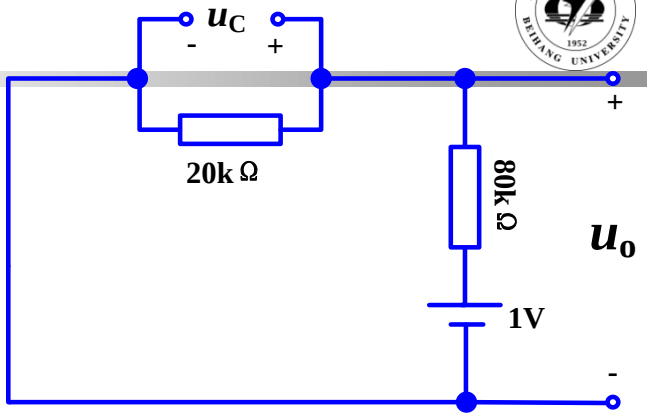




求t>0时，$u_O(t)$。







0₋电路图

解 方法一：

$$u_C(0_+)=u_C(0_-)=\frac{1}{80+20}\times 20=0.2\,\mathrm{V}$$

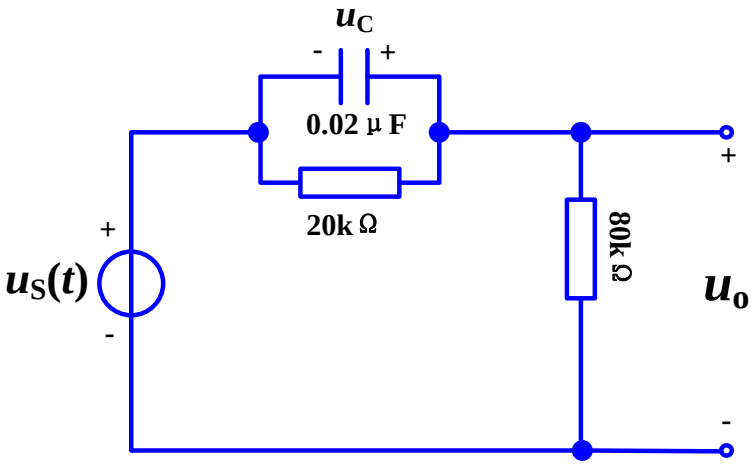
$$\tau=\frac{20\times 80}{20+80}\times 10^3\times 0.02\times 10^{-6}=3.2\times 10^{-4}\,\mathrm{s}$$

利用叠加定理：先求初始条件和1V直流电压源单独作用时的$u_O^{(1)}(t)$

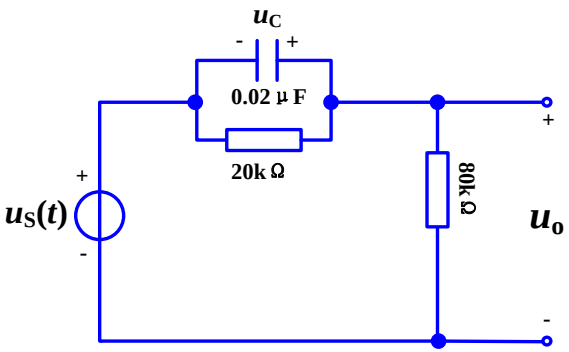
为：$u_O^{(1)}(0_+)=0.2\,\mathrm{V}$　　$u_O^{(1)}(\infty)=0.2\,\mathrm{V}$

$$\therefore u_O^{(1)}(t)=0.2\,\mathrm{V}$$

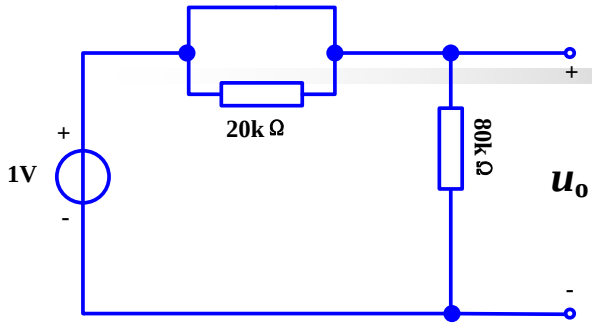
再求u_s(t)单独作用下的零状态响应$u_o^{(2)}$(t)



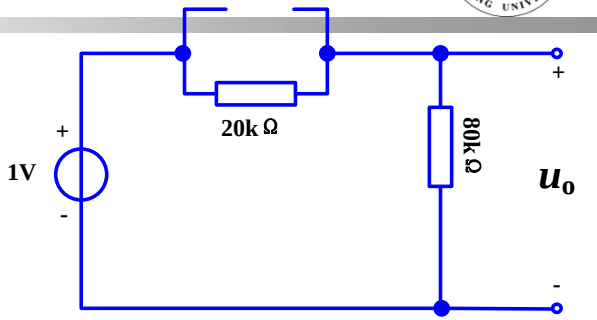
u_S单独作用电路图



u_S单独作用电路图



0_+电路图



∞电路图

$$u_C^{(2)}(0_+)=0\,\mathrm{V}$$

令 $u_S(t)=\varepsilon(t)$ $S_{u_o}(0_+)=1\,\mathrm{V}$ $S_{u_o}(\infty)=0.8\,\mathrm{V}$

$$S_{u_O}(t)=\left[0.8+(1-0.8)\mathrm{e}^{-\frac{t}{\tau}}\right]\varepsilon(t)=\left(0.8+0.2\,\mathrm{e}^{-3.125\times10^3 t}\right)\varepsilon(t)\,\mathrm{V}$$

$\therefore u_S(t)=\varepsilon(t)-\varepsilon(t-1)$ 时

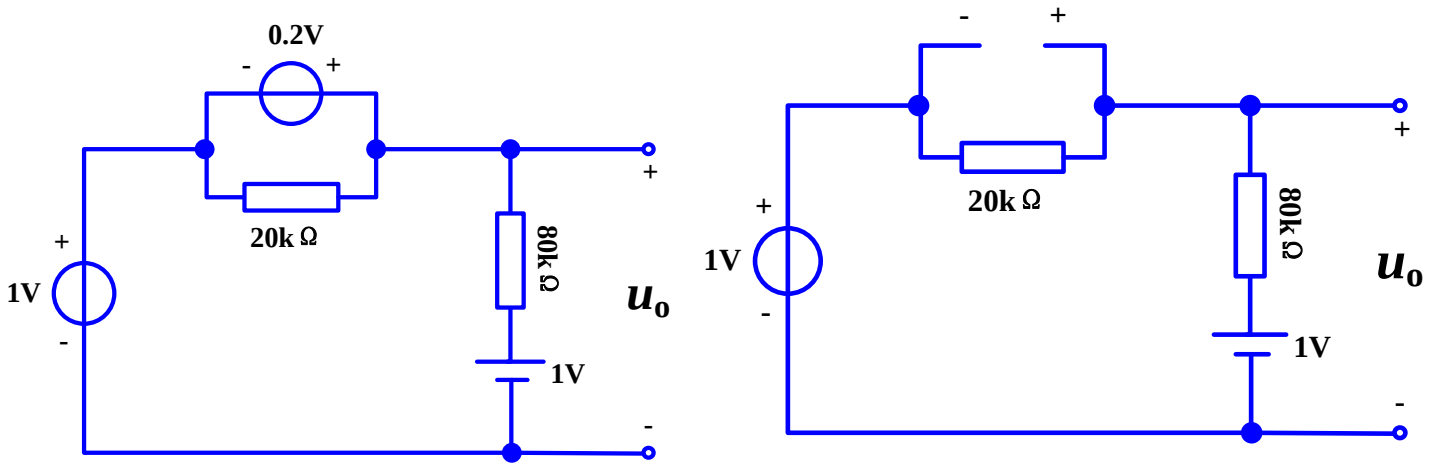
$$u_O^{(2)}(t)=\left(0.8+0.2\,\mathrm{e}^{-3.125\times10^3 t}\right)\varepsilon(t)-\left(0.8+0.2\,\mathrm{e}^{-3.125\times10^3 (t-1)}\right)\varepsilon(t-1)$$

共同作用下：

$$u_O(t)=0.2+\left(0.8+0.2\,\mathrm{e}^{-3.125\times10^3 t}\right)\varepsilon(t)-\left(0.8+0.2\,\mathrm{e}^{-3.125\times10^3 (t-1)}\right)\varepsilon(t-1)$$

方法二：分段法。

$0<t<1$时　$u_C(0_+)=u_C(0_-)=\dfrac{1}{80+20}\times 20=0.2\,\mathrm{V}$



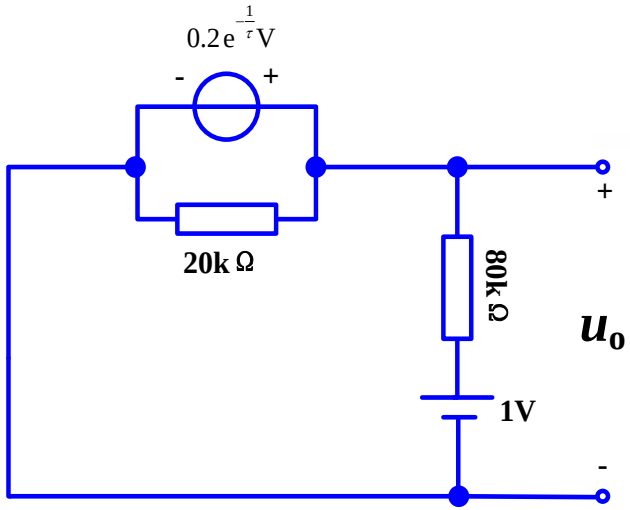
0_+电路图　　∞电路图

$u_O(0_+)=1.2\,\mathrm{V}$　　$u_O(\infty)=1\mathrm{V}$

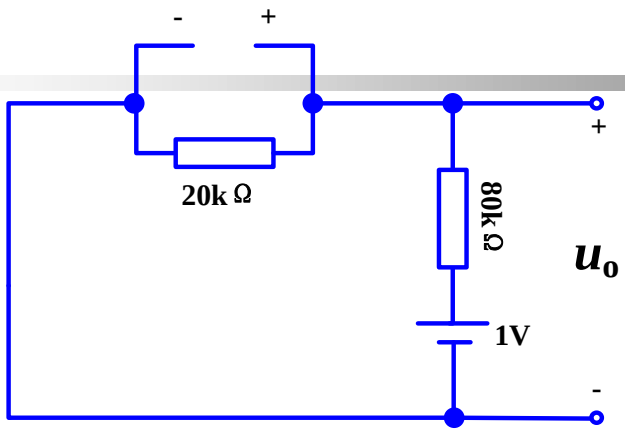
$$\therefore u_O(t)=1+0.2\mathrm{e}^{-\frac{t}{\tau}}\mathrm{V}$$

$$u_C(t)=0.2\mathrm{e}^{-\frac{t}{\tau}}\mathrm{V}$$

$t>1$时，　$u_C(1)=0.2\mathrm{e}^{-\frac{1}{\tau}}\mathrm{V}$



1_+电路图



∞电路图

$$\therefore u_O(1_+) = u_C(1_+) = 0.2e^{-\frac{1}{\tau}}V$$

$$\therefore u_O(\infty) = 0.2V$$

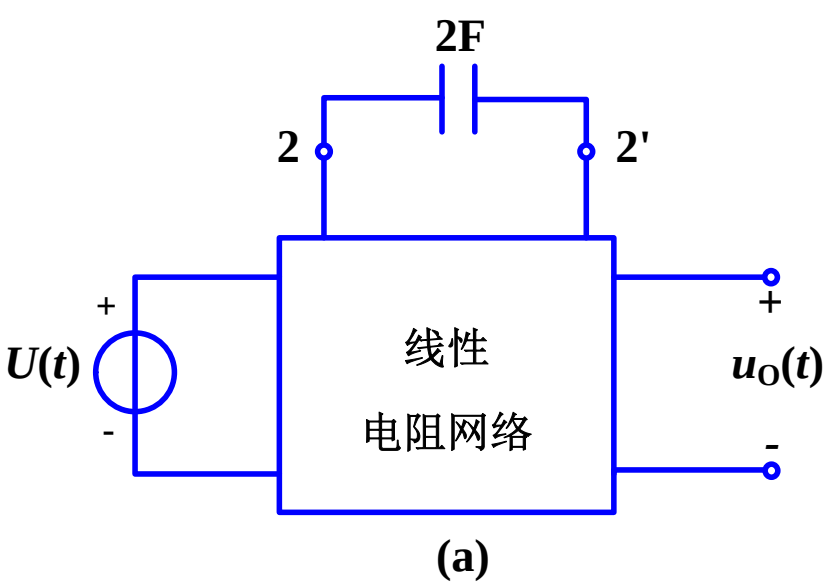
$$\therefore u_O(t) = 0.2 + \left(0.2e^{-\frac{1}{\tau}} - 0.2\right)e^{-\frac{t-1}{\tau}}V$$

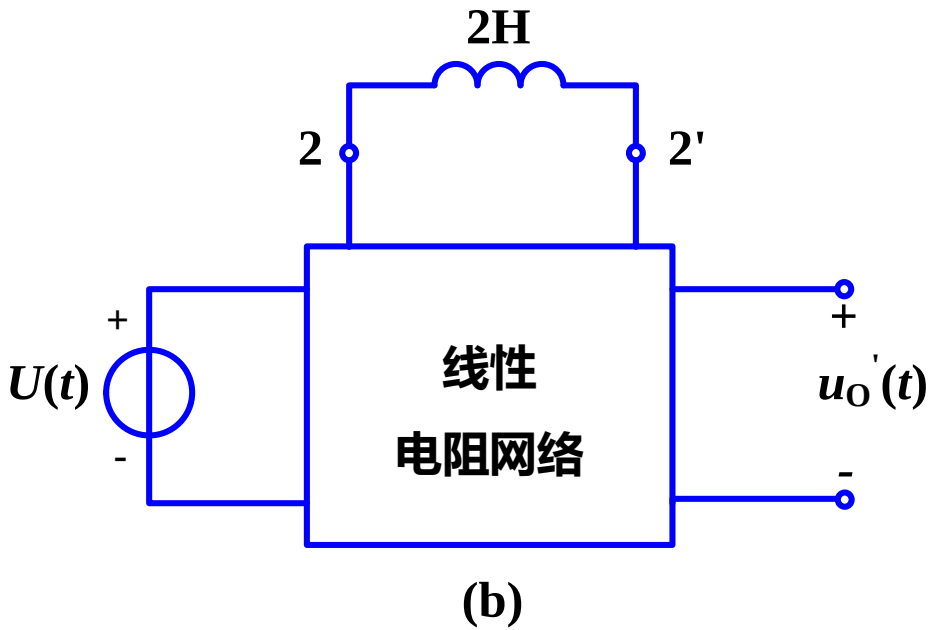
$$\therefore u_O(t) = \begin{cases} 1 + 0.2e^{-3.125\times10^3 t}(V), & 0 < t < 1\text{时} \\ 0.2 + 0.2\left(e^{-3.125\times10^3} - 1\right)e^{-3.125\times10^3 (t-1)}(V), & t > 1\text{时} \end{cases}$$

【题3】 图示电路 $u_S(t)=\varepsilon(t)$

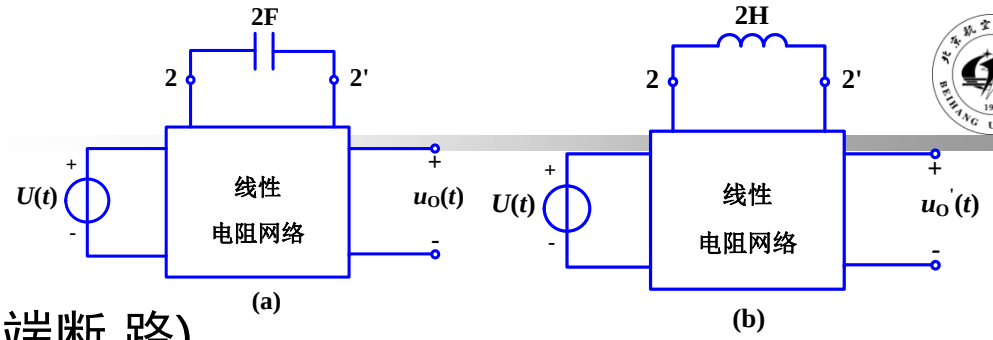
作用下的零状态响应为 $u_0(t)=\left(\frac{1}{2}+\frac{1}{8}e^{-0.25t}\right)\varepsilon(t)\text{V}$

，问若把电路中的电容换为2H的电感，其零状态响应 $u_0'(t)=?$





解



图（a）： $u_0(\infty)=\frac{1}{2}\mathrm{V}$ (2-2’端断 路)

$$u_0(0)=\frac{1}{8}+u_0(\infty)=\frac{1}{8}+\frac{1}{2}=\frac{5}{8}\mathrm{V}$$ (2-2’端短 路)

$$\tau=4(s),R_{eq}=\frac{\tau}{C}=\frac{4}{2}=2\Omega$$

图（b）： $\tau'=\frac{L}{R_{eq}}=\frac{2}{2}=1(S)$

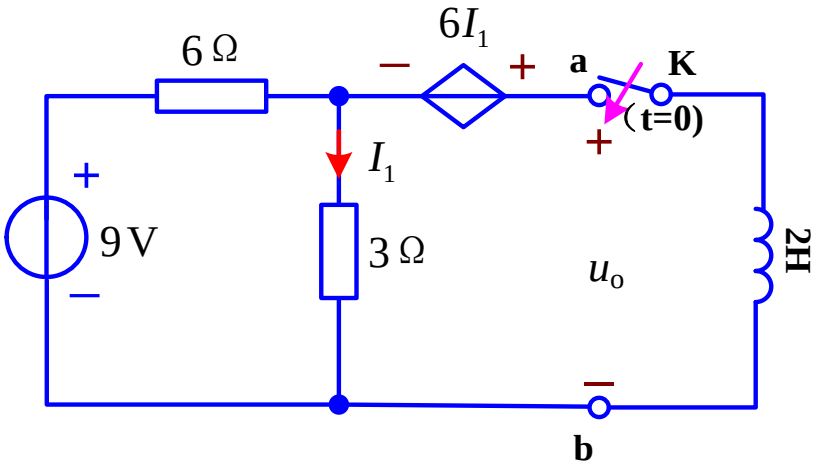
$$u_0'(\infty)=u_0(0)=\frac{5}{8}\mathrm{V}$$ (2-2’端短 路)

$$u_0'(0)=u_0(\infty)=\frac{1}{2}\mathrm{V}$$ (2-2’端断 路)

$$u_0'(t)=\left\{u_0'(\infty)+\left[u_0'(0)-u_0'(\infty)\right]\mathrm{e}^{-\frac{t}{\tau'}}\right\}\varepsilon(t)$$

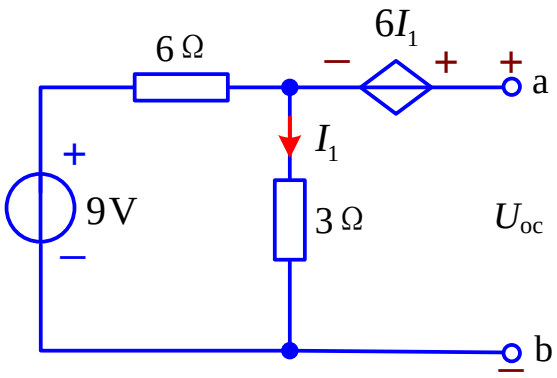
$$=\left[\frac{5}{8}+\left(\frac{1}{2}-\frac{5}{8}\right)\mathrm{e}^{-\frac{t}{\tau'}}\right]\varepsilon(t)=\left(\frac{5}{8}-\frac{1}{8}\mathrm{e}^{-t}\right)\varepsilon(t)(\mathrm{V})$$

【题4】求开关K闭合后的响应$u_o(t)$, t>0.



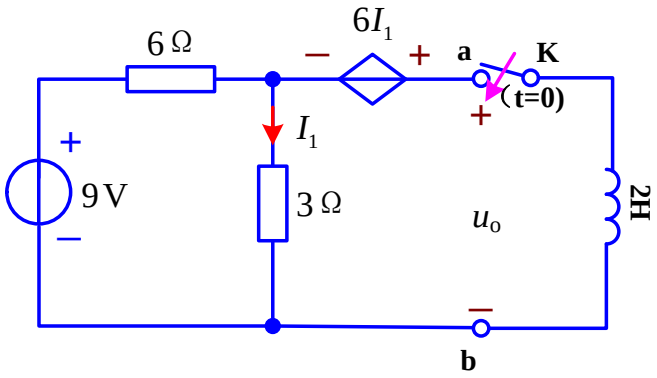
解

1.K断开时， 求U_{oc}



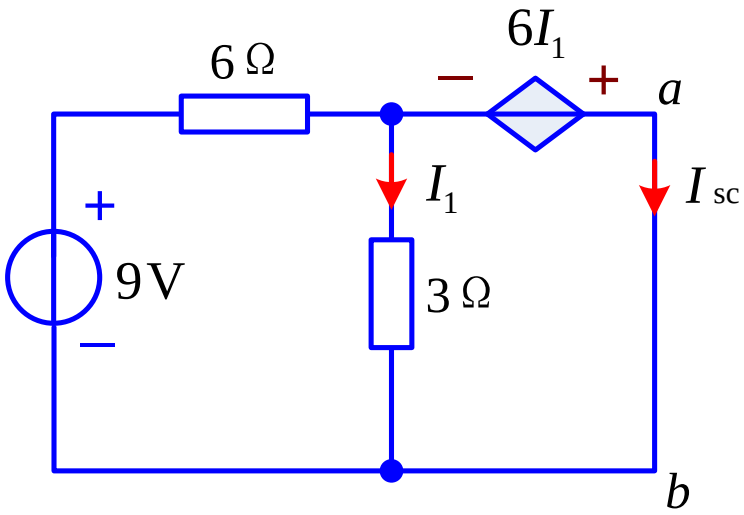
$$I_1=\frac{9}{6+3}=1\text{A}$$

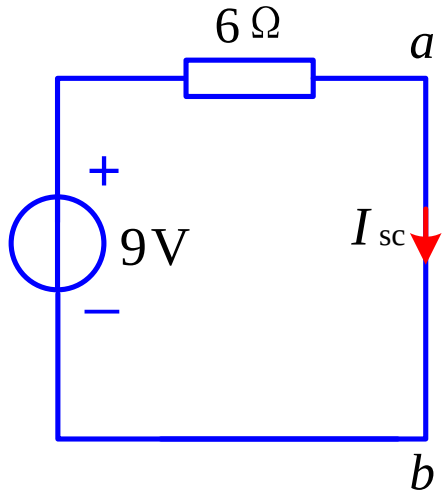
$$U_{oc}=6I_1+3I_1=9\text{V}$$



ab短路时

解



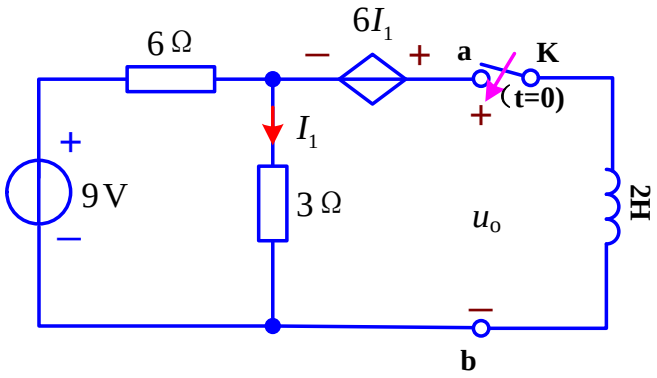


$$I_{sc}=\frac{9}{6}\text{A}=1.5\text{A}$$

$$I_1=\frac{-6I_1}{3}=-2I_1$$

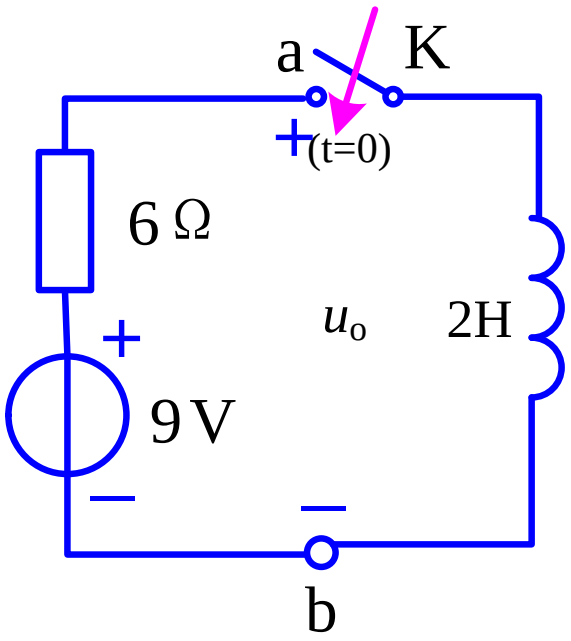
$$R_{eq}=\frac{U_{OC}}{I_{SC}}=\frac{9}{9/6}=6\Omega$$

$$I_1=0$$



解

等效为：



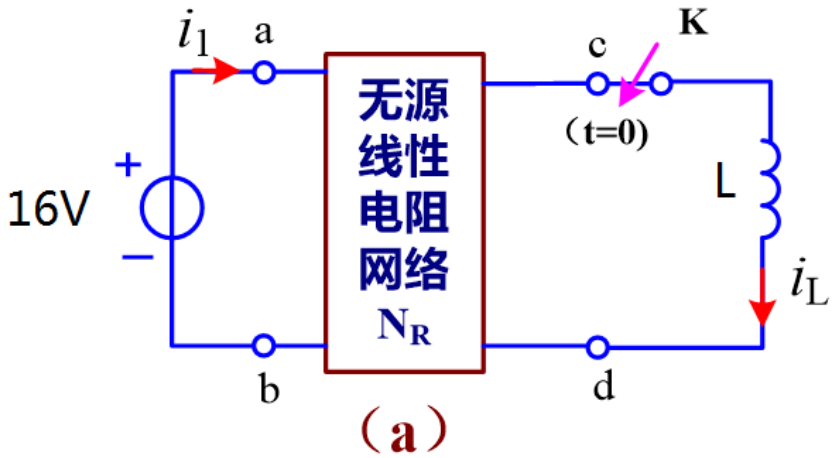
$$u_o = 9\,e^{-3t}\,V, t > 0$$

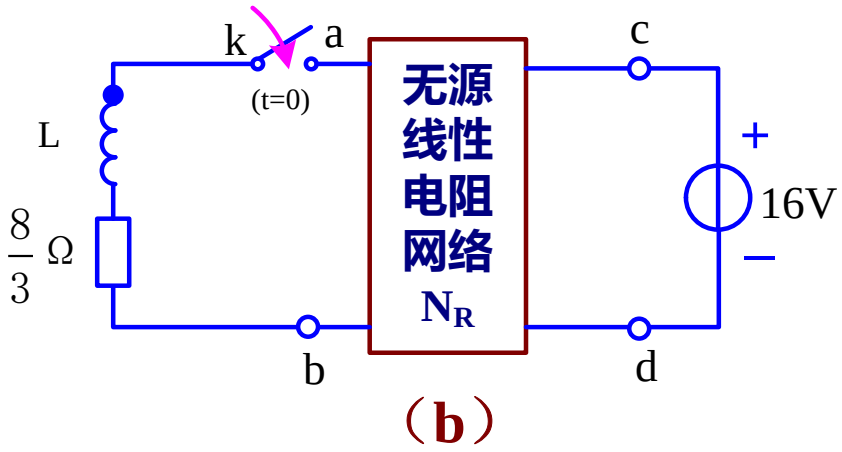
【题5】

已知：线性无源电阻网络N_R，图a开关K闭合前u_{cd}=8V，开关K闭合后i_1=6-2e^{-3t} A，i_L= 4(1-e^{-3t}) A。

现将电路进行调整，如图b所示，电感仍无初始储能。

求：图b中开关闭合后的u_{ab}=?





作业