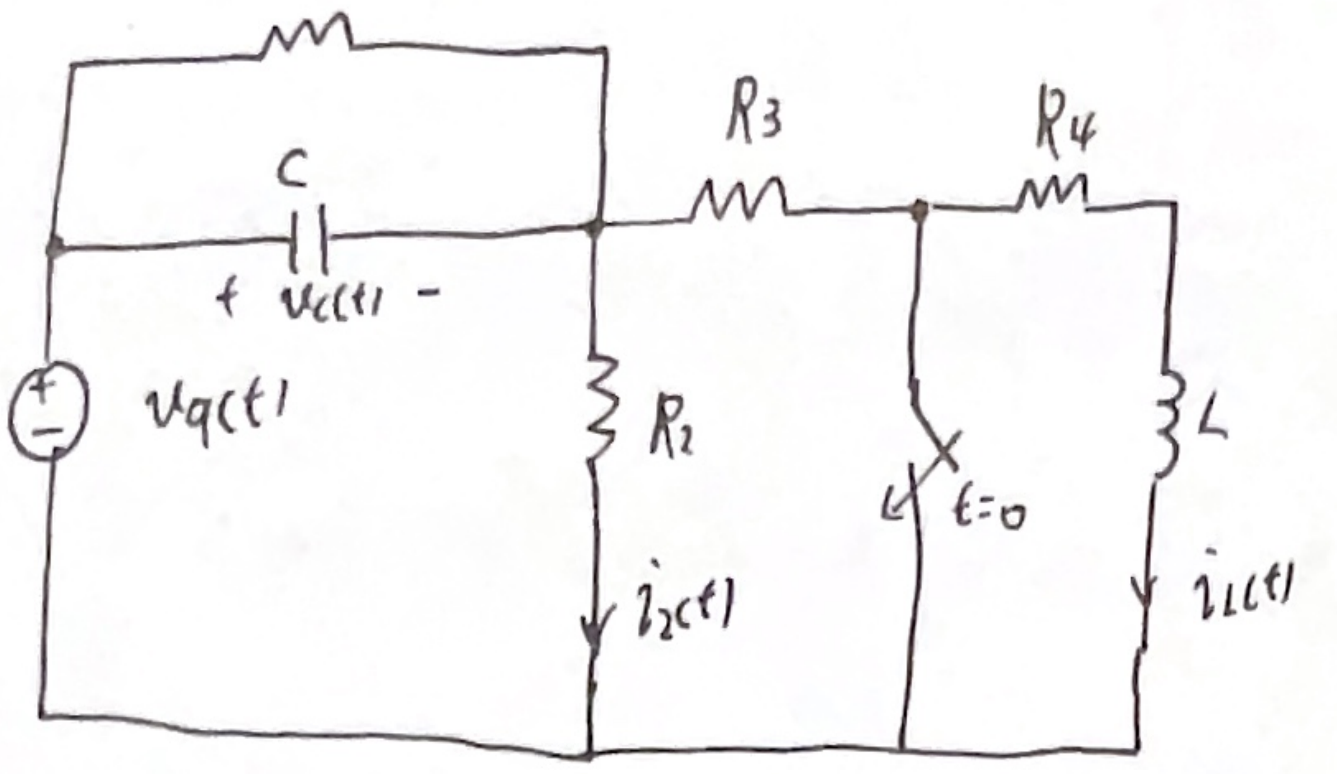
Auf 8

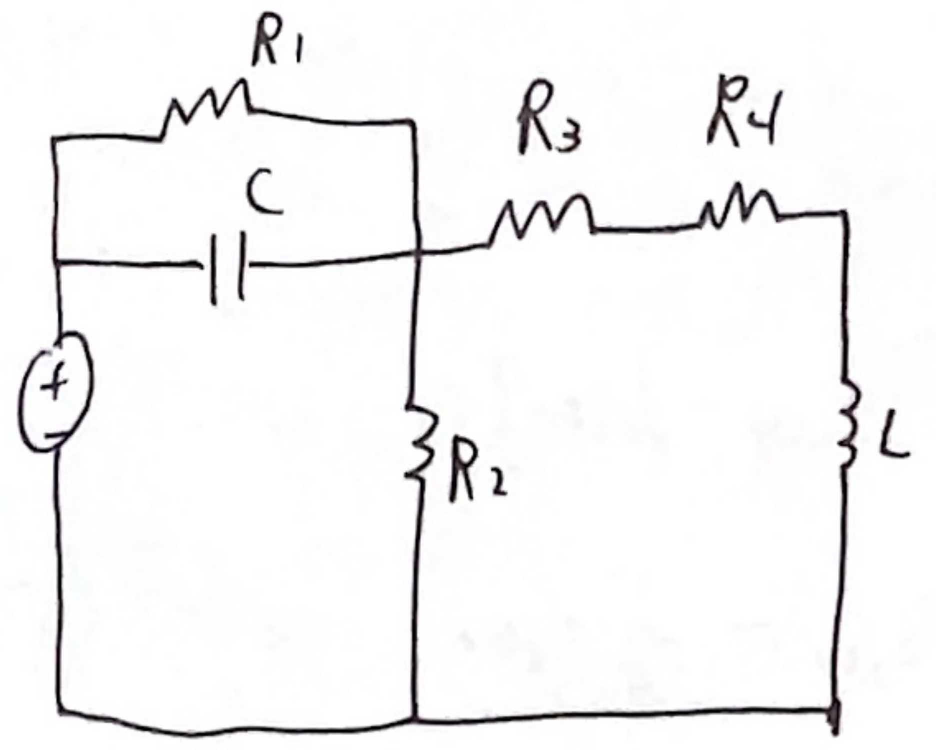


$u_q(t) = V_0 = \text{const}$

$t<0$, eingeschwungen

a. $t<0$, $i_2(t)$, $u_C(0^-)$, $i_L(0^-)$

eingeschwungen, $C \mathrel{\hat=}$ Leerlauf, $L \mathrel{\hat=}$ Kurzschluss



$$R_{34} = R_3 + R_4$$

$$R_{11} = \frac{R_{34} \cdot R_2}{R_{34} + R_2} = \frac{R_2(R_3+R_4)}{R_2+R_3+R_4}$$

$$R_{ges} = R_1 + R_{11} = R_1 + \frac{R_2(R_3+R_4)}{R_2+R_3+R_4} = \frac{R_1(R_2+R_3+R_4) + R_2(R_3+R_4)}{R_2+R_3+R_4}$$

$$u_C(0^-) = u_{R_1} = \frac{R_1}{R_{ges}} V_0 = \frac{R_1(R_2+R_3+R_4)}{R_1(R_2+R_3+R_4)+R_2(R_3+R_4)} V_0 = \frac{R_1}{R_1+R_{11}} V_0$$

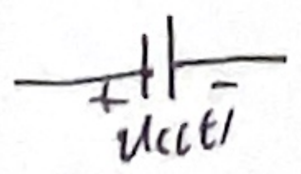
$$u_{11} = \frac{R_{11}}{R_{ges}} V_0 = \frac{R_{11}}{R_1+R_{11}} V_0$$

$$i_2(t) = \frac{u_{11}}{R_2} = \frac{R_{11}}{R_2(R_1+R_{11})} V_0$$

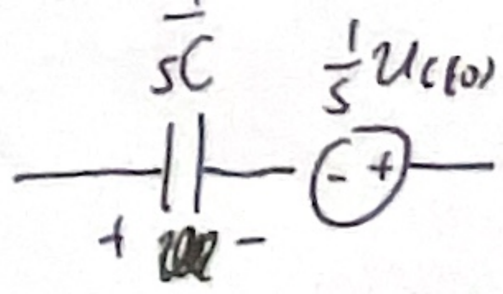
$$i_L(t) = \frac{u_{11}}{R_{34}} = \frac{R_{11}}{(R_3+R_4)(R_1+R_{11})} V_0$$

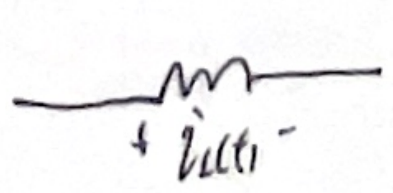
$$I_C(s) = sC\,U_C(s) - C\,u_C(0)$$

b. $t>0$, Laplace Netzwerk $\quad i_C(t) = C\frac{du_C(t)}{dt} \Leftrightarrow U_C(s) = \frac{1}{sC} I_C(s) + \frac{1}{s} u_C(0)$

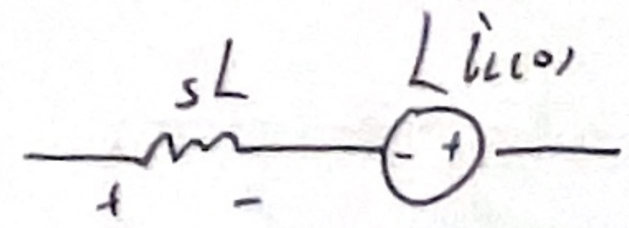


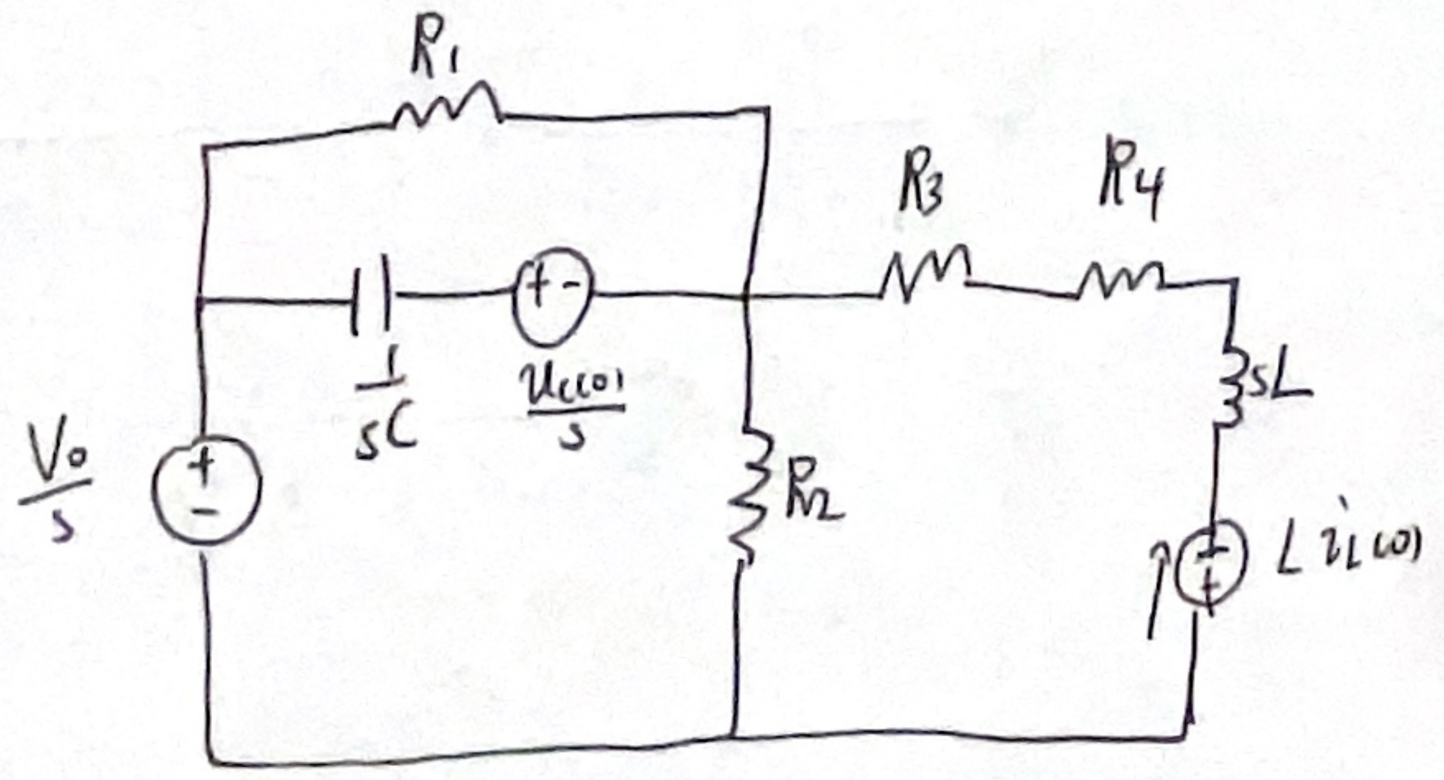
$\cancel{u_C(t) = C\frac{di_C(t)}{dt} \Leftrightarrow U_C(s) = sC\,I_C(s) - C\,u_C(0)}$





$\cancel{i_L(t) = L\frac{du_L(t)}{dt} \Leftrightarrow I_L(s) = sL\,U_L(s) - L\,i_L(0)}$

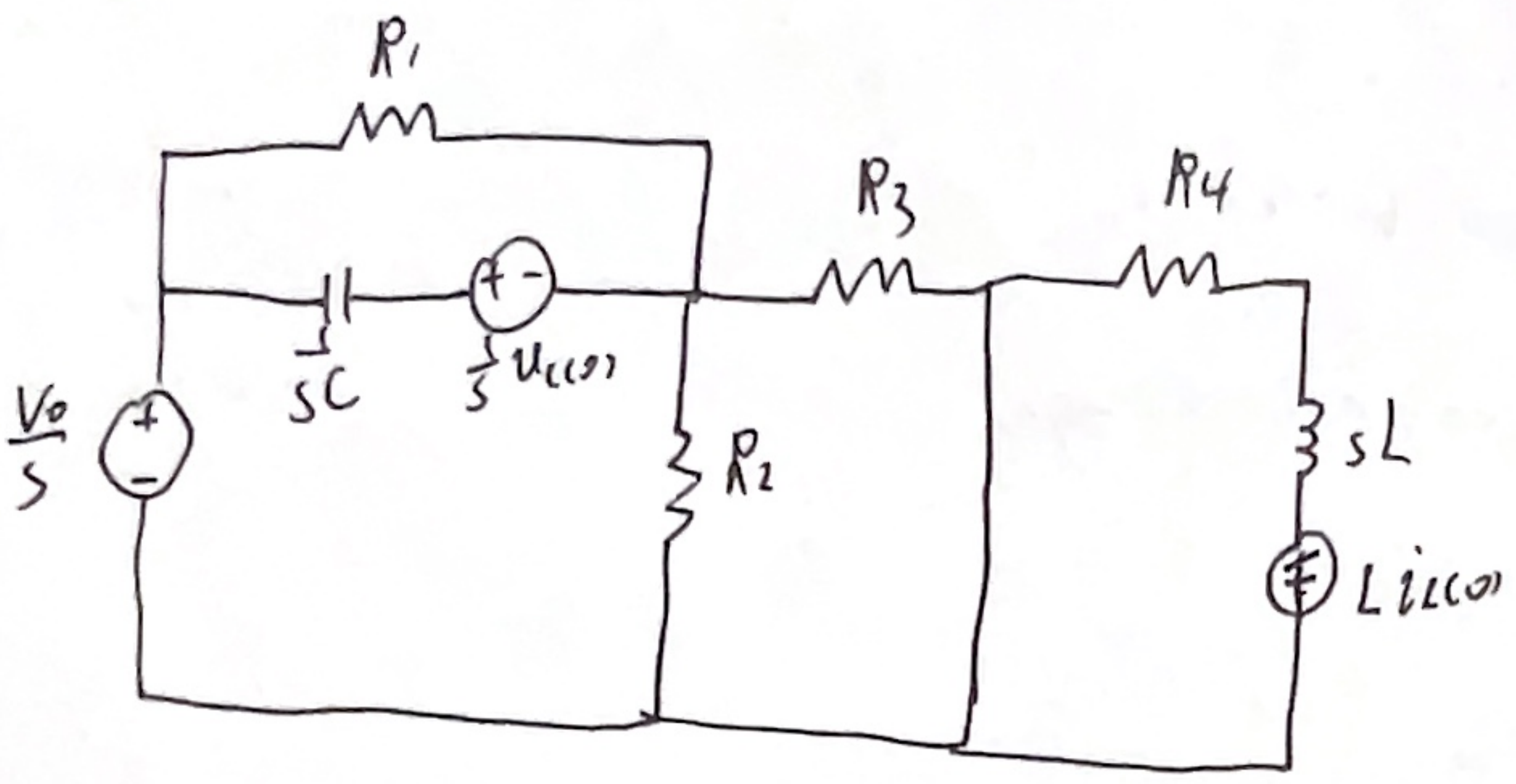




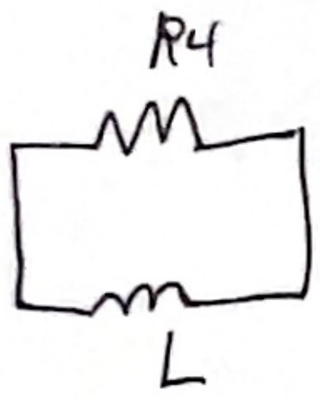
$$u_L(t) = L\frac{di_L(t)}{dt} \Leftrightarrow U_L(s) = sL\,I_L(s) - L\,i_L(0)$$

$\cancel{[illegible]}$

C. 开关闭合，求 $i_2(t)$, $i_L(t)$



$I_L(s)$



KCL: $i_L(t) + i_{R4}(t) = 0$, $u_L(t) = L\frac{di_L(t)}{dt}$

$i_L(t) + \frac{u_L(t)}{R_4} = 0$

$i_L(t) + \frac{L}{R_4}\frac{di_L(t)}{dt} = 0$

$\Longleftrightarrow I_L(s) + \frac{L}{R_4}\left[sI_L(s) - i_L(0)\right] = 0$

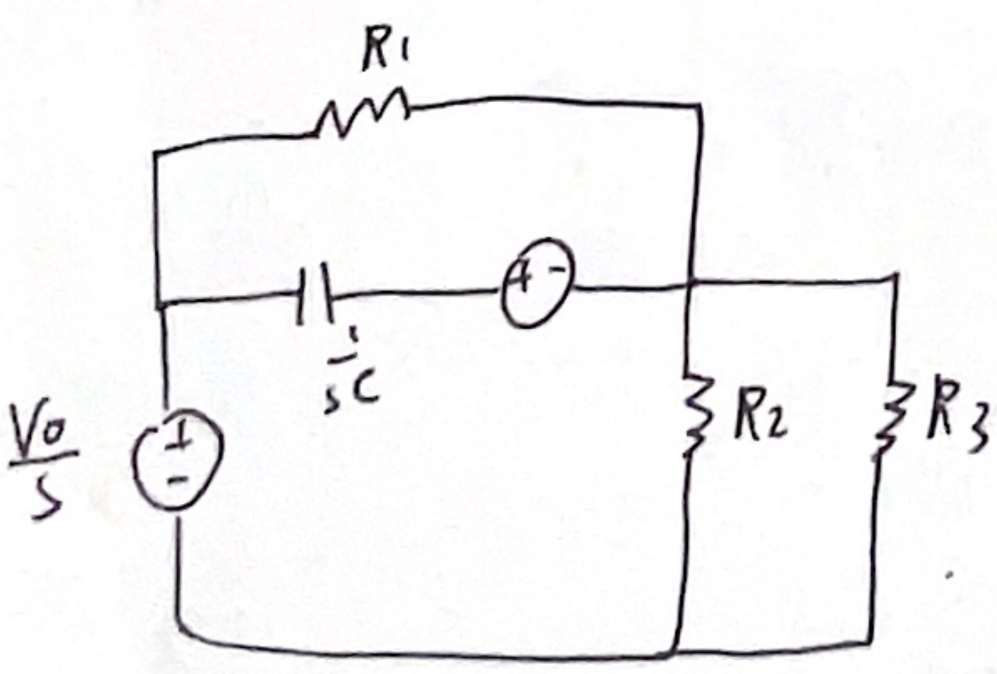
$I_L(s) + \frac{sL}{R_4}I_L(s) = \frac{L}{R_4}i_L(0)$ $\quad I_L(s) = \frac{L}{Z_L + Z_R}i_L(0)$

$\left(1 + \frac{sL}{R_4}\right)I_L(s) = \frac{L}{R_4}i_L(0)$

$\boxed{I_L(s)} = \frac{L}{R_4}i_L(0)\frac{R_4}{R_4 + sL} = \boxed{\frac{1}{s + \frac{R_4}{L}}i_L(0)}$

$\frac{1}{s-a} \leftrightarrow e^{at}1(t)$

$\Rightarrow i_L(t) = e^{-\frac{R_4}{L}t}i_L(0) = \frac{V_0}{R_3 + R_4}\frac{R_{11}}{R_1 + R_{11}}e^{-\frac{R_4}{L}t}$, $t > 0$

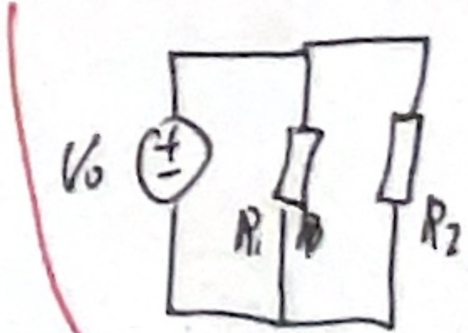


拉普拉斯域可用 superposition

$V_{2.1} = \frac{V_0}{s}\frac{Z_{23}}{Z_{23} + Z_{1C}} = \frac{V_0}{s}\frac{Y_{1C}}{Y_{23} + Y_{1C}}$

并联用导纳

导纳的引入



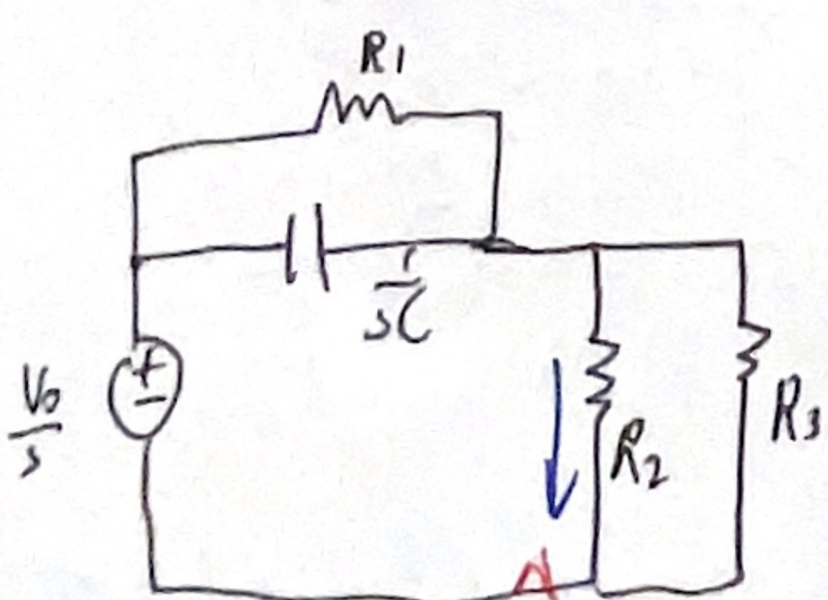
$V_1 = V_0\frac{R_1}{R_1 + R_2}$

$V_1 = V_0\frac{Y_2}{Y_1 + Y_2}$

$= V_0\frac{\frac{1}{R_2}}{\frac{1}{R_1} + \frac{1}{R_2}}$

$= V_0\frac{R_1}{R_2 + R_1}$

① $\frac{V_0}{s}$

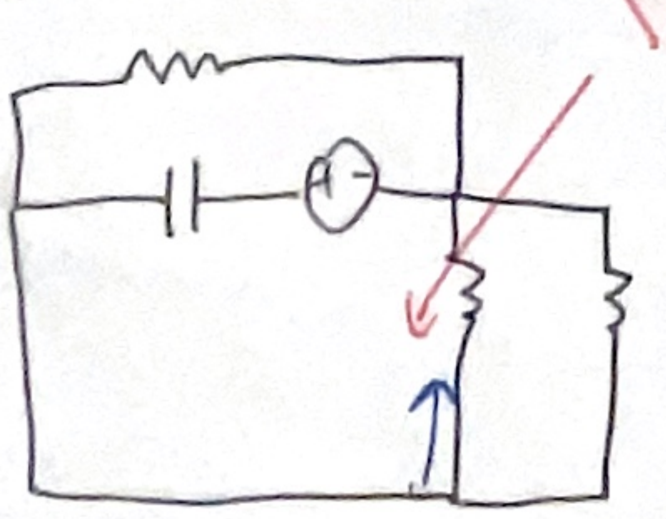


$V_{2.1} = \frac{V_0}{s}\frac{Y_C + Y_1}{Y_C + Y_1 + Y_2 + Y_3} = \frac{V_0}{s}\frac{sC + \frac{1}{R_1}}{sC + \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$

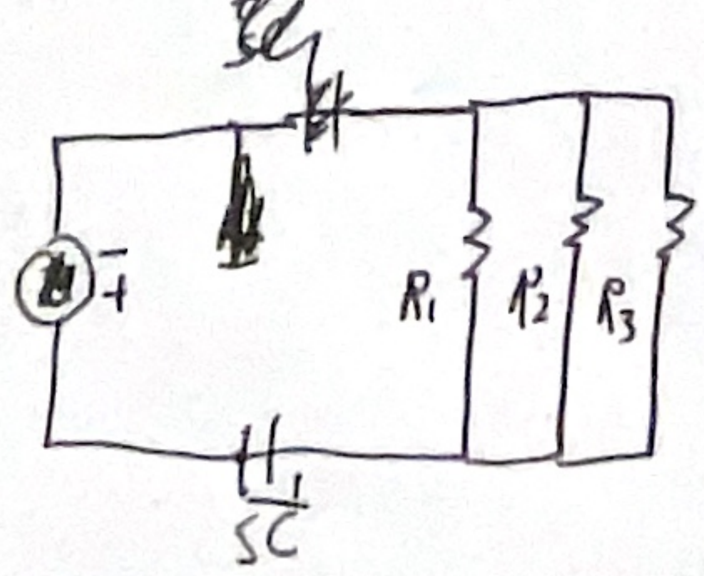
$I_{2.1} = \frac{V_{2.1}}{R_2} = \frac{1}{R_2}\frac{V_0}{s}\frac{sC + \frac{1}{R_1}}{sC + \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$

② $u_C(0)$

反向



$\Longleftrightarrow$



$V_{2.2} = \frac{u_C(0)}{s}\frac{Y_C}{Y_C + Y_1 + Y_2 + Y_3} = \frac{u_C(0)}{s}\frac{sC}{sC + \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$

$I_{2.2} = \frac{V_{2.2}}{R_2} = \frac{1}{R_2}\frac{u_C(0)}{s}\frac{sC}{sC + \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$

令 $\frac{1}{R_g} = \cancel{}\ \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$$\Rightarrow I_{2}(s) = I_{2,1} + I_{2,2} = \frac{1}{R_2}\frac{V_0}{s}\frac{sC+\frac{1}{R_1}}{sC+\frac{1}{R_g}} - \frac{1}{R_2}\frac{v_c(0)}{s}\frac{sC}{sC+\frac{1}{R_g}}$$

$$= \frac{1}{R_2}\left[\frac{V_0}{s}\frac{sC+\frac{1}{R_1}}{sC+\frac{1}{R_g}} - \frac{V_0}{s}\frac{R_1}{R_1+R_{11}}\frac{sC}{sC+\frac{1}{R_g}}\right]$$

$$= \frac{V_0}{R_2}\left[\underbrace{\frac{s+\frac{1}{R_1C}}{s(s+\frac{1}{CR_g})}}_{\text{部分分式}} - \frac{R_1}{R_1+R_{11}}\underbrace{\frac{s}{s(s+\frac{1}{CR_g})}}_{\frac{1}{s+a} \Longleftrightarrow e^{-at},\ t>0}\right]$$

$$\frac{s+\frac{1}{R_1C}}{s(s+\frac{1}{CR_g})} = \frac{A}{s} + \frac{B}{s+\frac{1}{CR_g}}$$

• s, $s=0$

$$\frac{s+\frac{1}{R_1C}}{s+\frac{1}{CR_g}} = A = \frac{\frac{1}{R_1C}}{\frac{1}{CR_g}} = \frac{CR_g}{R_1C} = \frac{R_g}{R_1}$$

• $s+\frac{1}{CR_g}$, $s=-\frac{1}{CR_g}$

$$\frac{s+\frac{1}{R_1C}}{s} = B = \frac{-\frac{1}{CR_g}+\frac{1}{R_1C}}{-\frac{1}{CR_g}} = \left(-\frac{1}{CR_g}+\frac{1}{R_1C}\right)(-CR_g) = 1-\frac{R_gC}{R_1C} = 1-\frac{R_g}{R_1}$$

$$\Rightarrow \frac{s+\frac{1}{R_1C}}{s(s+\frac{1}{CR_g})} = \frac{R_g}{R_1}\frac{1}{s} + \left(1-\frac{R_g}{R_1}\right)\frac{1}{s+\frac{1}{CR_g}} \Longleftrightarrow \cancel{\frac{R_g}{R_1} - \frac{R_g}{R_1}e^{-\frac{1}{CR_g}t},\ t>0}$$

$$\frac{R_g}{R_1} + \left(1-\frac{R_g}{R_1}\right)e^{-\frac{1}{CR_g}t},\ t>0$$

$$\Rightarrow i_2(t) = \frac{V_0}{R_2}\left[\frac{R_g}{R_1} + \left(1-\frac{R_g}{R_1}\right)e^{-\frac{1}{CR_g}t} - \frac{R_1}{R_1+R_{11}}e^{-\frac{1}{CR_g}t}\right],\ t>0$$