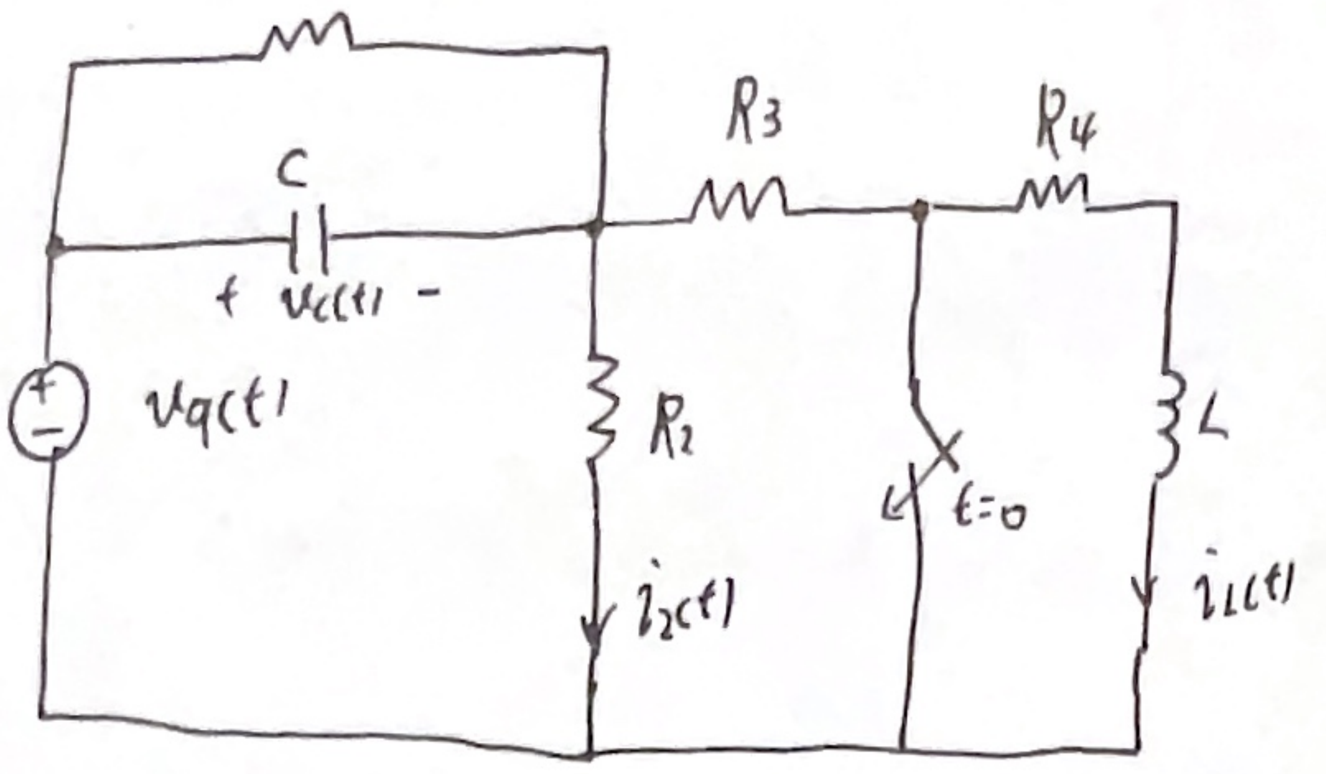
Auf 8

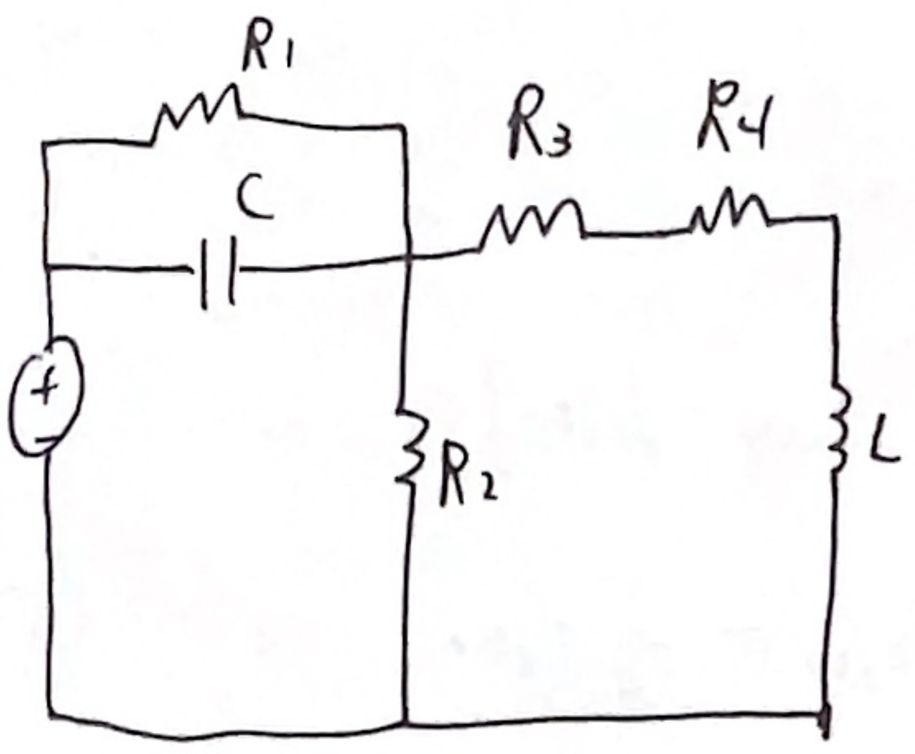


$u_q(t) = V_0 = \text{const}$

$t<0$, eingeschwungen

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

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



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

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

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

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

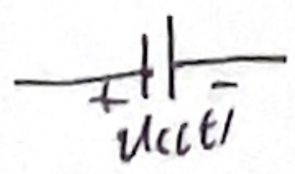
$$u_{11} = \frac{R_{11}}{R_{ges}} V_0 = \frac{R_{11}}{R_1+R_{11}} V_0$$

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

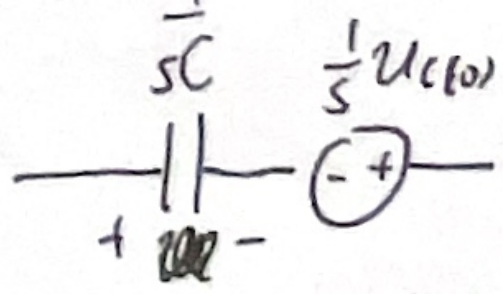
$$i_L(t) = \frac{u_{11}}{R_{34}} = \frac{R_{11}}{(R_3+R_4)(R_1+R_{11})} V_0$$

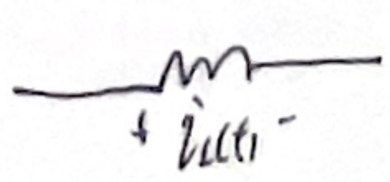
$$I_{C(s)} = sC\,U_{C(s)} - C\,u_{C(0)}$$

b. $t>0$, Laplace Netzwerk $\quad i_{C(t)} = C\frac{du_{C(t)}}{dt} \Leftrightarrow U_{C(s)} = \frac{1}{sC} I_{C(s)} + \frac{1}{s} u_{C(0)}$

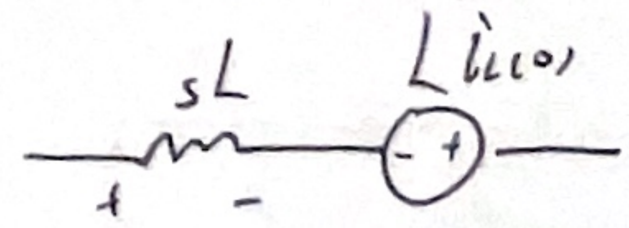


$\cancel{u_{C(t)} = C\frac{di_{L(t)}}{dt} \Leftrightarrow U_{C(s)} = sC I_{C(s)} - C u_{C(0)}}$



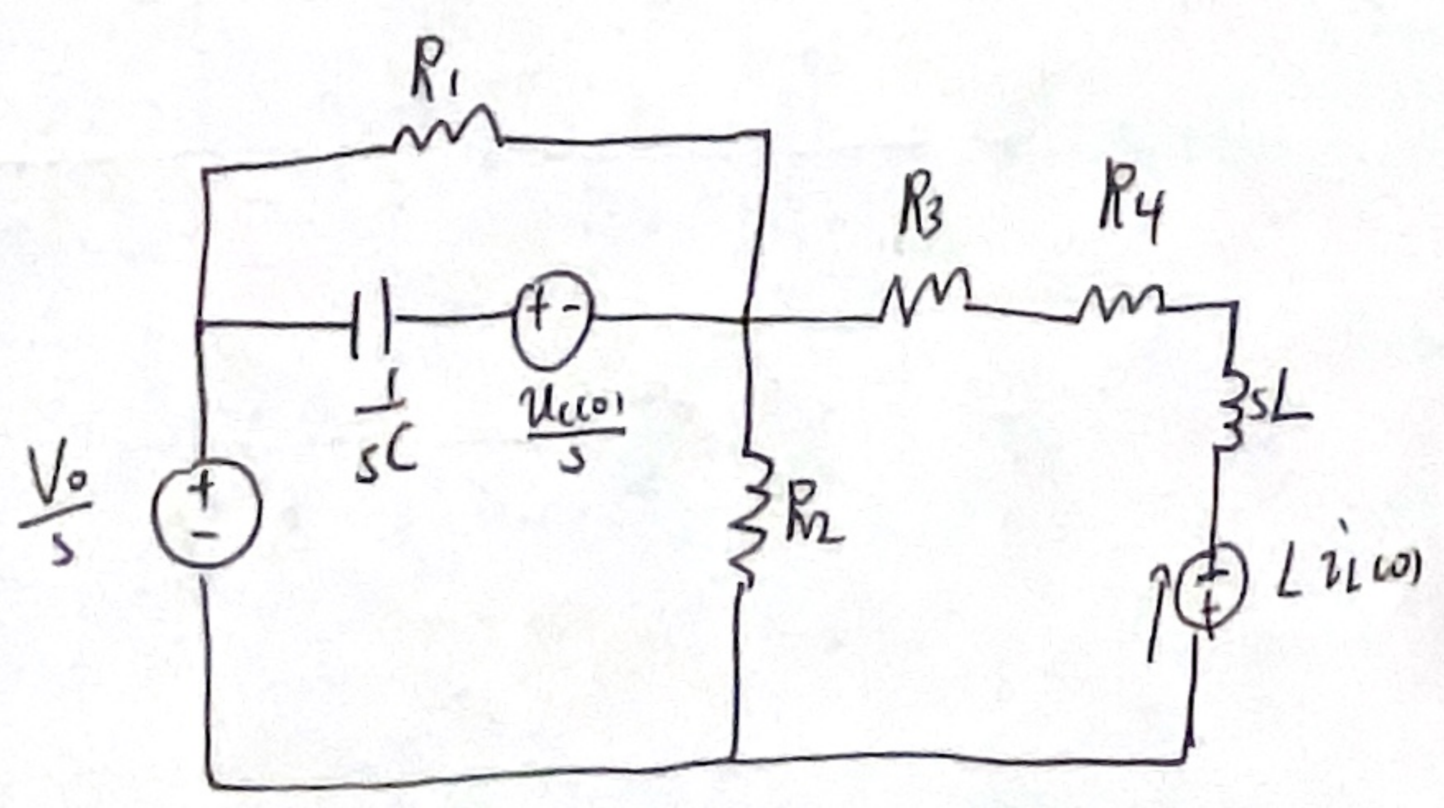


$\cancel{i_{L(t)} = L\frac{du_{C(t)}}{dt} \Leftrightarrow I_{L(s)} = sL\,U_{L(s)} - L i_{L(0)}}$

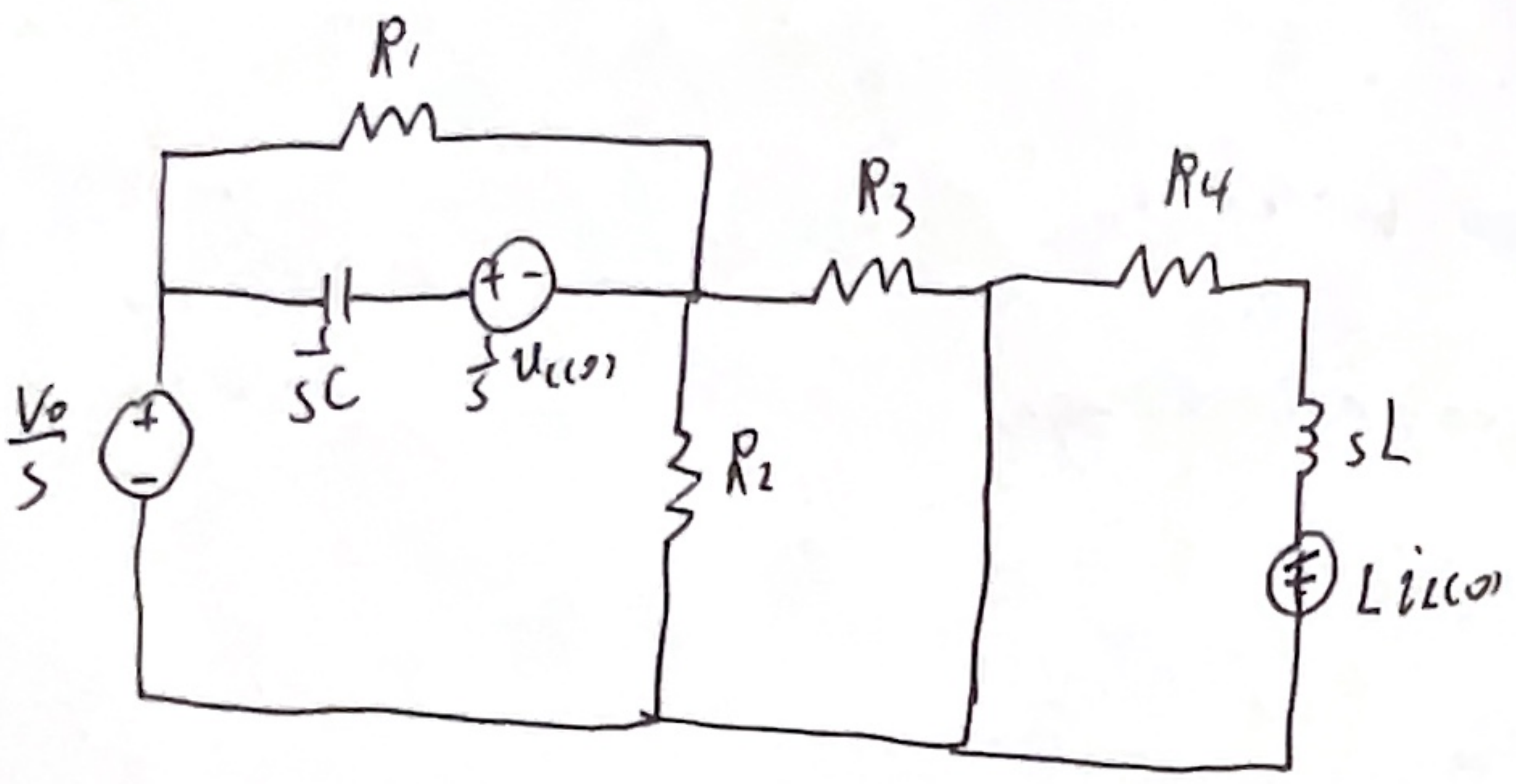


$$u_{L(t)} = L\frac{di_{L(t)}}{dt} \Leftrightarrow U_{L(s)} = sL\,I_{L(s)} - L\,i_{L(0)}$$

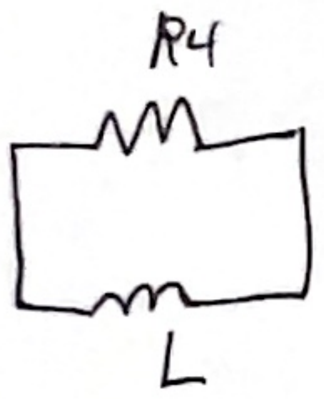
$\cancel{I_{L(s)} = \ldots}$



C. 开关闭合，求 $i_2(t)$，$i_L(t)$



$I_L(s)$



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

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

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

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

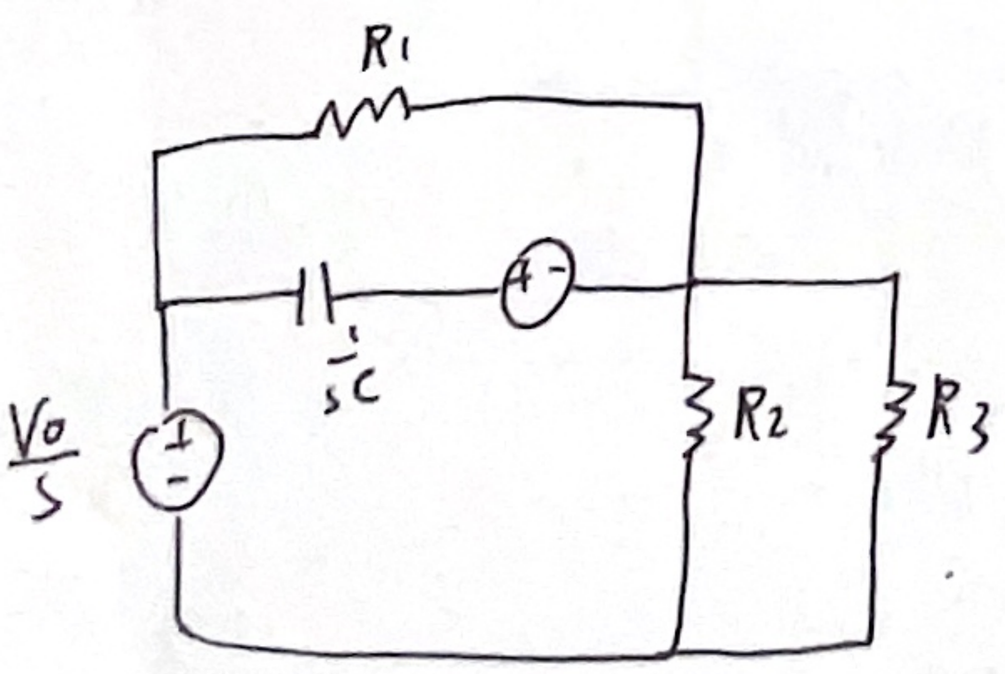
$$I_L(s) + \frac{sL}{R_4}I_L(s) = \frac{L}{R_4}i_L(0) \qquad I_L(s) = \frac{L}{Z_L + Z_R}i_L(0)$$

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

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

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

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

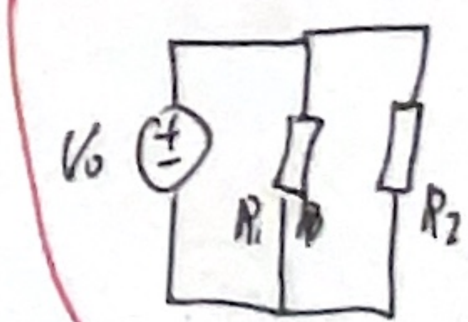


拉普拉斯域 可用 superposition

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

并联用导纳

导纳的引入



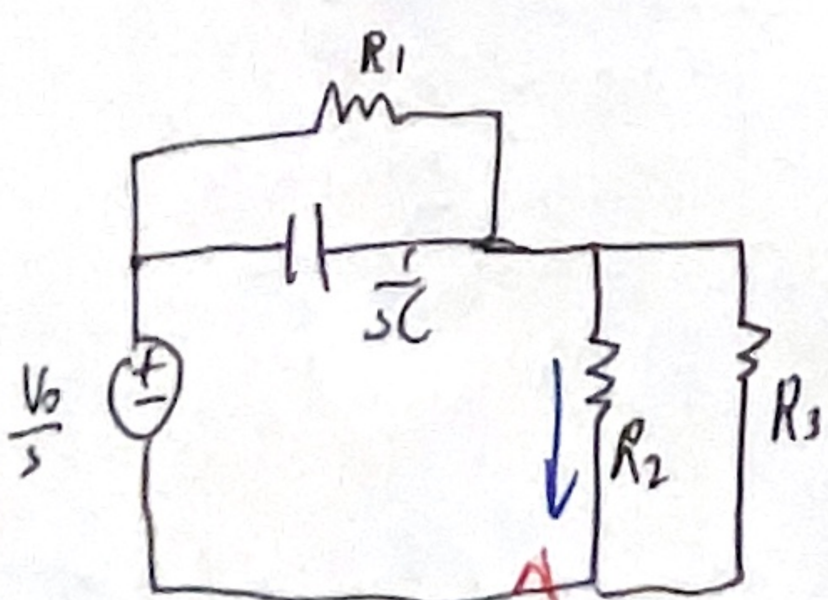
$$V_1 = V_0\frac{R_1}{R_1+R_2}$$

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

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

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

① $\frac{V_0}{s}$

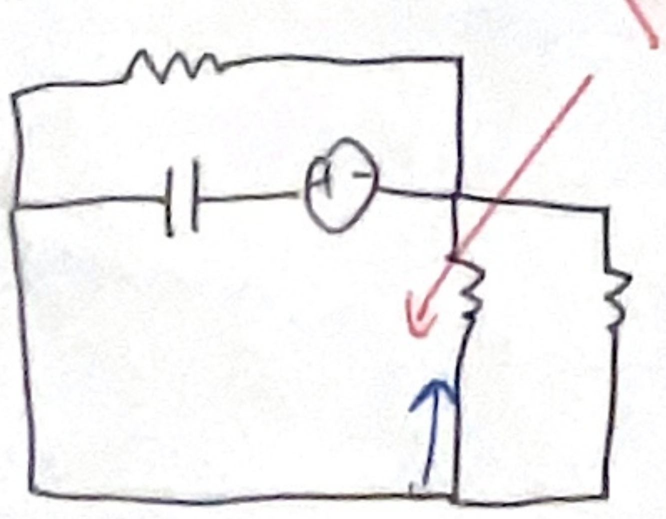


$$V_{2.1} = \frac{V_0}{s}\frac{Y_C+Y_1}{Y_C+Y_1+Y_2+Y_3} = \frac{V_0}{s}\frac{sC+\frac{1}{R_1}}{sC+\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}}$$

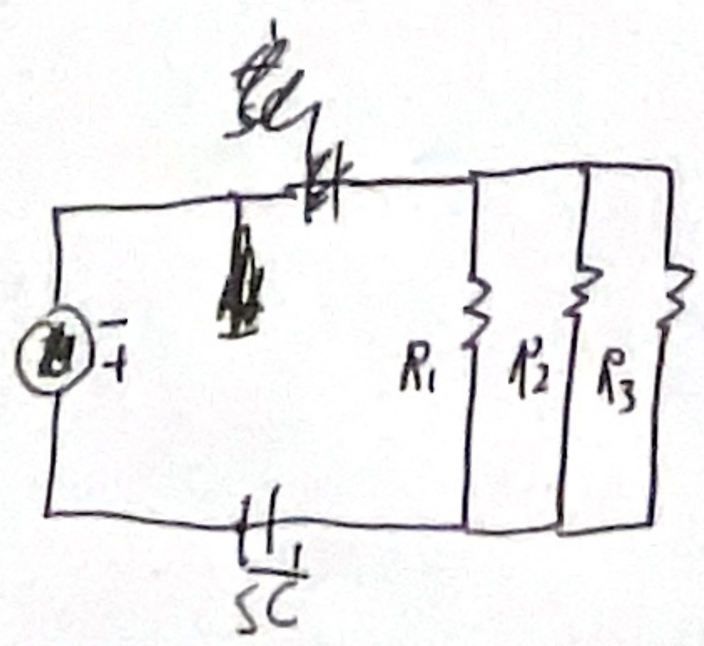
$$I_{2.1} = \frac{V_{2.1}}{R_2} = \frac{1}{R_2}\frac{V_0}{s}\frac{sC+\frac{1}{R_1}}{sC+\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}}$$

② $u_C(0)$

[illegible]方向



$\Longleftrightarrow$



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

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

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

$$\Rightarrow I_2(s) = I_{2,1} + I_{2,2} = \frac{1}{R_2}\frac{V_0}{s}\frac{sC+\frac{1}{R_1}}{sC+\frac{1}{R_g}} - \frac{1}{R_2}\frac{v_c(0)}{s}\frac{sC}{sC+\frac{1}{R_g}}$$

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

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

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

• s, $s=0$

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

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

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

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

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