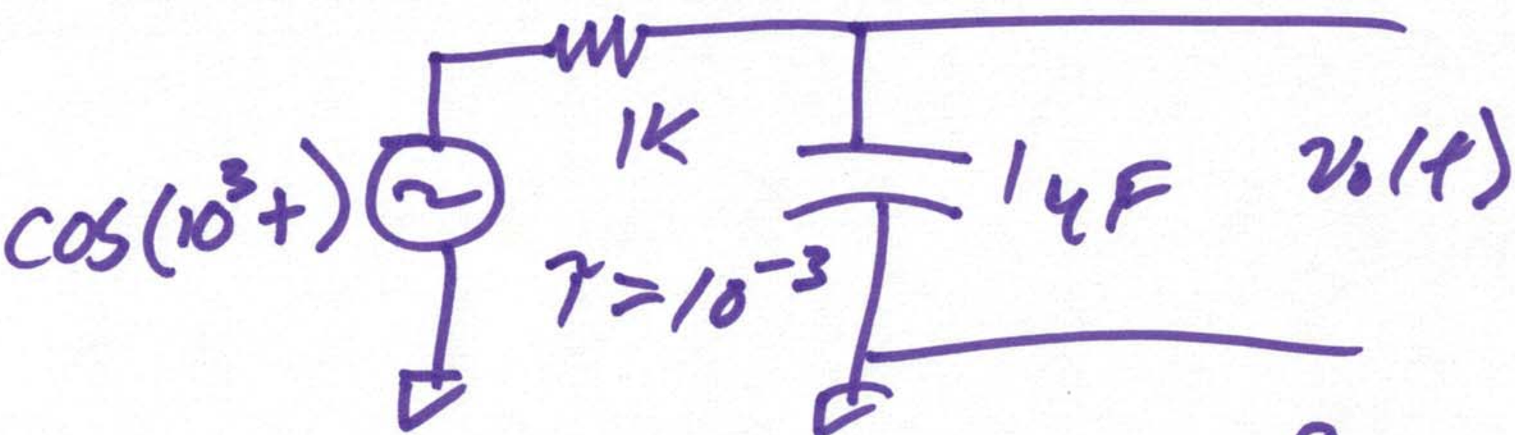
EE 221

Circuits II

Lecture 19

April 15, 2019

s^2



$$V_o(s) = \frac{-\frac{1}{2}}{s+10^3} + \frac{B}{s+j10^3} + \frac{C}{s-j10^3}$$

$$-\frac{1}{2}e^{-10^3 t} = -\frac{1}{2}e^{-\frac{t}{10^{-3}}}$$

$$V_o(s) = \frac{-\frac{1}{2}}{s+10^3} + \frac{B}{\cancel{s+j10^3}} + \frac{\cancel{C}}{\cancel{s-j10^3}}$$

$$\left| \begin{array}{l} s+j10^3 \\ s=-j10^3 \end{array} \right. \cancel{s+j10^3} = \frac{s \cdot 10^3}{(s+10^3)\cdot\cancel{(s+j10^3)}(s-j10^3)}$$

$$B = \frac{\cancel{-j10^3}}{(10^3-j\cancel{10^3})(\cancel{-j}\cdot 2\cancel{10^3})}$$

$$= \frac{1}{2(1-j)}$$

$$V_0(s) = \frac{5\cdot 10^3}{(s+10^3)(s+j10^3)\cancel{(s-j10^3)}}\Bigg|_{s=j10^3}$$

$$j\cdot 10^3 + j10^3$$

$$= \frac{C}{\cancel{s-j10^3}}$$

$$C = \frac{\cancel{j10^3}}{(j\cancel{10^3}+\cancel{10^3})(\cancel{j}\cdot 2\cdot \cancel{10^3})}$$

$$C = \frac{1}{2(1+j)}$$

$$V_o(s) = \frac{-\frac{1}{2}}{s+10^3} + \frac{\frac{1}{2(1-j)}}{s+j10^3} + \frac{\frac{1}{2(1+j)}}{s \pm j10^3}$$

$$v_o(t) = -\frac{1}{2}e^{-t/10^{-3}} + \frac{e^{-jt\cdot 10^3}}{(1+j)\,2(1-j)} + \frac{e^{jt10^3}}{2(1+j)}$$

$$= \frac{1}{2}\left[-e^{-t/10^{-3}} + \frac{(1+j)e^{-jt10^3}}{2} + \frac{(1-j)e^{jt\cdot 10^3}}{2}\right]$$

$$= \frac{1}{2}\left[-e^{-t/10^{-3}} + \frac{e^{-jt10^3} + e^{jt10^3}}{2} + j\cdot j\left(\frac{-e^{-jt10^3} + e^{jt10^3}}{2j}\right.\right.$$

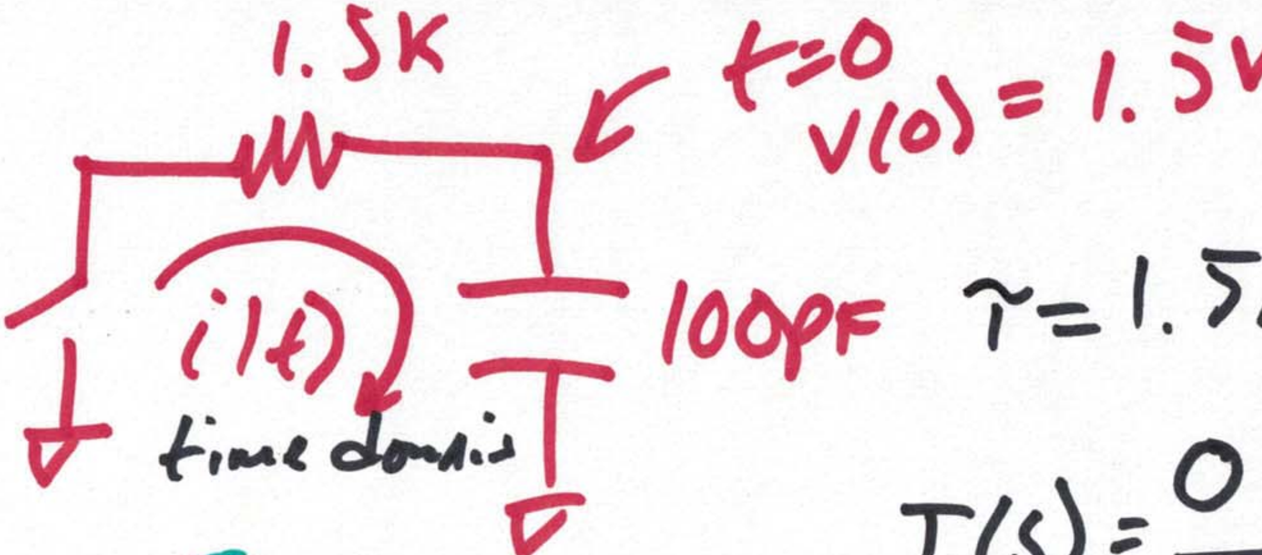
4)

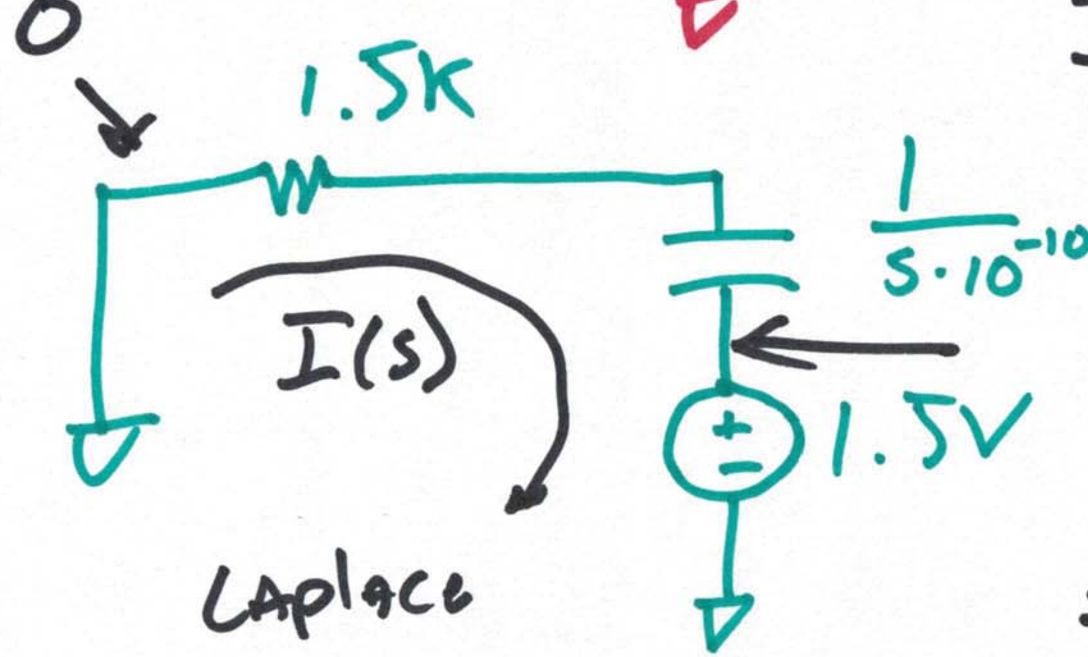
$$\frac{1}{2}\left[-e^{-t/10^{-3}} + \cos 10^3 t + \sin 10^3 t\right]$$

$$\cos x = \frac{e^{jx} + e^{-jx}}{2}$$

$$\sin x = \frac{e^{jx} - e^{-jx}}{2j}$$

$$v_0(t) = \frac{1}{2}\left[-e^{-t/10^{-3}} + \cos 10^3 t + \sin 10^3 t\right] u(t)$$





$$\tau = 1.5k\cdot 10^{-10}$$

$$I(s) = \frac{0 - 1.5\cdot\frac{1}{s}}{1.5k + \frac{1}{s\cdot 10^{-10}}}$$

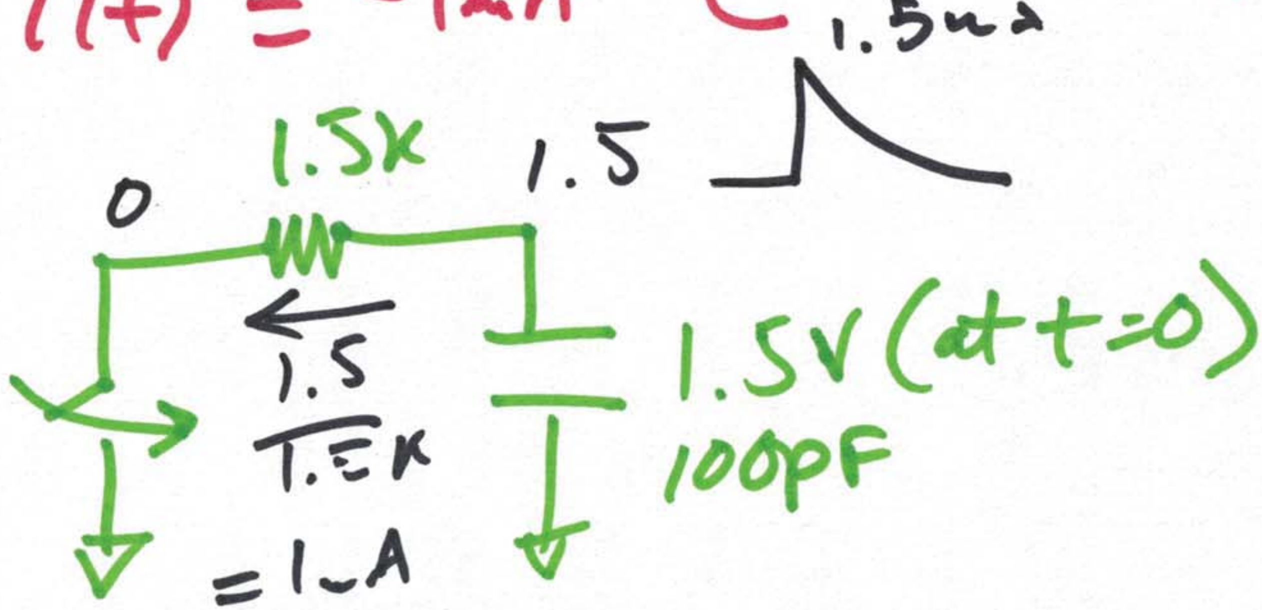
$$= \frac{-1.5\cdot\cancel{s}\cdot 10^{-10}}{1.5k\cdot s\cdot 10^{-10} + 1}$$

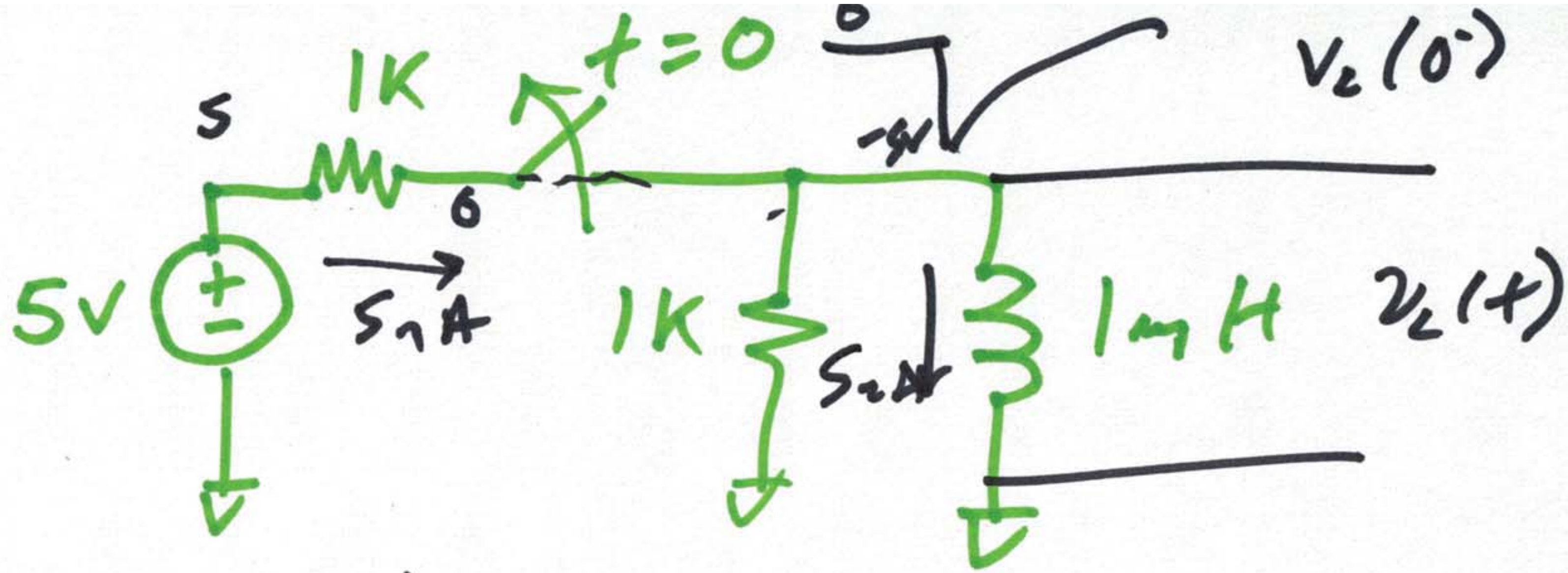
$$= \frac{-\cancel{1.5\cdot 10^{-10}}\cdot\cancel{s}}{\cancel{1.5}K\cdot\cancel{10^{-10}}}$$

$$\frac{\quad}{s + \frac{1}{1.5K\cdot 10^{-10}}}$$

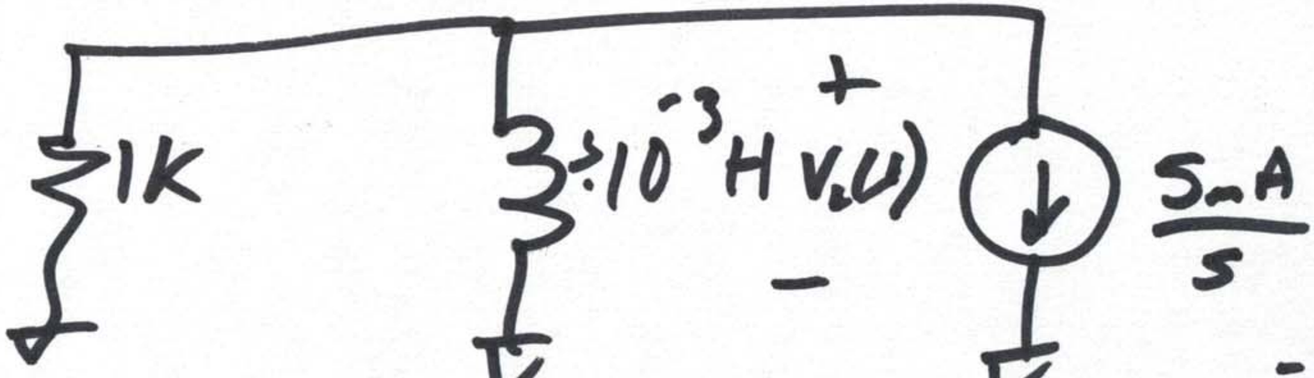
$$I(s) = \frac{-10^{-3} \cdot \cancel{s}}{s + \frac{1}{1.5k \cdot 10^{-10}}}$$

$$i(t) = -1mA \; e^{-\frac{t}{1.5k \cdot 10^{-10}}} \cdot u(t)$$





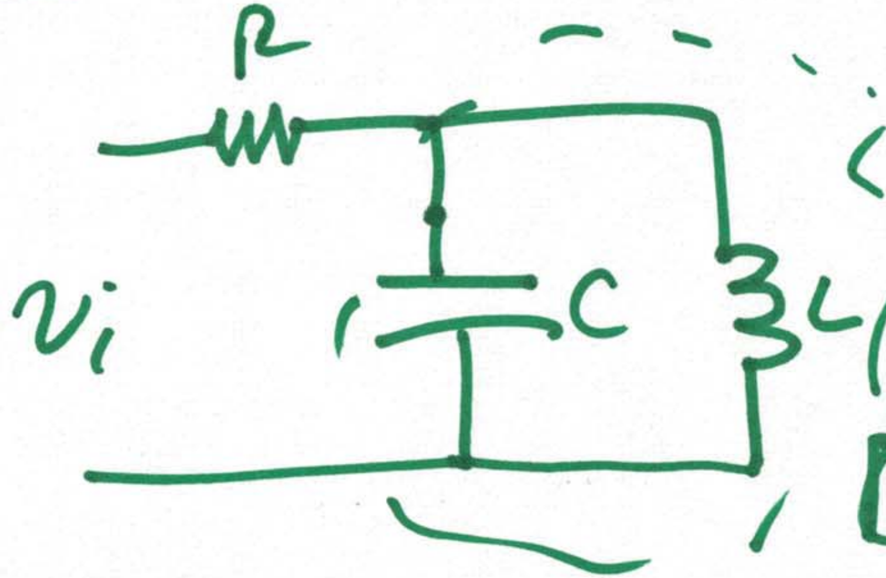
Laplace



$$V_L(s) = -\frac{5mA}{\cancel{s}} \cdot \frac{10^3 \cdot 10^{-3} \cdot \cancel{s}}{10^3 + 10^{-3} \cdot s}$$

$$V_L(s) = -5mA \cdot \frac{10^3}{s + 10^6}$$

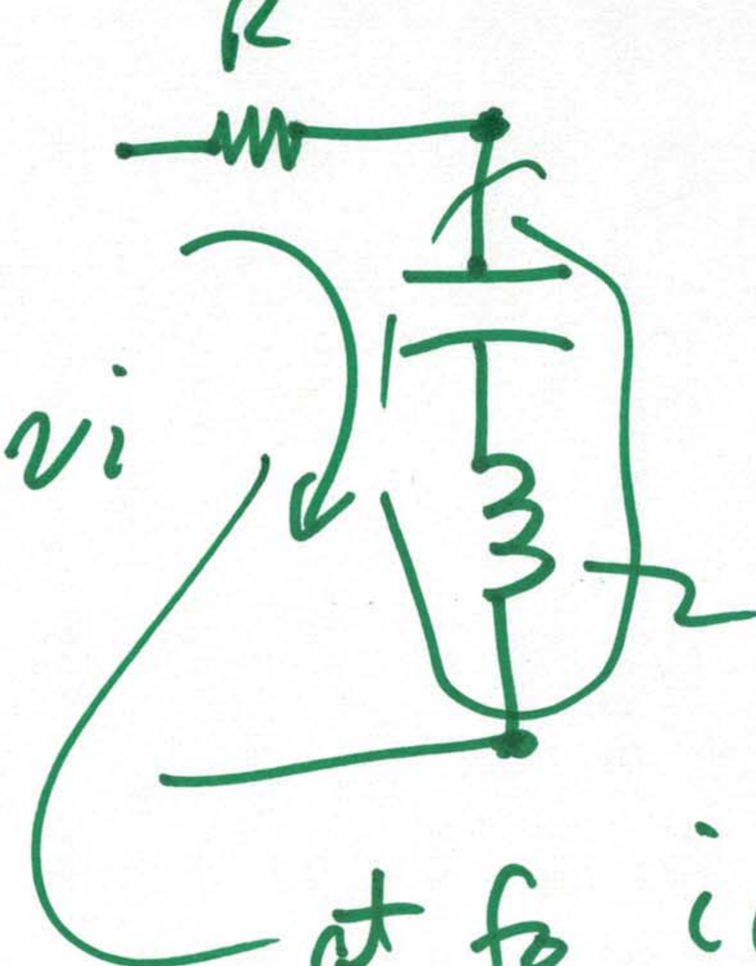
$$v_L(t) = -5mA \cdot 1K \cdot e^{-t/10^{-6}} \cdot u(t)$$



$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

Resonance

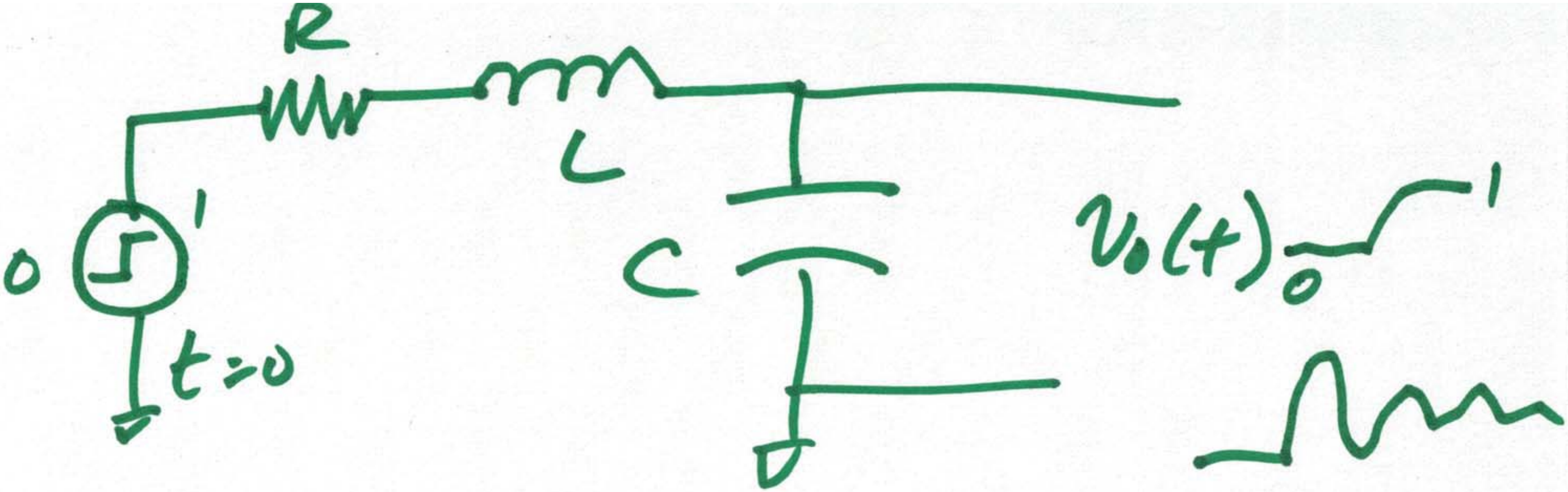
Open

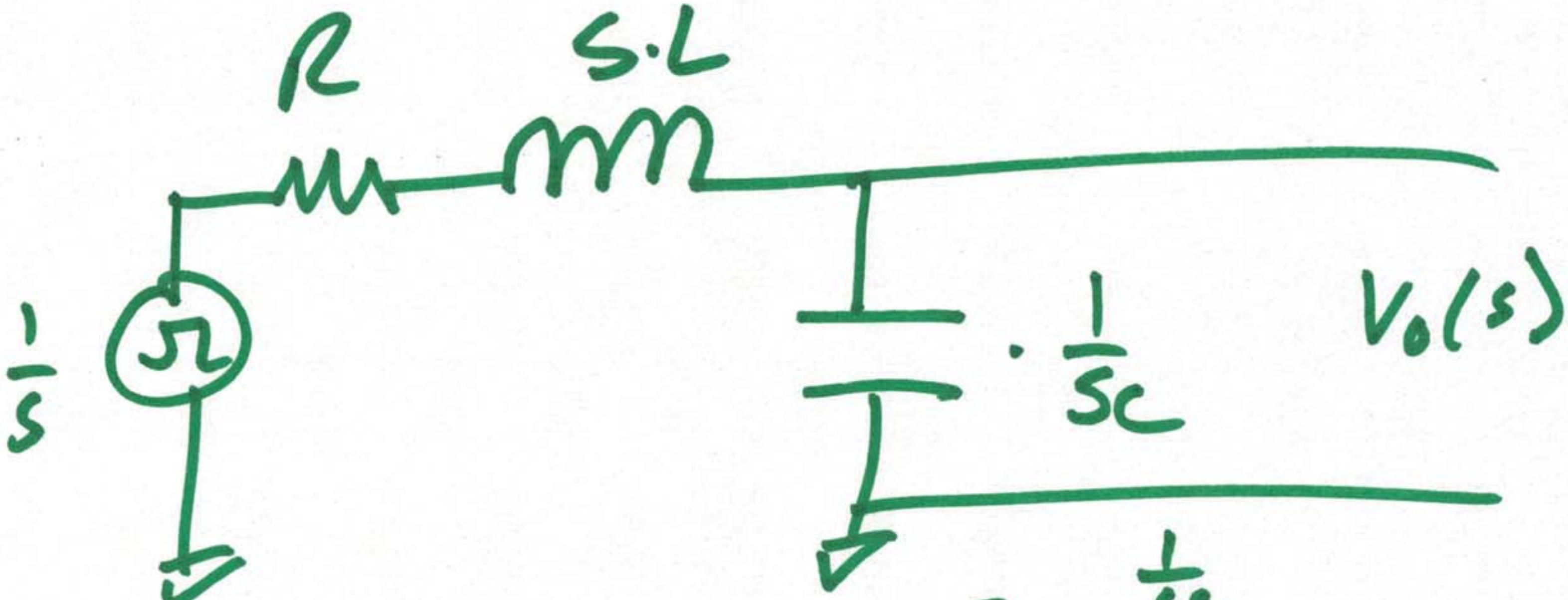


short

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

at f_0 $\quad i(t) = \frac{v_i(t)}{R}$





$$= \frac{\frac{1}{sC}}{\frac{1}{sC} + sL + R}$$

$$V_o(s) = \frac{1}{s} \cdot \frac{\frac{1}{sC}}{\frac{1}{sC} + sL + R}$$

$$= \frac{1}{s} \cdot \frac{1}{s^2LC + sRC + 1}$$

$$= \frac{1}{s} \cdot \frac{\frac{1}{LC}}{s^2 + s\frac{R}{L} + \frac{1}{LC}}$$

$$s_{1,2} = \frac{-\frac{R}{L} \pm \sqrt{\frac{R^2}{L^2} - 4/LC}}{2}$$

$$V_0(s) = \frac{\frac{1}{LC}}{s} \cdot \frac{1}{(s+s_1)(s+s_2)}$$

$$s_{1,2} = \frac{-\frac{R}{L} \pm \sqrt{\frac{R^2}{L^2} - \frac{4}{LC}}}{2}$$

$$\frac{4}{LC} > \frac{R^2}{L^2} \quad (\text{imaginary})$$

$$< \quad (\text{Real})$$