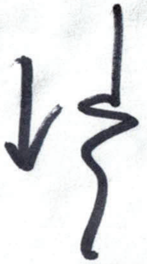
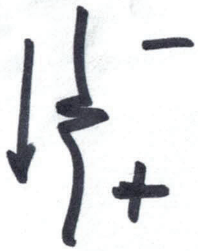
EE 221 Circuits II

March 29, 2023

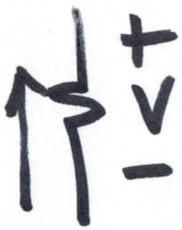
Lecture 17



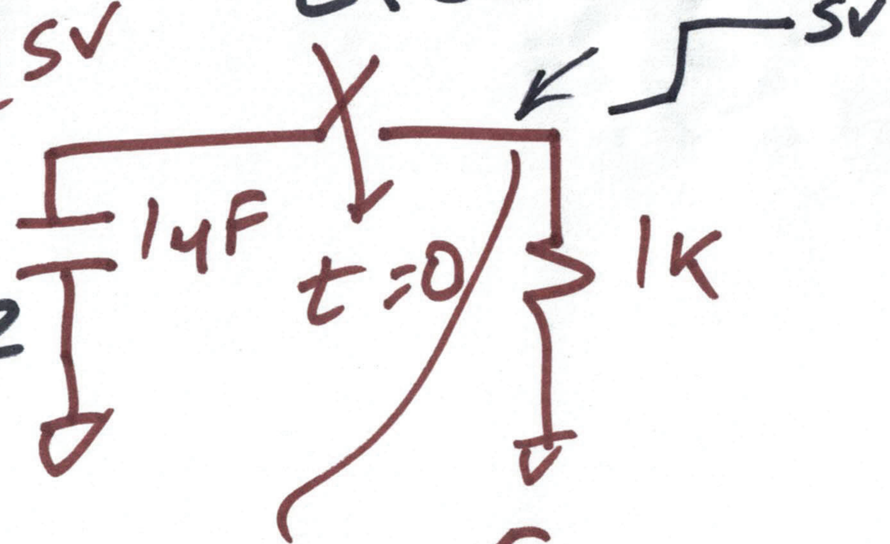
$v = IR$



$v = -IR$



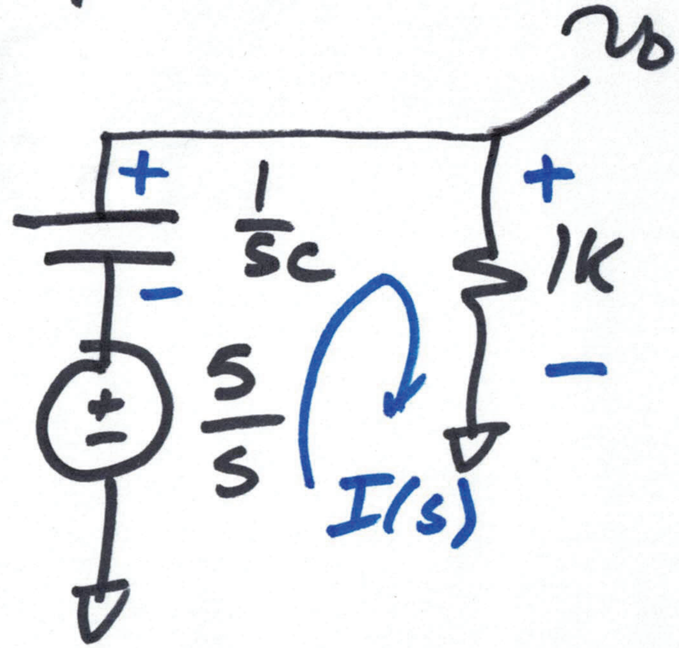
$v = -IR$



$v_i = 5$

$v_f = 0$

$v_o = 5e^{-t/1\mu s} \quad t > 0$



$$\frac{5}{s} + I(s)\cdot\frac{1}{sC} - 1K\cdot I(s) = 0$$

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$$\frac{5}{s} - I(s)\cdot\frac{1}{sC} - 1k\,I(s) = 0$$

$$\frac{5}{s} + I(s)\left(\frac{-1}{sC} - 1k\right) = 0$$

$$I(s) = \frac{+\frac{5}{s}}{\frac{1}{s\,1\mu} + 1K}$$

$$I(s) = \frac{5}{\frac{1}{1\mu} + s\cdot 1K}\cdot\frac{\frac{1}{1K}}{\frac{1}{1K}}$$

$$= \frac{5\,mA}{s + \frac{1}{1m}}$$

$$I(s) = \frac{5\text{mA}}{s + \frac{1}{1\text{m}}}$$

$$i(t) = 5\text{mA}\, e^{-t/\text{m}}\, u(t)$$

$$v_0 = 1\text{k} \cdot i(t)$$

$$v_0(t) = 5 e^{-t/1\text{ms}}\, u(t)$$

$$K\int e^{x}\cdot dx = Ke^{x}$$

$$\int e^{-at}\cdot dt$$

let $dx = \frac{d}{}(-at)$

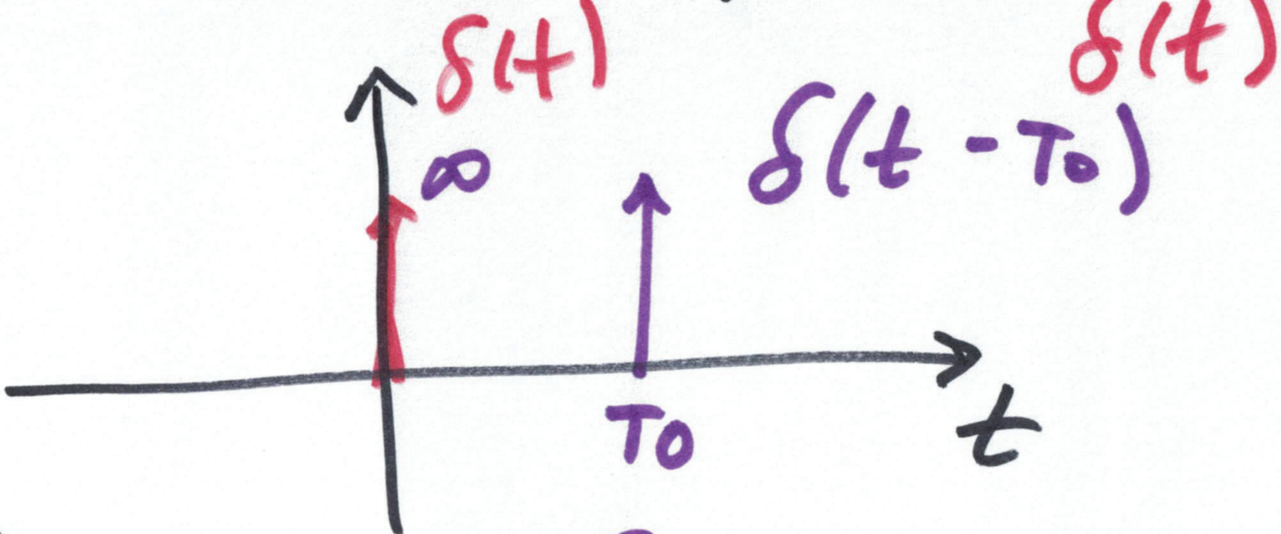
$$dx = -a\cdot dt$$

$$dt = -\frac{1}{a}\,dx$$

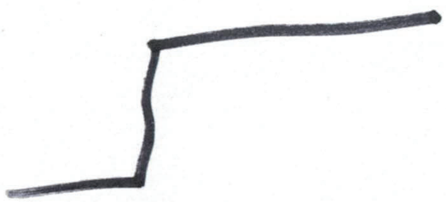
$$-\frac{1}{a}\int e^{x}dx = -\frac{1}{a}e^{x} \rightarrow x=-at$$

$$= -\frac{1}{a}e^{-at}$$

Unit impulse function



$u(t)$



$$\int_{-\infty}^{\infty} \delta(t) \cdot dt = 1$$

$$\frac{du(t)}{dt} = \delta(t)$$

Sampling property

$$\int_{-\infty}^{\infty} x(t)\cdot\delta(t-T)\cdot dt$$

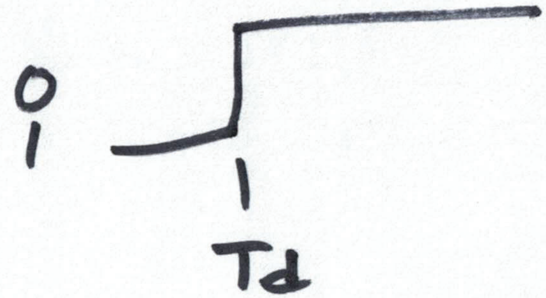
$$= x(T)$$

$$\mathcal{L}\{f(t)\} = \int_{0^-}^{\infty} f(t)\cdot e^{-st}\cdot dt$$

$$\mathcal{L}\{u(t)\} = \int_{0^-}^{\infty} e^{-st}\cdot dt = \frac{-1}{s}e^{-st}\Big|_0^{\infty}$$

$$\frac{1}{s} = -\frac{1}{s}\left(\cancel{e^{-\infty}}^{\,0} - \cancel{e^{0}}^{\,1}\right)$$

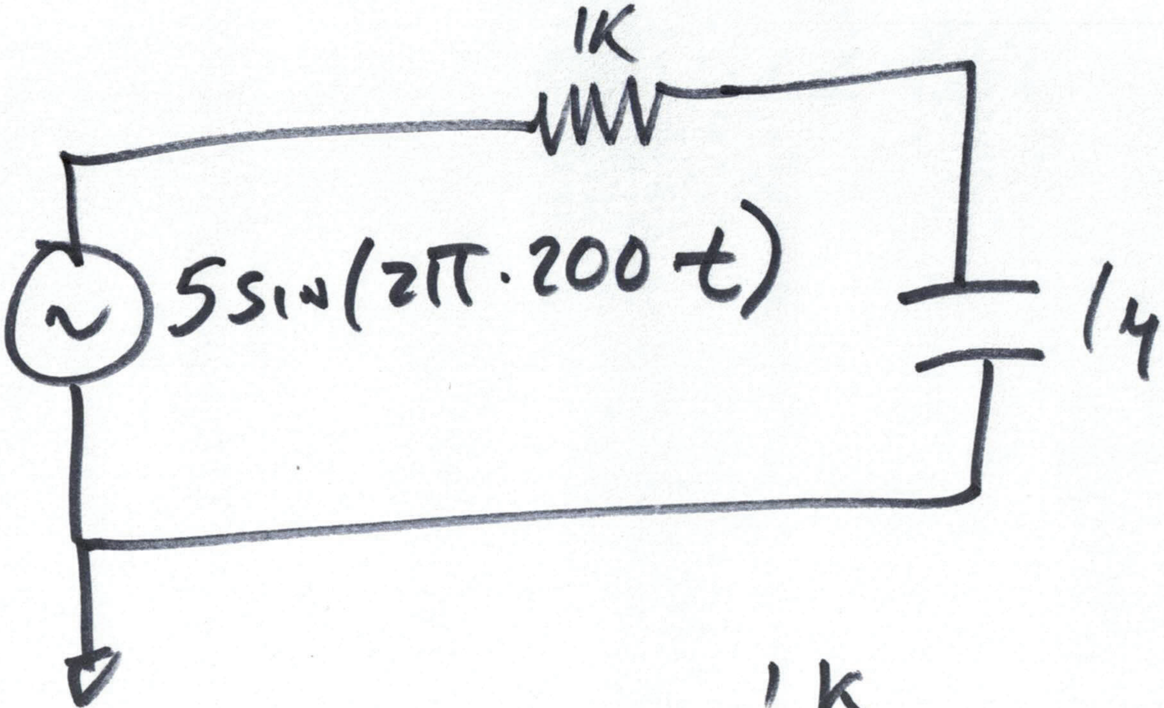
$u(t - T_d)$

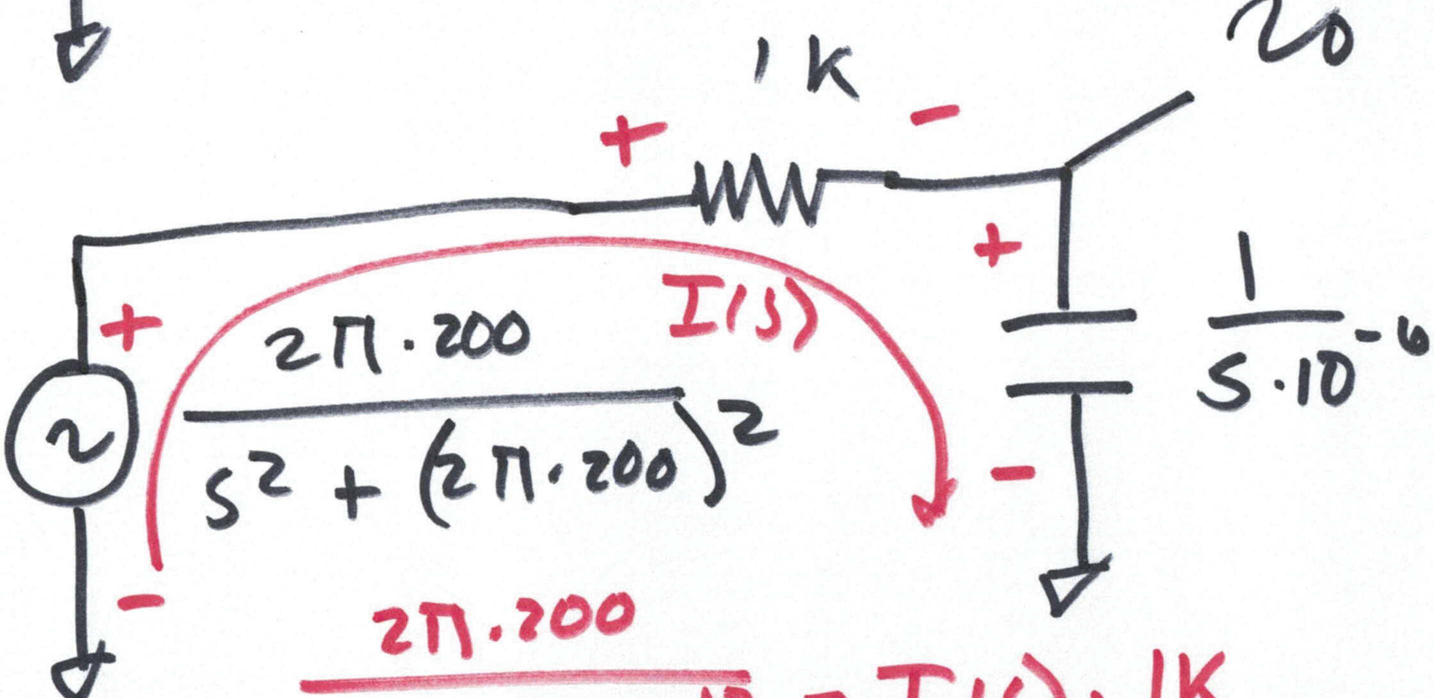


$$\mathcal{L}\{u(t - T_d)\} = \int_{0^-}^{\infty} u(t - T_d) e^{-st} \cdot dt$$

$$= \int_{T_d}^{\infty} e^{-st} \cdot dt = \frac{-1}{s} e^{-st} \Big|_{T_d}^{\infty}$$

$$\mathcal{L}\{u(t - T_d)\} = \frac{e^{-sT_d}}{s} = -\frac{1}{s}\left(\cancel{e^{-\infty}}^{\,0} - e^{-sT_d}\right)$$





$$\frac{2\pi\cdot 200}{s^2+(2\pi\cdot 200)^2} - I(s)\cdot 1K$$

$$v_o = \frac{2\pi \cdot 200}{s^2 + (2\pi \cdot 200)^2} \cdot \frac{\frac{1}{s \cdot 10^{-6}}}{\frac{1}{s \cdot 10^{-6}} + 1k}$$

$$= \frac{2\pi \cdot 200}{s^2 + (2\pi \cdot 200)^2} \cdot \frac{1}{10^{-3} \cdot s + 1}$$

$$= \frac{2\pi \cdot 200}{10^{-3}} \cdot \frac{1}{s^2 + (2\pi \cdot 200)^2} \cdot \frac{1}{s + 10^3}$$

$$s = \frac{\pm\sqrt{-4(2\pi \cdot 200)^2}}{2} = \frac{\pm j\, 4\pi \cdot 200}{2}$$

$$= \pm j\, 2\pi \cdot 200$$

$$V_o(s) = \frac{2\pi\cdot 200}{10^{-3}} \cdot \frac{1}{(s+j2\pi\cdot 200)(s-j2\pi\cdot 200)\cdot(s+10^3)}$$

partial fraction expansion

$$= \frac{A}{s+j2\pi\cdot 200} + \frac{B}{s-j2\pi\cdot 200} + \frac{C}{s+10^3}$$

$$\cancelto{0}{\frac{A\cdot(\overset{-10^3}{s}+10^3)}{s+j2\pi\cdot 200}} + \cancelto{0}{\frac{B(\overset{-10^3}{s}+10^3)}{s-j2\pi\cdot 200}} + C$$

$$C = \frac{2\pi\cdot 200}{10^{-3}} \cdot \frac{1}{\underset{10^6}{s^2} + (2\pi\cdot 200)^2}$$

$$C = \frac{2\pi \cdot 200}{10^{-3} \cdot \left(10^6 + (2\pi \cdot 200)^2\right)}$$

$$A = \left.\frac{2\pi \cdot 200}{10^{-3}} \cdot \frac{1}{(s - j2\pi \cdot 200)(s + 10^3)}\right|_{s = -j2\pi 200}$$

$$A = \frac{2\pi \cdot 200}{10^{-3}} \cdot \frac{1}{(-j4\pi \cdot 200)(-j2\pi 200 + 10^3)}$$

$$B = \frac{2\pi \cdot 200}{10^{-3}} \cdot \frac{1}{(j4\pi 200) \cdot (j2\pi 200 + 10^3)}$$

$$\frac{1}{s^2} \rightarrow \frac{A}{s} \cdot s^2 + \frac{B}{s^2} \cdot s^2$$

$$\frac{A}{s} \cdot s + \frac{B \cdot \cancel{s}}{s\cancel{^2}}$$