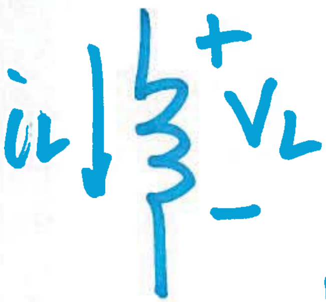
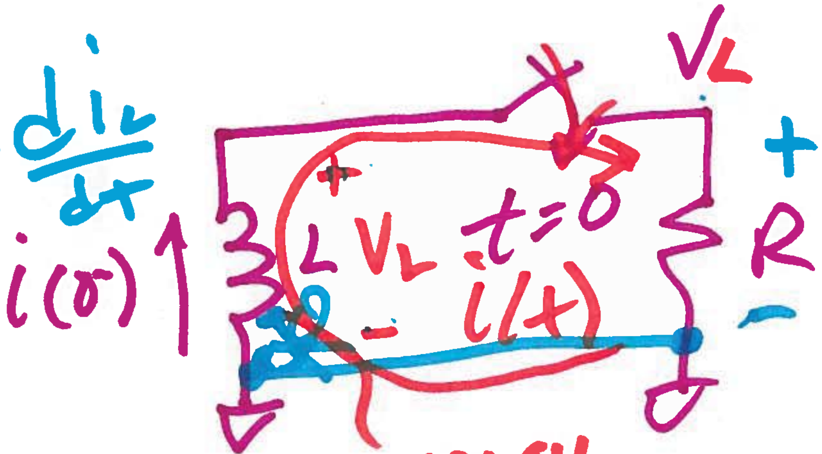
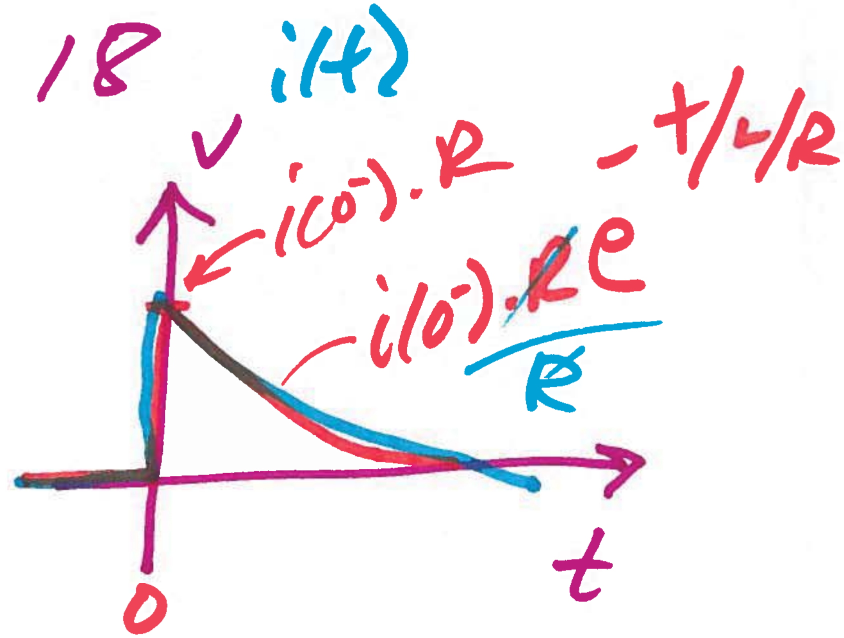
EE 220
Circuits I
Lecture 18



$$v_L = L \cdot \frac{di_L}{dt}$$



energy (magnetic flux)



$$v = L \frac{di}{dt}$$

$$\int_a^b \frac{dx}{x} = \ln x \Big|_a^b$$

$$= \ln b - \ln a$$

$$= \ln \frac{b}{a}$$

$$V_L - i \cdot R = 0$$

$$-L \cdot \frac{di}{dt} - i \cdot R = 0$$

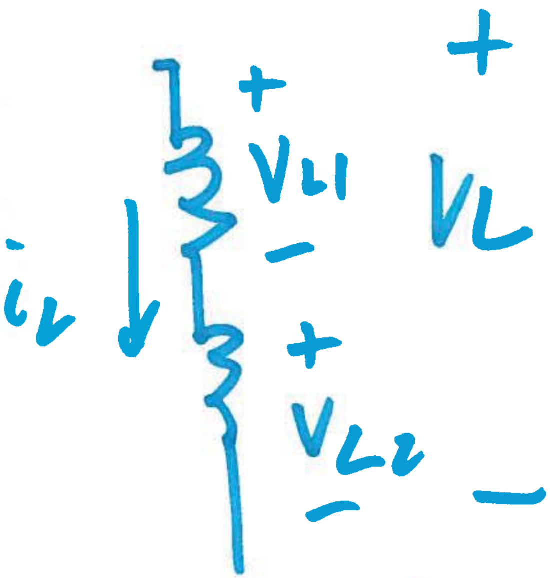
$$-L \cdot \frac{di}{dt} = i \cdot R$$

$$\int_{i(0^-)}^{i(t)} (-L) \cdot \frac{di}{i} = \int_0^t R \cdot dt = R \cdot t$$

$$(-L)\left(\ln i(t) - \ln i(0^-)\right) \Rightarrow -L \cdot \ln \frac{i(t)}{i(0^-)}$$

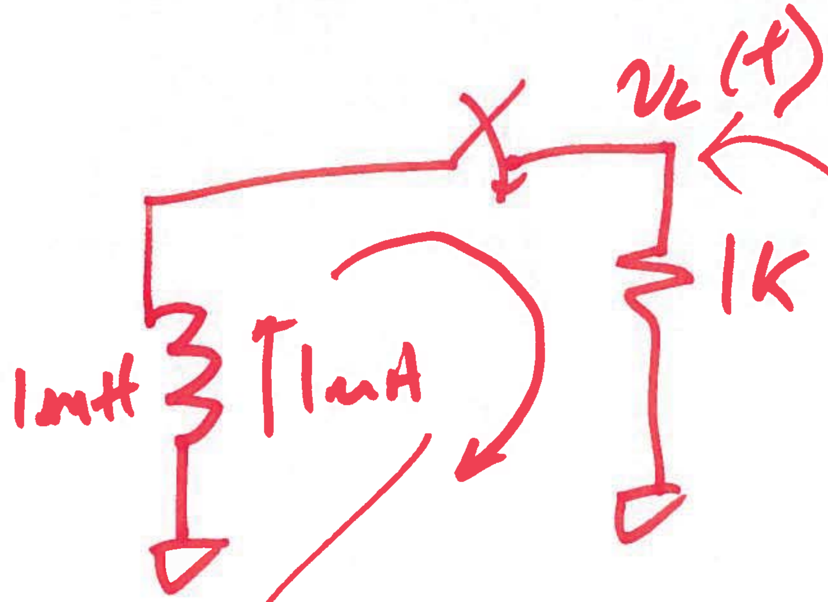
$$-L\cdot \ln\frac{i(t)}{i(0^-)} = R\cdot t$$

$$e^{\ln x} = x \qquad \ln\frac{i(t)}{i(0^-)} = -\frac{R}{L}\cdot t = \frac{-t}{L/R}$$



$$\boxed{i(t) = i(0^-)\cdot e^{-t/L/R}}$$

$$i = L\cdot\frac{dv}{dt} \qquad \frac{1}{i_T} = \frac{1}{i_{L1}} + \frac{1}{i_{L2}}$$

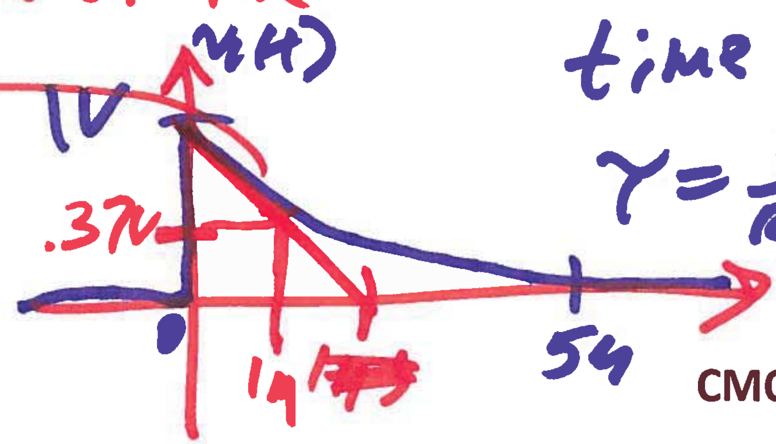


$$v = L \cdot \frac{di}{dt}$$

$$i(t) = 1mA\, e^{-t/\frac{10^{-3}H}{10^{3}\Omega}} = 1mA\, e^{-t/1\mu s}$$

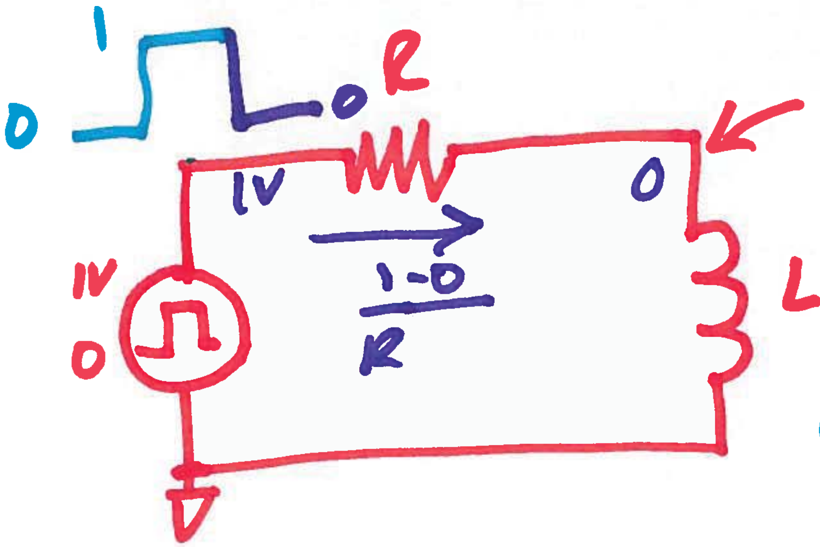
$$v_L(t) = i(t) \cdot 1K = 1V e^{-t/1\mu s}$$

Gone down 63% in one τ



time constant

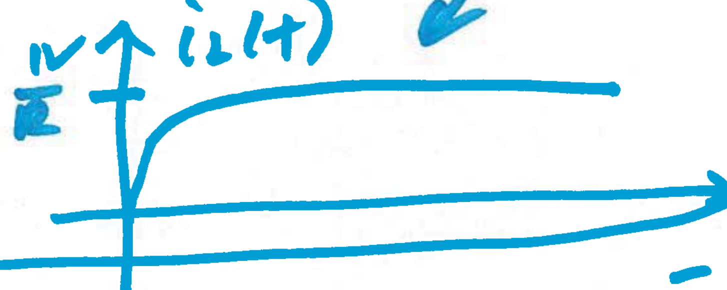
$\tau = \frac{L}{R} = 1\mu s$



$$V_L(t) = 1V\, e^{-t/L/R}$$

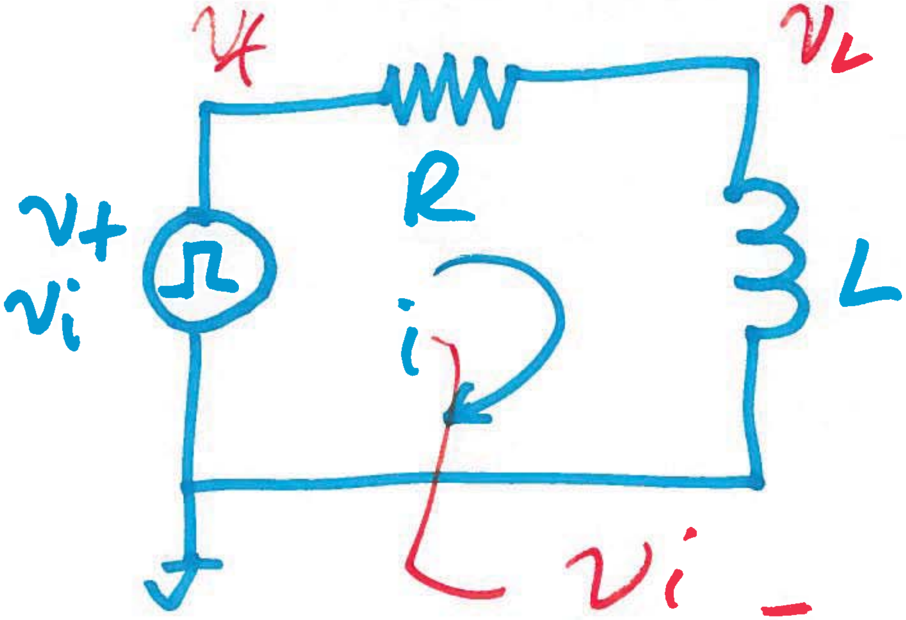
$$i_L(t) = \frac{1 - V_L(t)}{R} = \frac{1 - 1e^{-t/L/R}}{R}$$

$$\lim_{x\to\infty} e^{-x} = \lim_{x\to\infty} \frac{1}{e^x} \to 0 = \frac{1}{R}\cdot\left(1 - e^{-t/L/R}\right)$$



$$x(t) = x_f + (x_i - x_f)\, e^{-t/\tau}$$

$$0 \qquad (1-0)\, e^{-t/\tau}$$



$$\tau = \frac{L}{R}$$

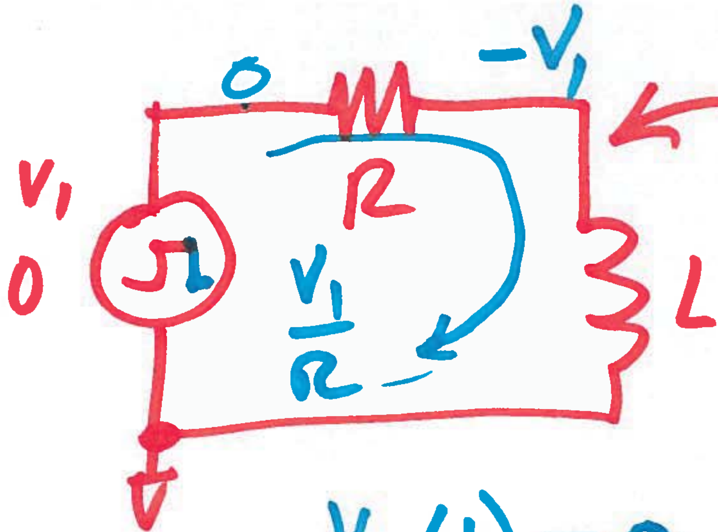
OR

$$\tau = RC$$

$$\frac{v_i}{\cancel{R}} = \frac{v_f - v_L}{\cancel{R}}$$

$$v_L = v_f - v_i$$

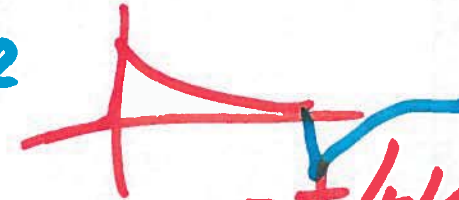
$$\boxed{x(t) = x_f + (x_i - x_f)e^{-t/\tau}}$$

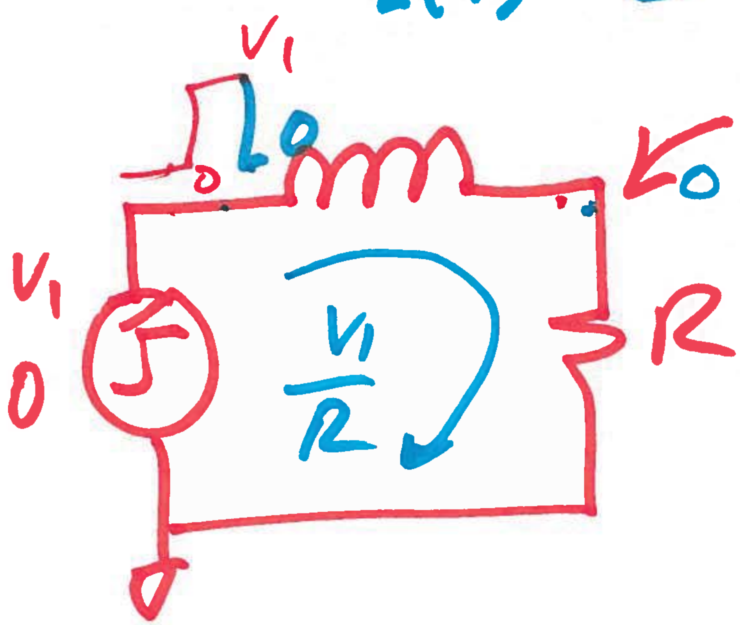


$$V_L(t) = V_f + (V_i - V_f)e^{-t/L/R}$$

$$= 0 + (V_1 - 0)e^{-t/L/R}$$

$$V_L(t) = 0 + (-V_1 - 0)e^{-t/L/R}$$





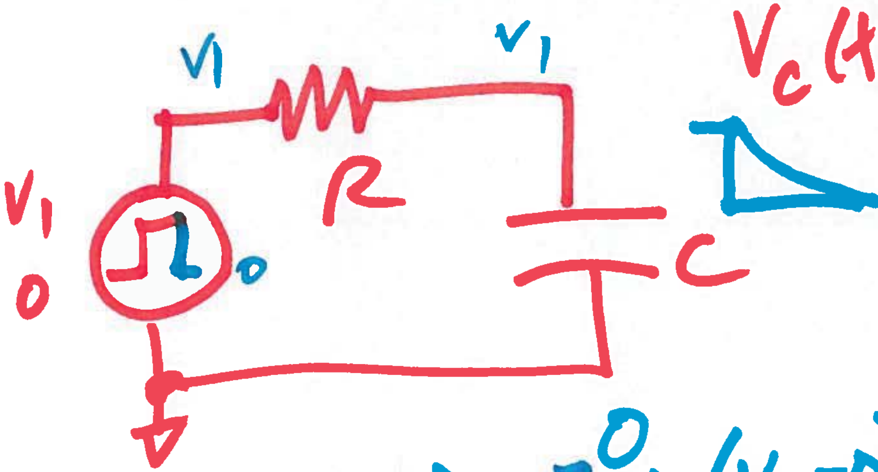
$$V_L(t) = V_f + (V_i - V_f)e^{-t/L/R}$$

$$= V_1 + (0 - V_1)e^{-t/L/R}$$

$$= V_1(1 - e^{-t/\tau})$$

$$V_L(t) = 0 + (V_1 - 0)e^{-t/L/R}$$

$$= V_1 e^{-t/L/R}$$



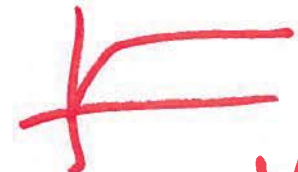
$$V_c(t) = V_f + (V_i - V_f)e^{-t/RC}$$

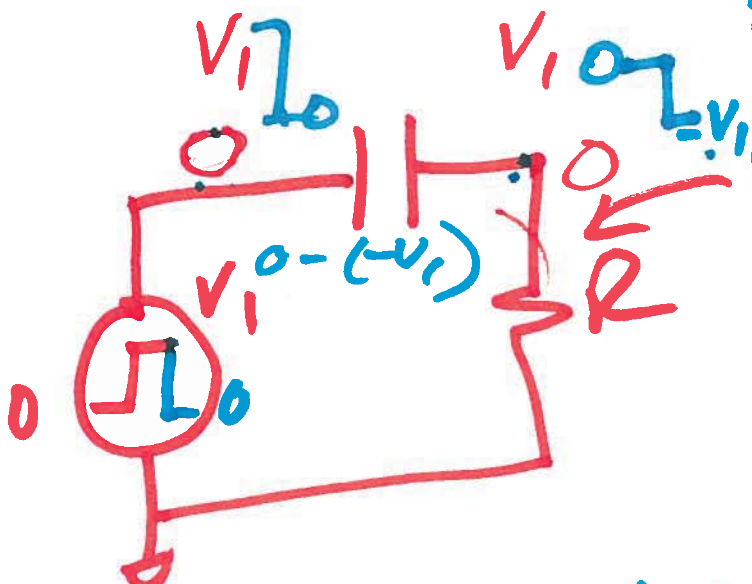
$$= V_1 + (0 - V_1)e^{-t/RC}$$

$$= V_1(1 - e^{-t/RC})$$

$$v_r(t) = 0 + (V_1 - 0)e^{-t/RC}$$

$$= V_1 e^{-t/RC}$$





$$V_R(t) = V_f + (V_i - V_f)e^{-t/RC}$$

$$= 0 + (V_1 - 0)e^{-t/RC}$$

$$V_R(t) = V_1 e^{-t/RC}$$

$$V_c(t) = 0 + (-V_1 + 0)e^{-t/RC}$$

$$= V_R(t) = -V_1 e^{-t/RC}$$