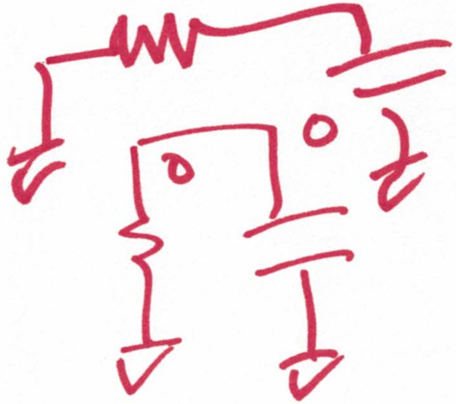
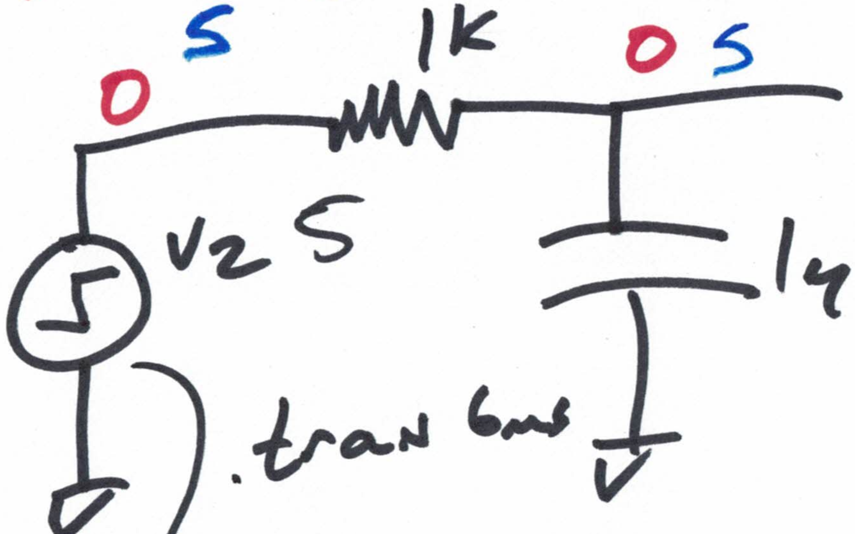
EE220 Circuits I
Lecture 17
OCTOBER 30, 2023



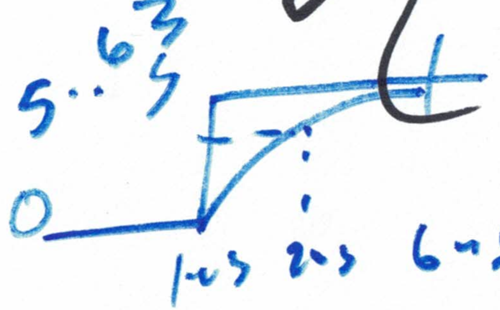


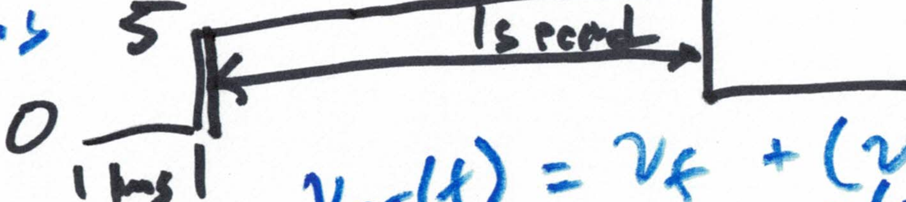
$$\tau = RC = 1ms = 10^{3} \cdot 10^{-6}$$

$v_i = 0$

$v_f = 5$

pulse(0 5 1ms 1μ 1μ 1 1)

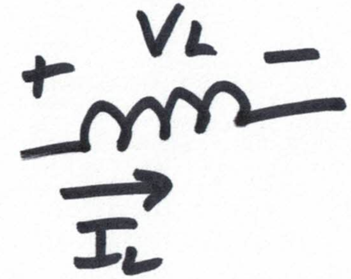


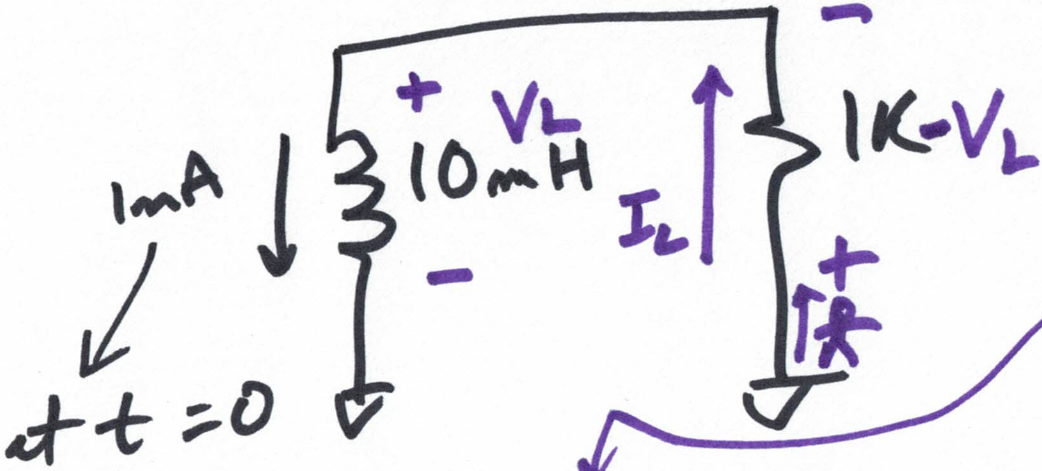


$$v_{out}(t) = v_f + (v_i - v_f)e^{-t/RC}$$

$$= 5 - 5e^{-(t-1ms)/1ms} \quad t \geq 1ms$$

$$= 5(1 - e^{-(t-1ms)/1ms}) \quad t \geq 1ms$$





$$V_L = L \cdot \frac{dI_L}{dt}$$

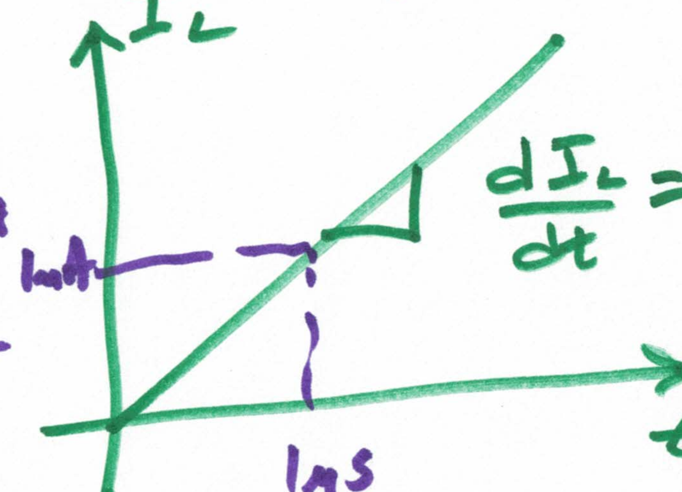
$$-I_L \cdot 1K - V_L = 0$$

$$I_L \cdot R + L \cdot \frac{dI_L}{dt} = 0$$

$$I_L = -\frac{L}{R} \cdot \frac{dI_L}{dt}$$

$$-\frac{R}{L} \cdot dt = \frac{dI_L}{I_2}$$

$$\frac{V_L}{L} = \frac{1}{1mH} = \frac{1\,A}{ms} = \frac{1mA}{\mu s}$$



$$\frac{dI_L}{dt} = \frac{V_L}{L}$$

$$\int_{t_{init}}^{t} \frac{dt}{-\frac{L}{R}} = \int_{I_{init}}^{i(t)} \frac{dI_L}{I_L}$$

$$-\frac{R}{L} \cdot dt = -\frac{R \cdot dt}{L} = \frac{R \cdot dt \cdot \frac{1}{R}}{-L \cdot \frac{1}{R}} = \frac{dt}{-\frac{L}{R}} = \frac{dt}{L/R}$$

$$\frac{t}{-\frac{L}{R}} \Bigg|_{t_{init}}^{t} = \ln I_L \Bigg|_{I_{init}}^{i(t)}$$

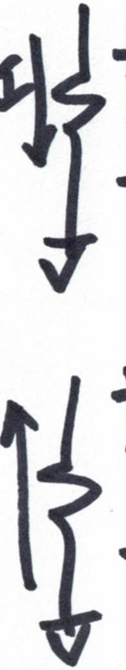
$$\frac{-(t - t_{init})}{\tau} = \ln i(t) - \ln I_{init}$$

$$e^{\frac{-(t-t_{init})}{\tau}} = e^{\ln \frac{i(t)}{I_{init}}}$$

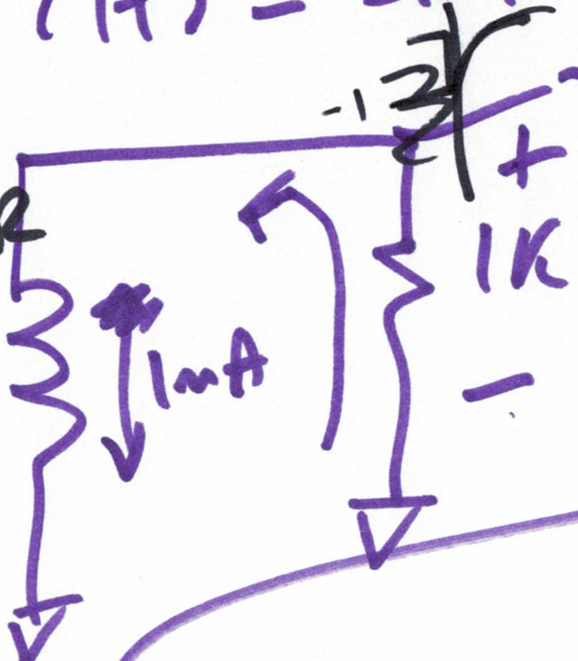
$$\tau = \frac{L}{R}$$

$$e^{-(t-t_{init})} = \frac{i(t)}{I_{init}}$$

$$t \geq t_{init}$$



$$i(t) = I_{init}\, e^{-\frac{(t - t_{init})}{L/R}}, \quad t \geq t_{init}$$



$$I_{init} = 1\text{mA}$$

$$\frac{L}{R} = \frac{10\text{mH} \cdot 10^{-3}}{1\text{K} \cdot 10^{-3}} = 10\text{ms}$$

$$10^{3} \cdot 10^{-3} = 10^{3-3} = 10^{0} = 1$$

$$i(t) = 1\text{mA} \cdot e^{-\frac{(t - 1\text{ms})}{10\text{ms}}}, \quad t \geq 1\text{ms}$$

$$v_{NT} = -1\text{K} \cdot i(t) = -1\text{V}\, e^{-\frac{(t-1\text{ms})}{10\text{ms}}}$$

$$i(t) = i_f + (i_i - i_f)\, e^{-t/(L/R)}$$

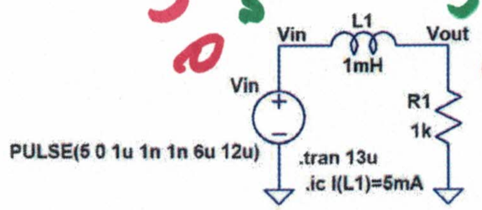
Quiz #13 EE 220 Fall 2022 Name: $= v_f + (v_i - v_f)e^{-t/L/R}$

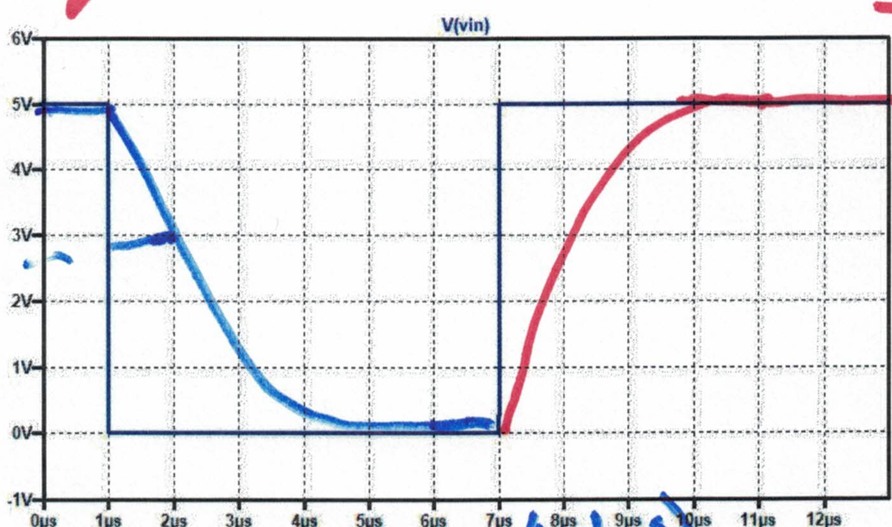
Closed book and notes.

Show your work for credit!

$L/R = \frac{1m}{1k} = 1\mu s$

1. Plot Vout for the following circuit on the plot seen below for both transitions of the input pulse. Write equations for both edges as well. Do not derive the equations, simply write them. (5 points)



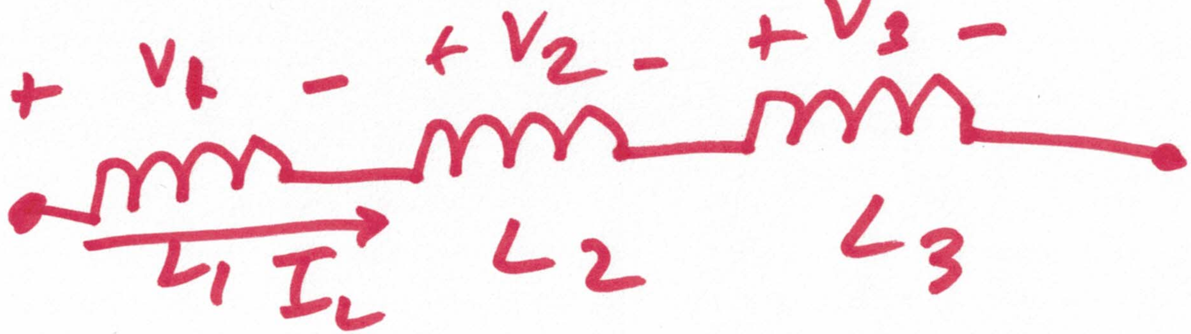


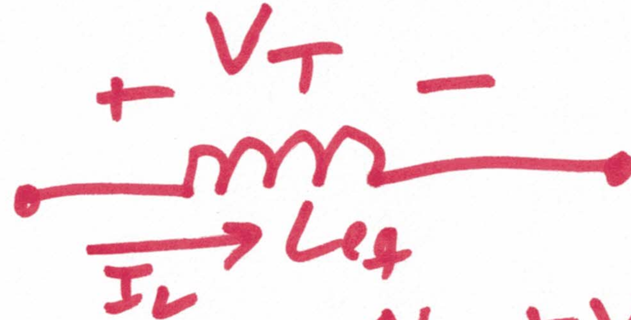
$5 \cdot .37$

$V_{out}\big|_{falling} = 5e^{-\frac{(t-1\mu s)}{1\mu s}}, \quad t \geq 1\mu s, \; t \leq 7\mu s$

$V_{out}\big|_{rising} = 5 + (0-5)e^{-(t-7\mu s)/1\mu s}, \quad t \geq 7\mu s$

5)





$$V_T = V_1 + V_2 + V_3$$

$$V_1 = L_1 \frac{dI_L}{dt}, V_2 = L_2 \frac{dI_L}{dt}$$

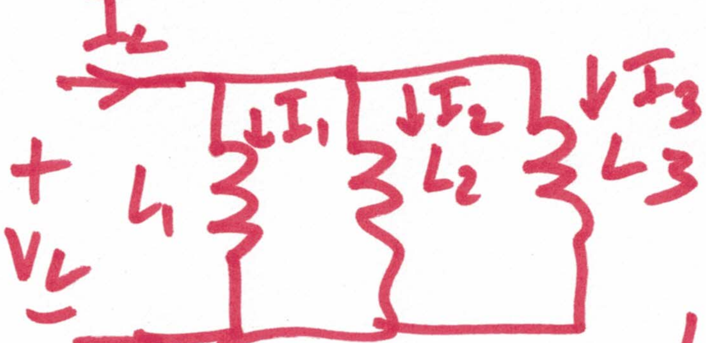
$$V_3 = L_3 \frac{dI_L}{dt}$$

$$V_T = V_1 + V_2 + V_3$$

$$= \underbrace{(L_1 + L_2 + L_3)}_{L_{eq}} \frac{dI_L}{dt}$$

$$V_L = L \cdot \frac{dI_L}{dt}$$

$$I_L = \frac{1}{L}\int V_L \cdot dt$$



$$I_L = I_1 + I_2 + I_3$$

$$= \frac{1}{L_1}\int V_L \cdot dt + \frac{1}{L_2}\int V_L \cdot dt + \frac{1}{L_3}\int V_L \cdot dt$$

$$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$$

$$\frac{1}{L_{eq}}\int V_L\, dt = \left(\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}\right)\int V_L \cdot dt$$