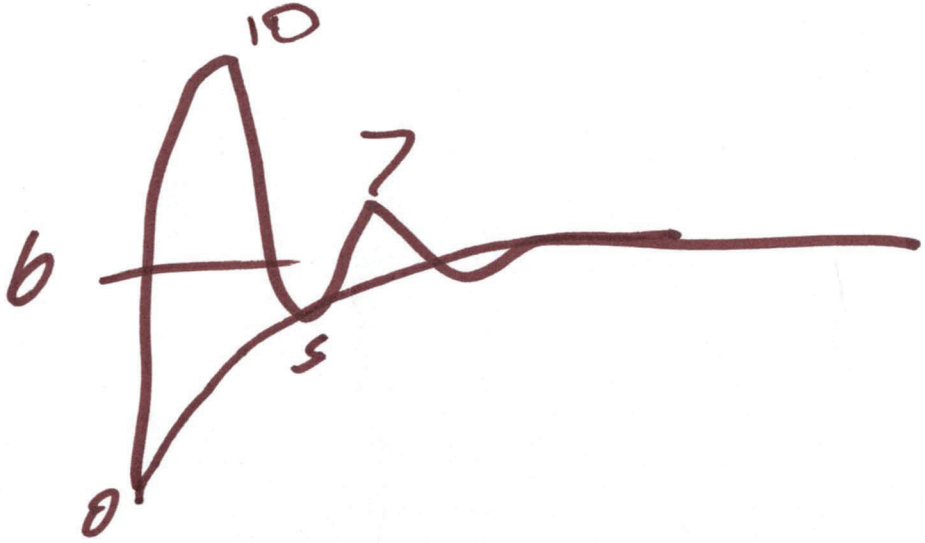
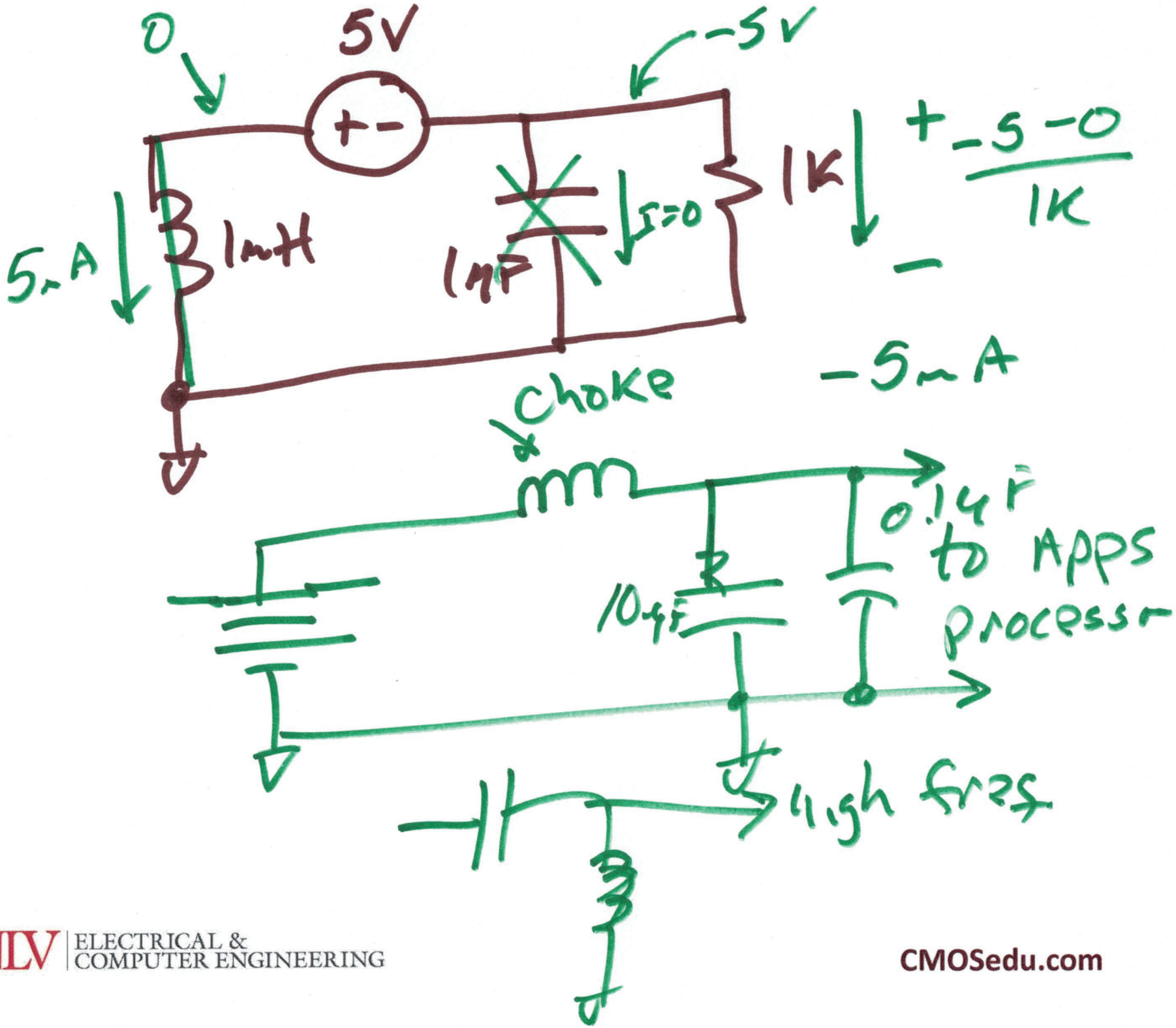
EE 220 Circuits I

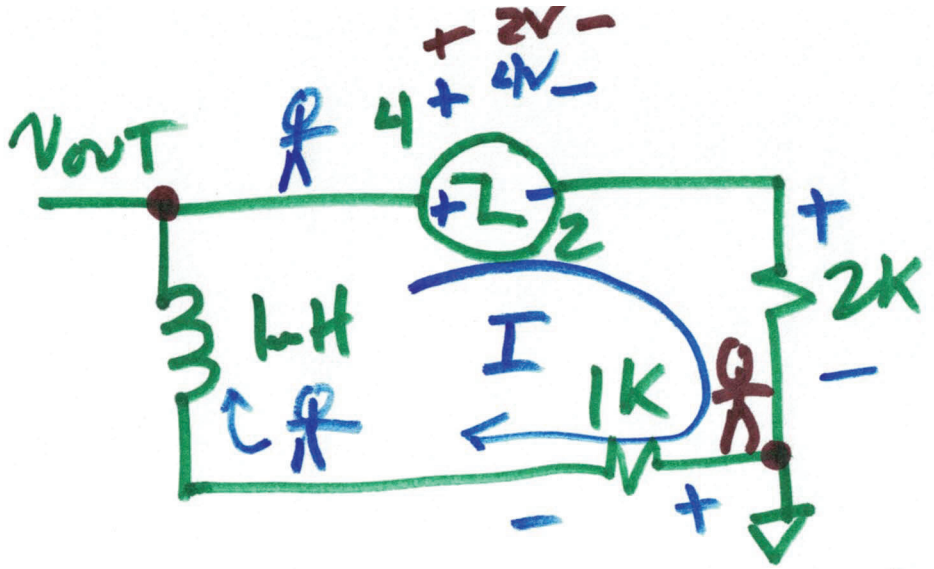
Nov. 1, 2023

Lecture 18

first-order response




0
5V
-5V
+-
1mH
5mA
1μF
t=0
1K
+-5-0
1K
-
-5mA
choke
0.1μF
to Apps
processor
10μF
high freq



$V_{OUT} = ?$

$\tau = \frac{L}{R} = \frac{1mH}{1K+2K} = \frac{1}{3}\frac{m}{K}\cdot 10$

$-4 - 2K I_I - 1K I_I = 0$

$-3K I_I = 4V = \frac{1}{3}4S$

$i_i = \frac{-4}{3}mA$

$i_i = -1.33mA$

$i_f = -\frac{2}{3}mA$

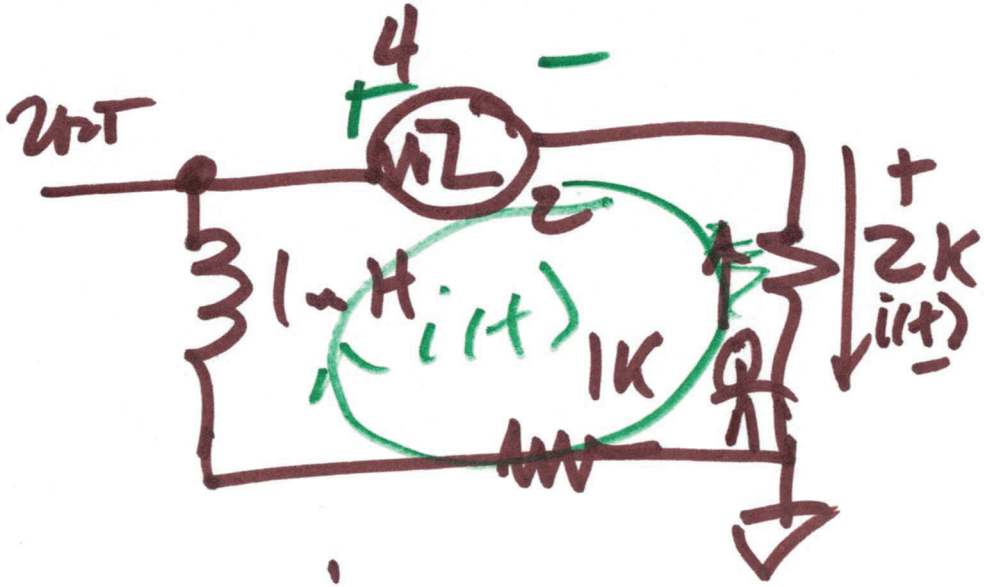
$i(t) = i_f + (i_i - i_f)e^{-t/4R}$

$= -\frac{2}{3} + (-1\frac{1}{3} + \frac{2}{3})e^{-t/1/34}$ mA

$= -\frac{2}{3}mA - \frac{2}{3}mA\,e^{-t/1/34} = -666\,\mu A$

$i(t) = -\frac{2}{3}mA\left(1 + e^{-t/1/3\,mA}\right)$

$$i(t) = -\frac{2}{3}\,mA\left(1 + e^{-(t-2ns)/0.33ns}\right) \qquad t \geq 2ns$$



$t \leq 2ns$

$$i(t) = \frac{-4}{3}\,mA$$

$$= -1.33\,mA$$

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

$$V_{OUT} = 2K\,i(t) + 2$$

$$= 2K\left(\frac{-2}{3}mA\left(1 + e^{-(t-2ns)/.33ns}\right)\right) + 2$$

$$V_{OUT} = \frac{-4}{3}V + \frac{-4}{3}e^{-(t-2ns)/.33ns} + 2$$

$$v_{nT} = -\frac{4}{3}V + \frac{6}{3}V - \frac{4}{3}e^{-(t-2\mu)/\frac{1}{3}\mu}$$

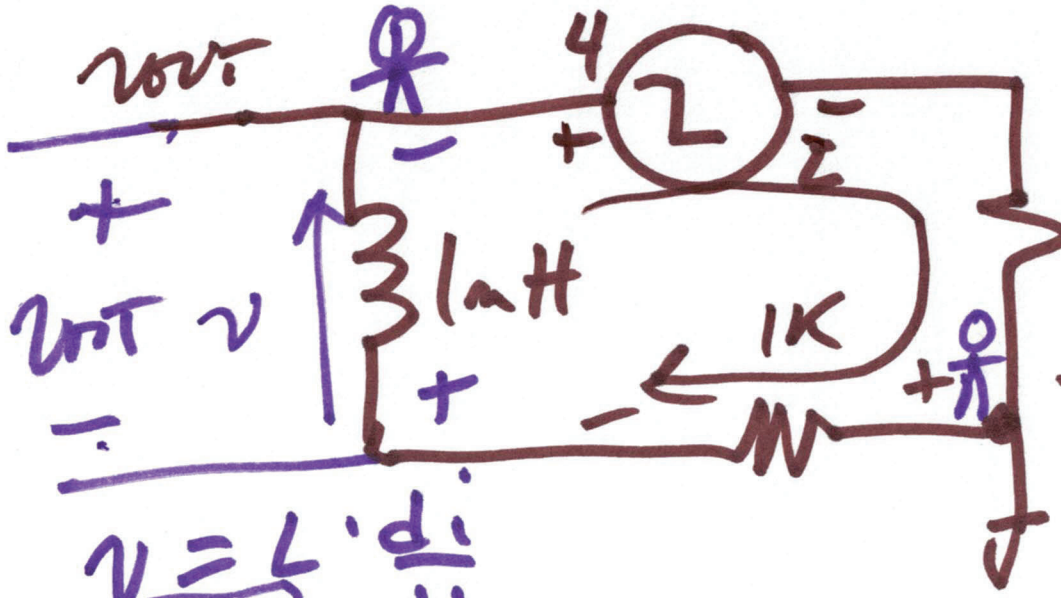
$$= \frac{2}{3}V - \frac{4}{3}e^{-(t-2\mu)/\frac{1}{3}\mu}$$

$$v_{OUT}(2\mu) = -\frac{2}{3}V$$

$$v_{OUT}(\infty) = \frac{2}{3}V$$

$$e^{-Big\#} = 0$$

$$\frac{1}{e^{Big\#}} = 0$$



$$-i(t) = \frac{-2}{3}mA\left(1+e^{-t/\frac{2}{3}\mu}\right)$$

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

$$\frac{d}{dx}e^{-ax} = -ae^{-ax}$$

$$v_{oT} = -1K \cdot i(t) - 1mH \cdot \frac{di(t)}{dt}$$

$$= \frac{2}{3}v + \frac{2}{3}e^{-(t-2n)/\frac{2}{3}\mu} - 1mH\left(\frac{d\left(\frac{-2}{3}mA - \frac{2}{3}mA\right.\right.$$

$$-1mH\left(-\frac{2}{3}mA\right.$$

see next page

$$\frac{d}{dt}\left(-\frac{2}{3}mt - \frac{2}{3}mA\,e^{-(t-2\tau)/1/3\tau}\right)$$

$$= 0 - \frac{2}{3}mA\left(\frac{-1}{1/3\tau}\right)e^{-(t-2\tau)/1/3\tau}$$

$$\frac{1}{1/3} = 3$$

$$\frac{d}{dt}\frac{-2}{3}mA\,e^{+2\tau}\,e^{-t/1/3\tau}$$

$$\frac{d-\frac{2}{3}mt\,e^{+2\tau}\,e^{-3\tau t}}{dt}$$

$$\frac{d}{dt} \quad -\frac{2}{3}me^{+2\tau}(-3\tau)e^{-3\tau t}$$

$$v_{out}(t) = -1k \cdot i(t) - 1mH \cdot \frac{di(t)}{dt}$$

$$= -1K \cdot \left(-\frac{2}{3}mA\left(1+e^{-t/1/3\mu}\right)\right) - 1mH\,\frac{di(t)}{dt}$$

$$= \frac{2}{3}V\left(1+e^{-t/1/3\mu}\right) - 1mH\,\frac{di(t)}{dt}$$

$$\frac{de^{-ax}}{dx} = de^{-ax} \cdot \underline{d-ax}$$

$$-1mH\,\frac{di(t)}{dt} = -1mH\,\frac{d\left(-\frac{2}{3}mA - \frac{2}{3}mA e^{-t/1/3\mu}\right)}{dt}$$

$$\frac{1}{\mu} = 10^6$$

$$= -1mH\left(-\frac{2}{3}mA\right)\cdot\left(\frac{-3\mu}{3}\right)e^{-t/1/3\mu}$$

$$= -2e^{-t/3\mu}$$

$$v_{OUT} = \frac{2}{3}\left(1 + e^{-t/1/34}\right) - 2e^{-t/1/34}$$