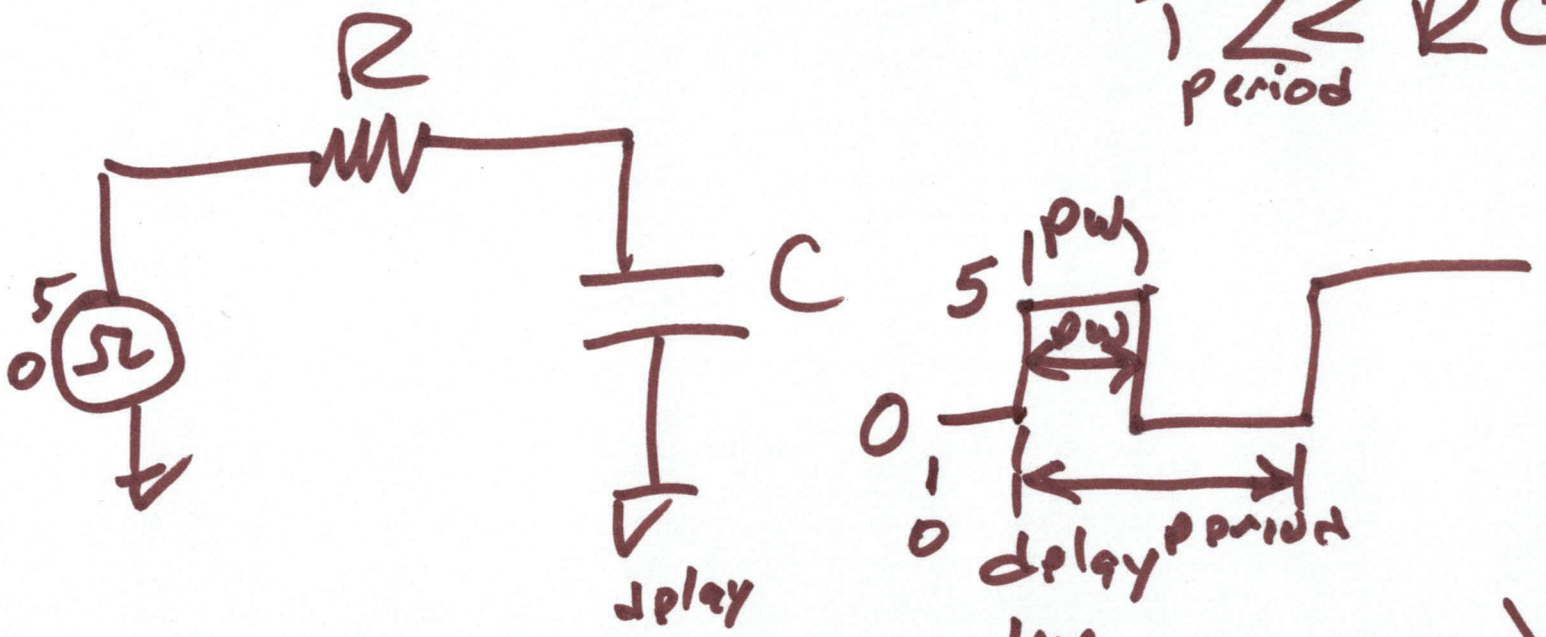
EE 221 Circuits II

Lecture 16

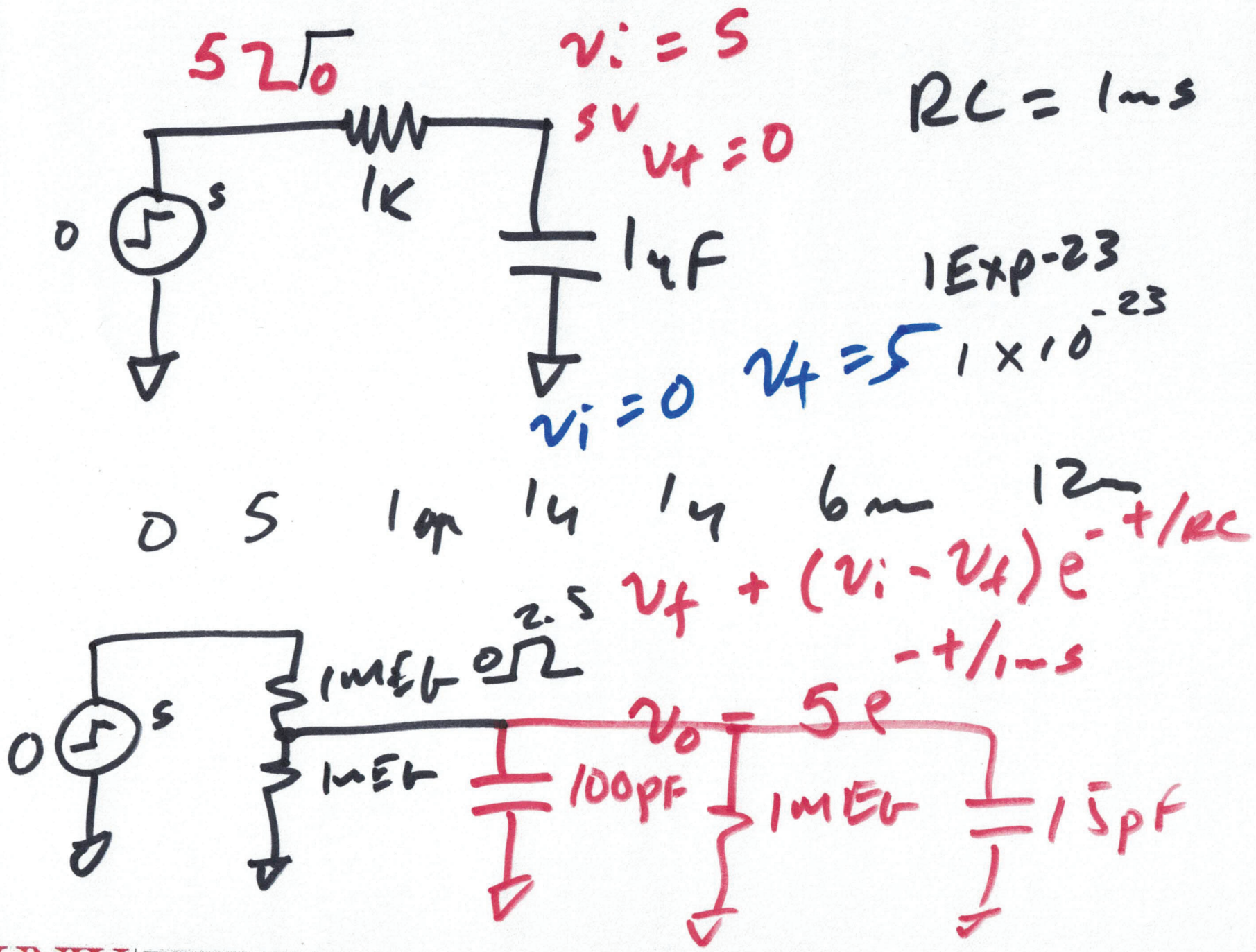
March 27, 2023

$T \ll RC$ (T: period)

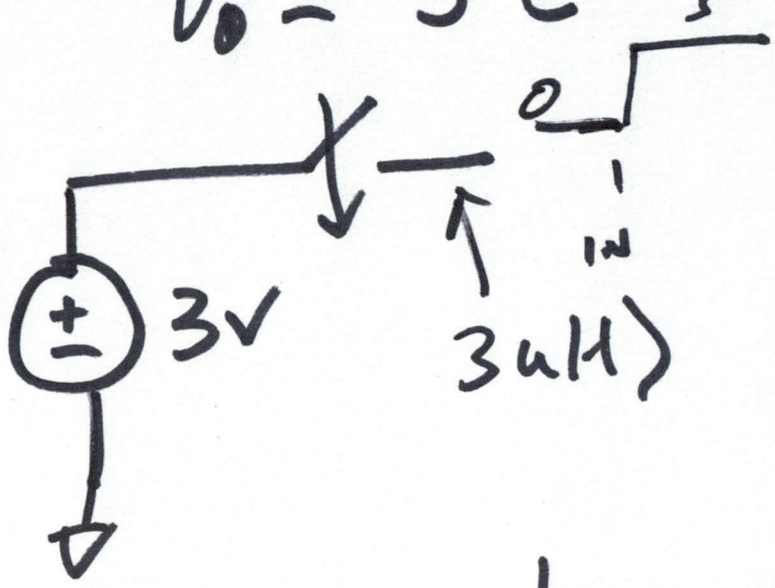


pulse(0 5 1n 1n 145n 5n 10n)

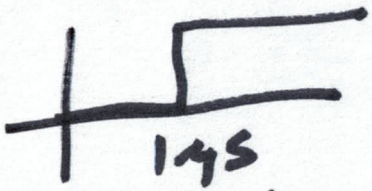
(init, final, rise, fall, PW, period)


5 2√0
vi = 5
5V
vf = 0
RC = 1ms
0
s
1K
1μF
1Exp-23
1 x 10^-23
vi = 0
vf = 5
0 5 1m 1μ 1μ 6m 12m
vf + (vi - vf) e^-t/RC
2.5
1MEG
0Ω
s
0
1MEG
-t/1ms
vo = 5e
100pF
1MEG
15pF

$$v_0 = 5\,e^{-(t-7ms)/1ms} \qquad t \geq 7ms$$



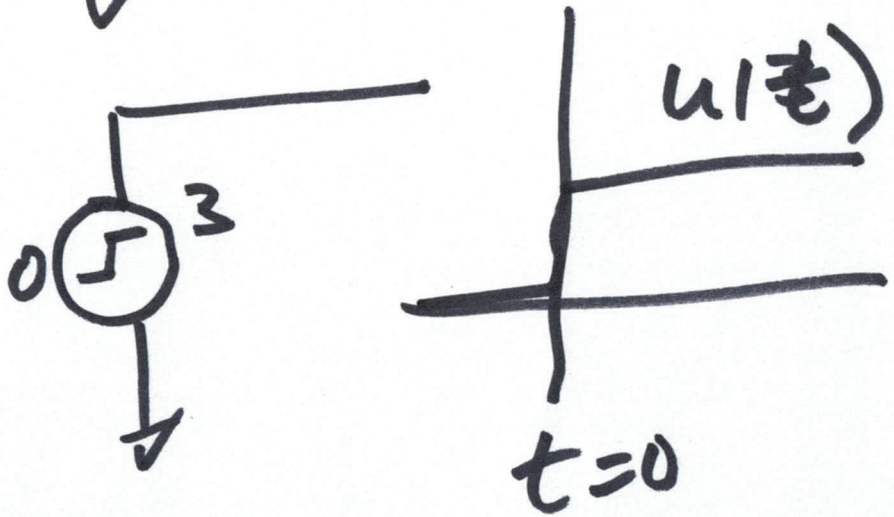
$u(t-1ms)$

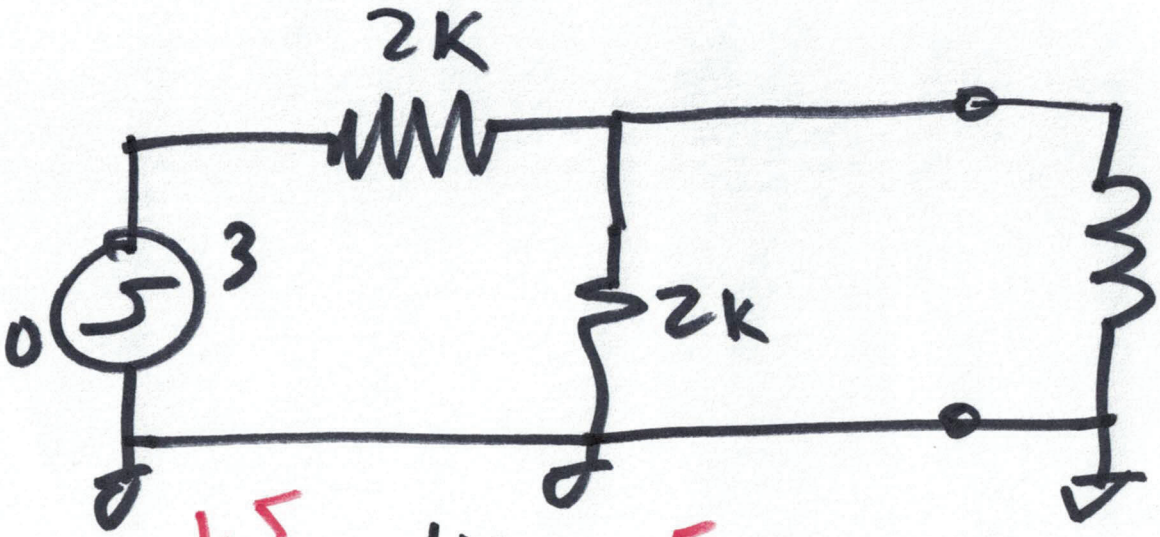


Unit step function

$$u(t) = 1 \qquad t \geq 0$$

$$= 0 \qquad -\infty < t < 0$$



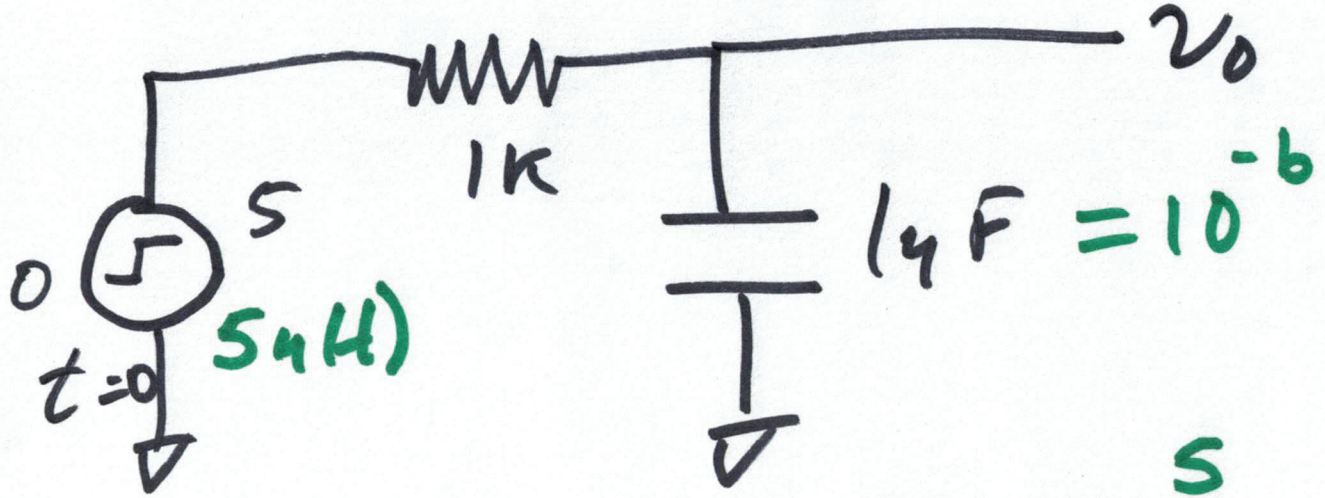


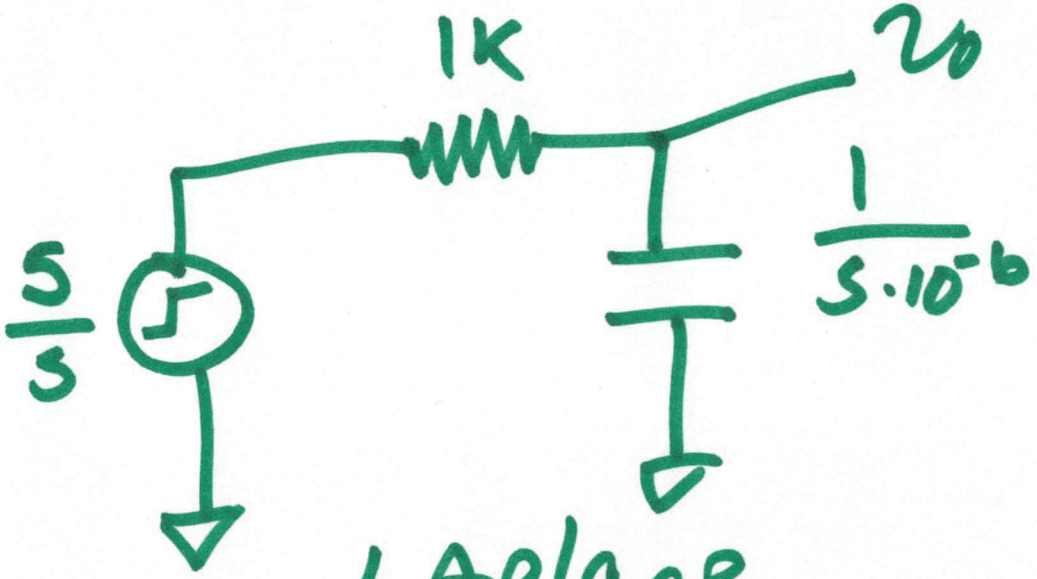
$v_i = 1.5 \quad v_f = 0$

$i_i = 0 \quad i_f = \frac{1.5}{1K} = 1.5mA$

$v_i = -1.5 \quad v_f = 0$

$i_i = 1.5mA \quad i_f = 0$





$$V_o = \frac{S}{S} \cdot \frac{\frac{1}{S \cdot 10^{-6}}}{\frac{1}{S \cdot 10^{-6}} + 1K}$$

Laplace ckt Representation

partial fraction expansion

$$V_o(s) = \frac{5}{s} \cdot \frac{1}{1 + s \cdot 10^{-3}}$$

$$\frac{5}{s} \cdot \frac{10^3}{s + 10^3}\bigg|_{s=0} = \frac{A}{s} + \frac{B}{s + 10^3}\bigg|_{s=0}$$

$$\boxed{5 = A}$$

$$\left.\frac{s}{s} \cdot \frac{10^3}{s + 10^3} \cdot (s + 10^3)\right|_{s = -10^3} = \left.\left(\frac{A}{s} + \frac{B}{s + 10^3}\right)(s + 10^3)\right|_{s = -10^3}$$

$$\frac{s}{-10^3} \cdot 10^3 = \boxed{-5 = B}$$

$$V_o(s) = \frac{5}{s} + \frac{-5}{s+10^3}$$

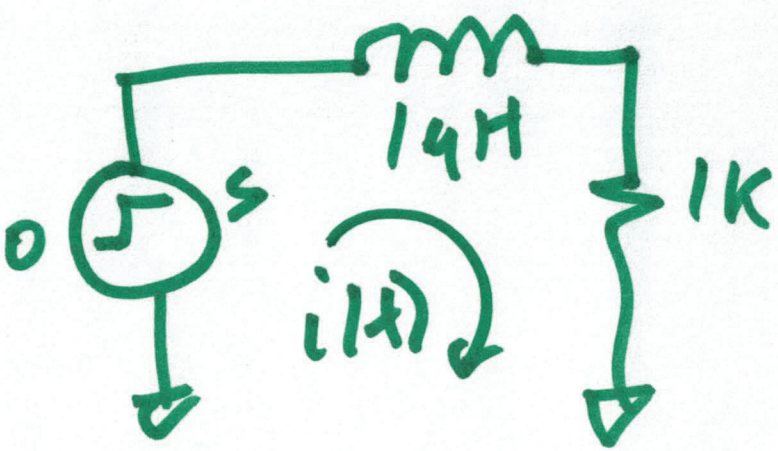
$$v_o(t) = \mathcal{L}^{-1}\{V_o(s)\} = 5u(t) - 5\cdot u(t)\cdot e^{-10^3 t}$$

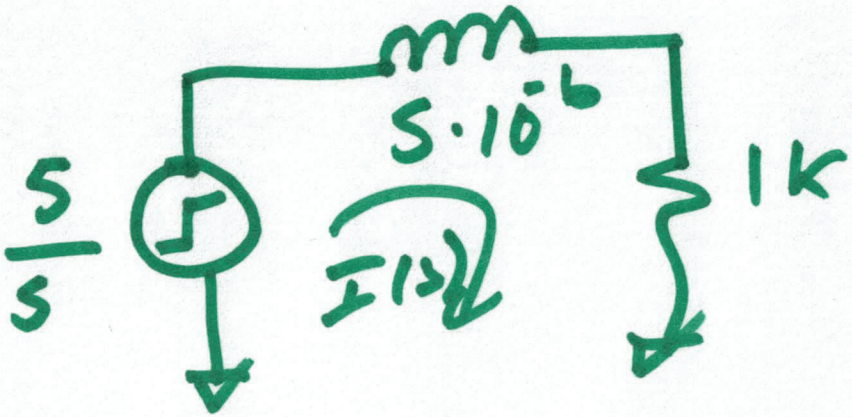
$$= 5u(t) - 5u(t)\, e^{-t/10^{-3}}$$

$$e^{-at}\cdot u(t) \Leftrightarrow \frac{1}{s+a}$$

$$v_o(t) = 5\left(1 - e^{-t/10^{-3}}\right)u(t)$$

$$t > 0$$





$i_i = 0 \qquad \frac{L}{R} = \frac{14}{1K} = 10^{-9}$

$i_f = 5mA$

$5mA\,(1 - e^{-t/1ns})$

$$I(s) = \frac{\frac{5}{s}}{5\cdot10^{-6} + 1K} = \frac{5\cdot10^{+6}}{s(s+10^9)}$$

$$\left.\frac{5\cdot10^6 \cdot s}{s(s+10^9)}\right|_{s=0} = \frac{A}{s} + \frac{B}{s+10^9}$$

$A = 5m$

$$\frac{5\cdot 10^6 (s+10^9)}{s(s+10^9)}\Bigg|_{s=-10^9} = \frac{A}{s} + \frac{B}{s+10^9}$$

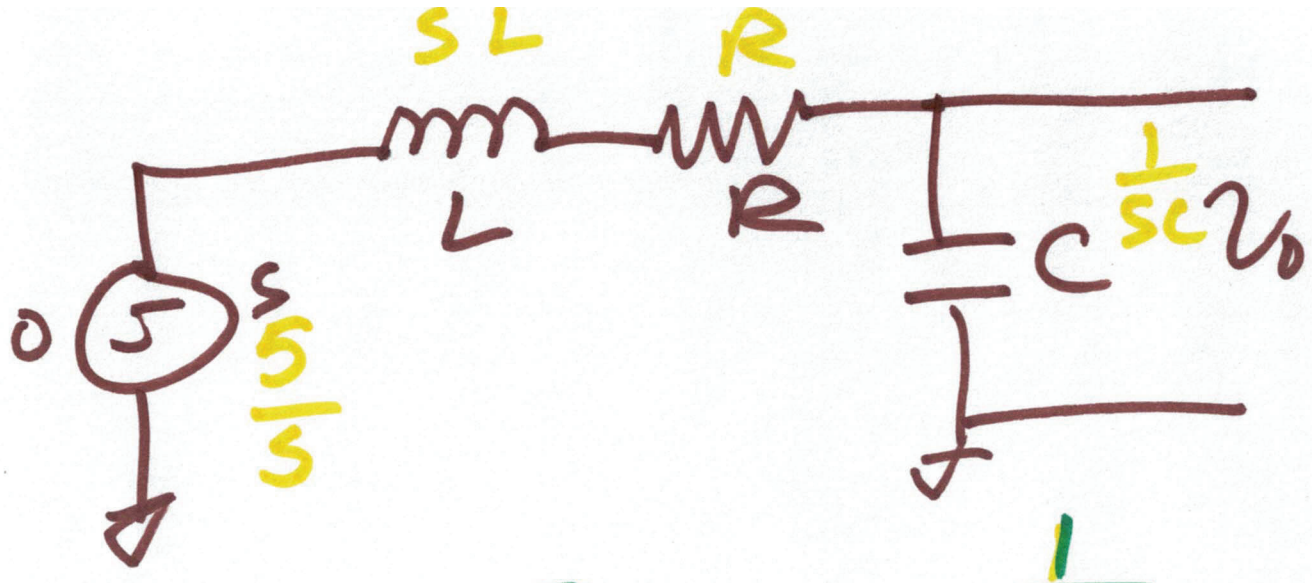
$$\frac{5\cdot 10^6}{-10^9} = B = -5\,mA$$

$$I(s) = \frac{+5\,mA}{s} + \frac{-5\,mA}{s+10^9}$$

$$5\,mA\,u(t) - 5\,mA\,e^{-\frac{t}{10^9}}u(t)$$

$$5\,mA\,(1-e^{-t/10^9})u(t)$$

$e^{-10^9 t}$



$$V_0 = \frac{5}{s} \cdot \frac{\frac{1}{sC}}{\frac{1}{sC} + R + sL}$$

$$V_0 = \frac{5}{s} \cdot \frac{1}{s^2LC + sRC + 1}$$

$$s_{1,2} = \frac{-RC \pm \sqrt{(RC)^2 - 4LC}}{2LC}$$