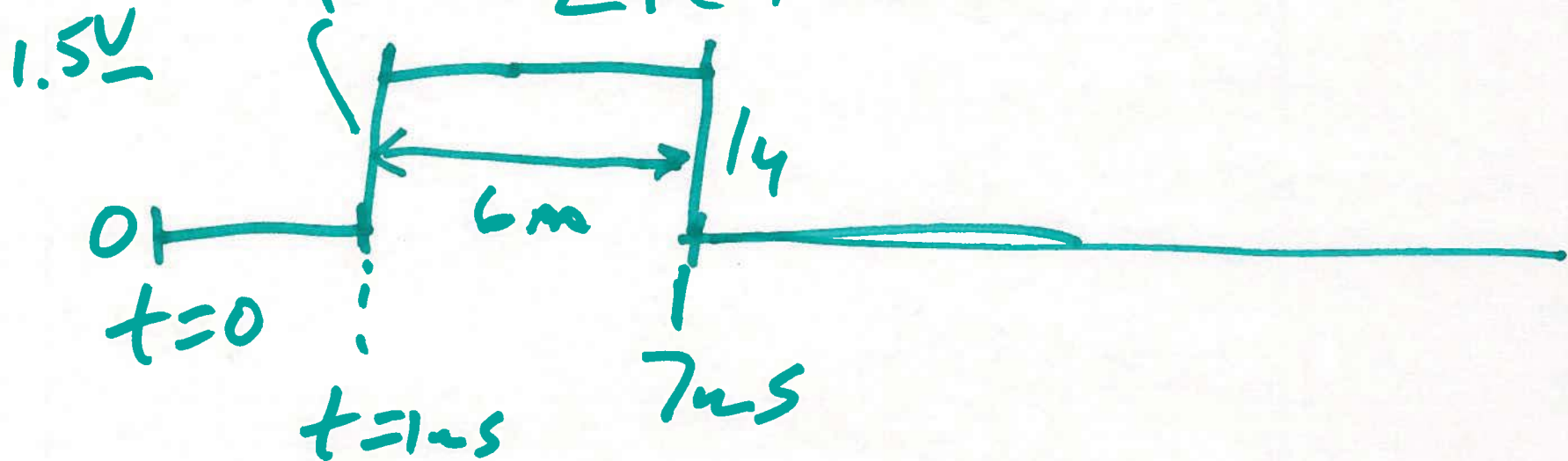


EE 220 Circuits I

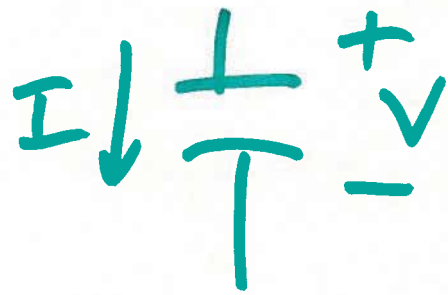
OCT. 30, 2017

fr = 14 Lecture 17



1)

Review: Cmps

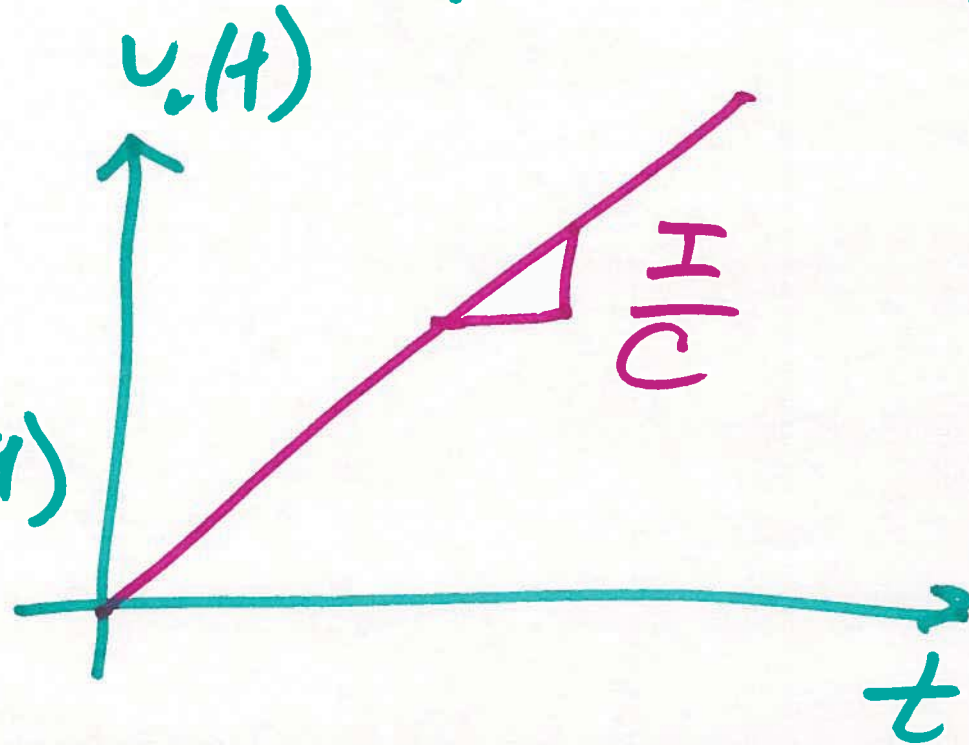
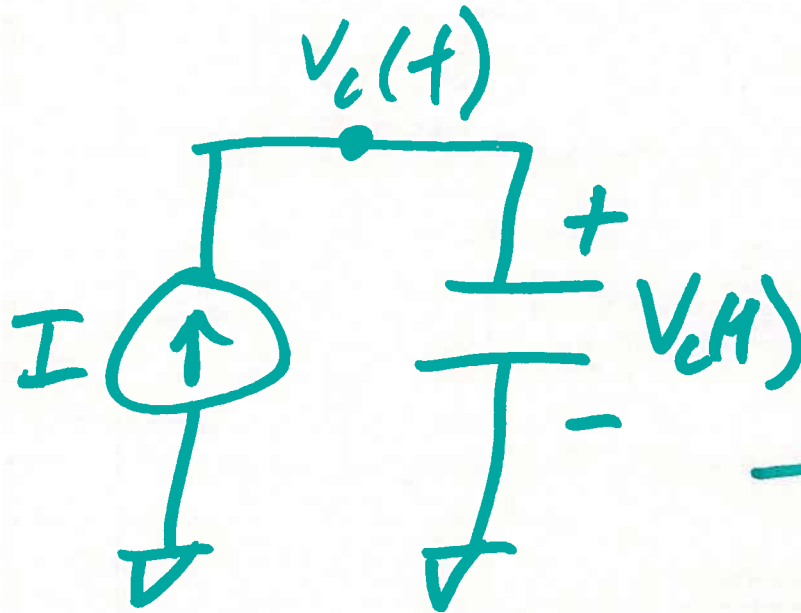


$$CV = Q$$

$$I = C \frac{dv}{dt}$$

$$v = \frac{1}{C} \int_{v_{init}}^{v(t)} I \cdot dt$$

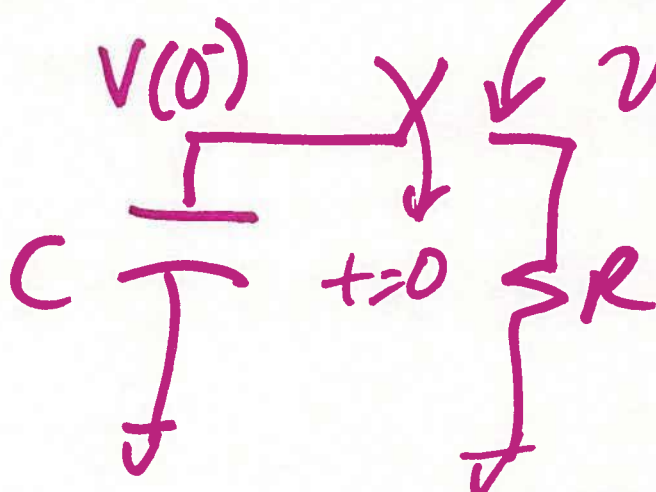
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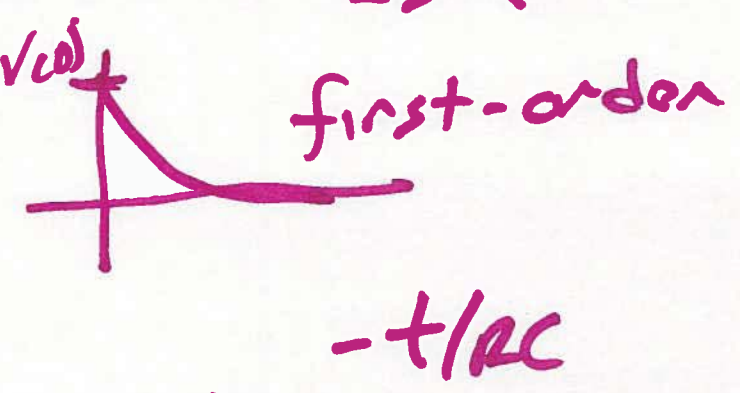
2)

CAP REVIEW

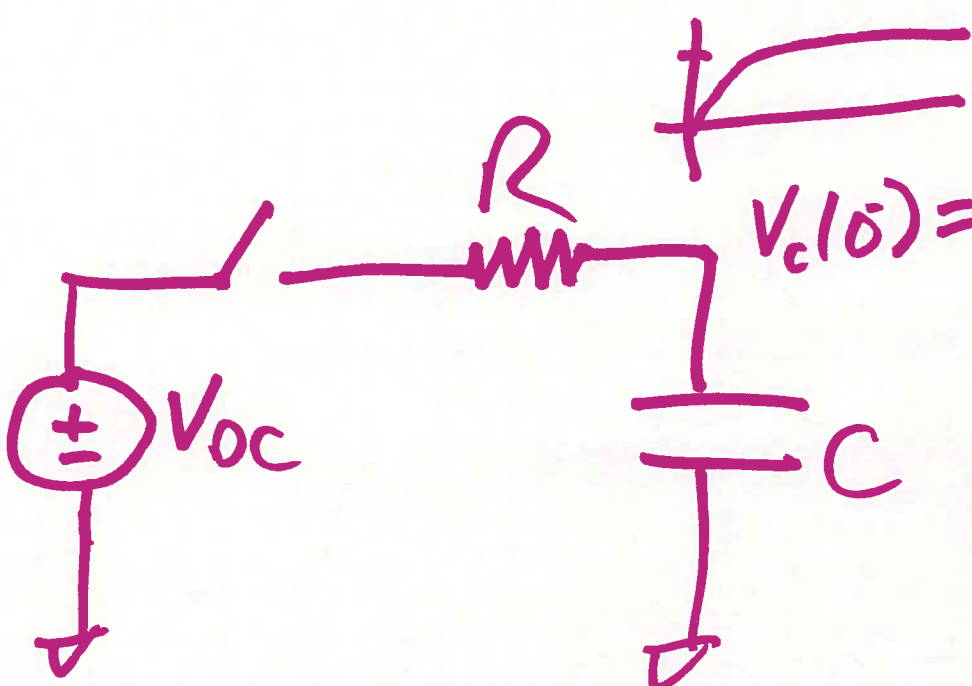
$$v(t) = v_f + (v_i - v_f) e^{-t/RC}$$



$v_i = V(0^-)$
 $v_f = 0$



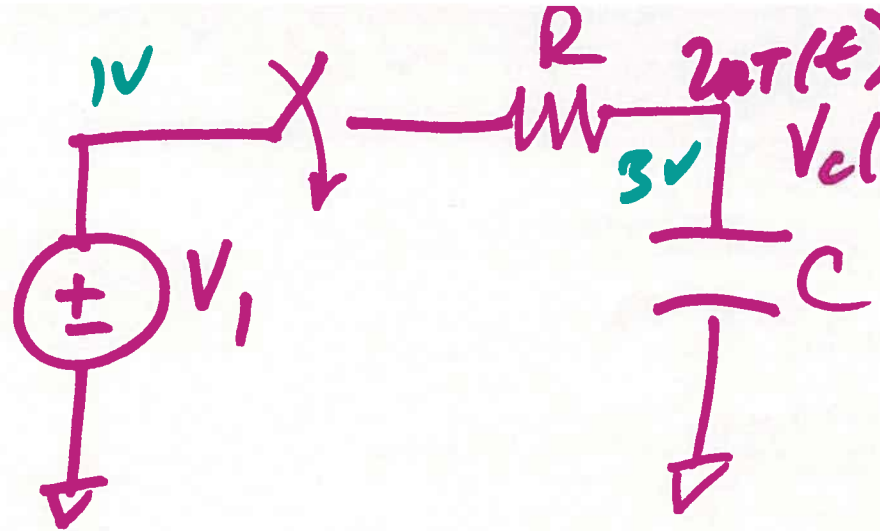
$$v(t) = V(0^-) e^{-t/RC}$$



$v_c(0) = 0$
 $v_i = 0$
 $v_f = V_{DC}$

$$v_c(t) = V_{DC} (1 - e^{-t/RC})$$

3)



$$v_c(0^-) = V_2$$

$$v_c(t) = V_2 \quad t \leq 1\mu s$$

$$V_i = V_2$$

$$V_f = V_1$$

$$v_c(t) = V_1 + (V_2 - V_1) e^{-(t-1\mu s)/RC} \quad t \geq 1\mu s$$

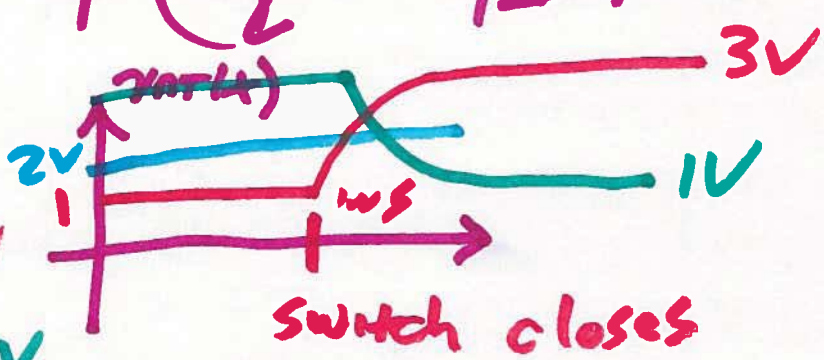
$$v_{out}(t) = V_1 + (V_2 - V_1) e^{-t/RC}$$

$$= V_1 + (V_2 - V_1) e^{-t/RC}$$

$$V_1 = V_2 = 2V$$

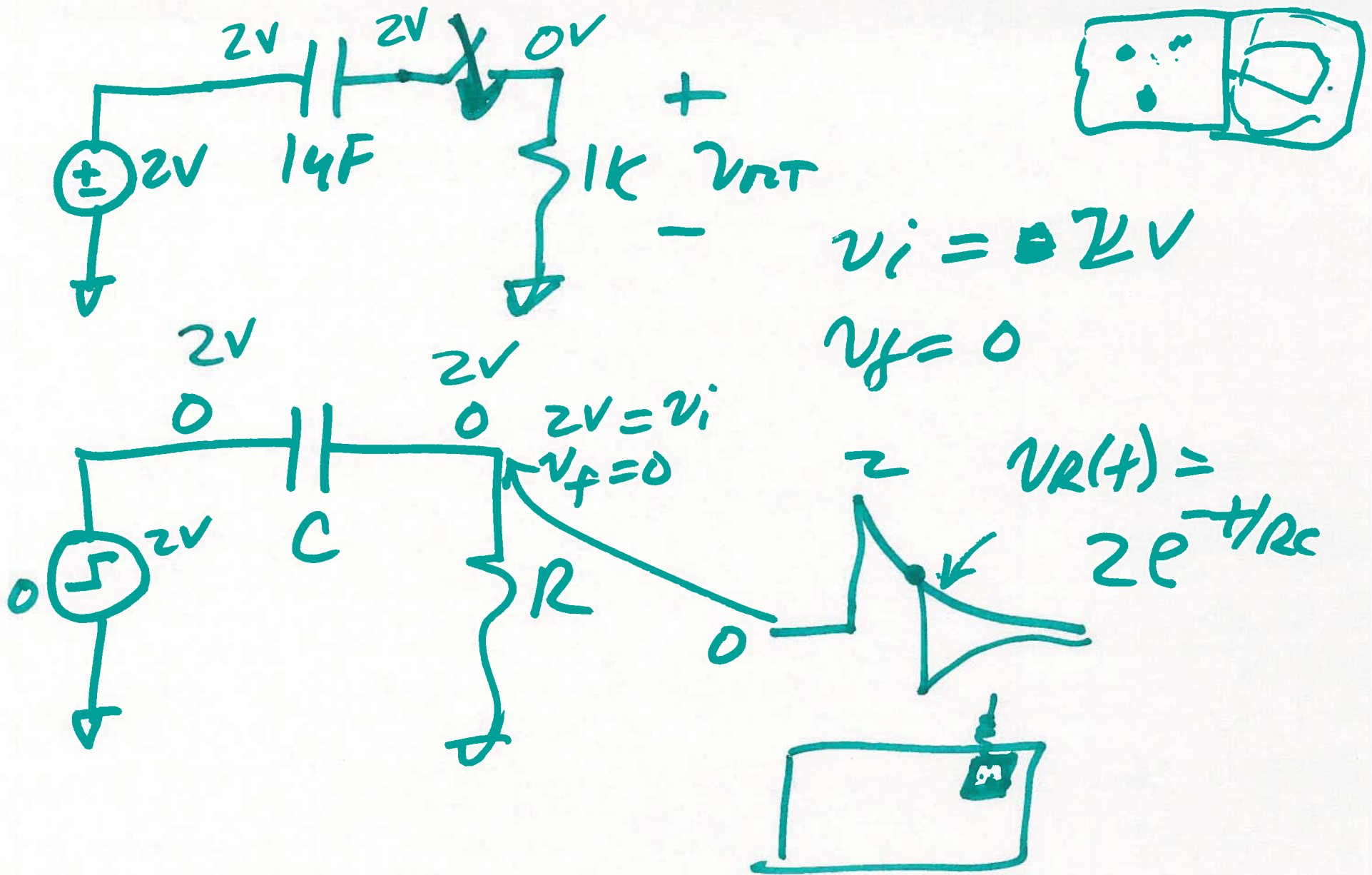
$$V_1 = 3V, V_2 = 1V$$

$$V_1 = 1V, V_2 = 3V$$



switch closes

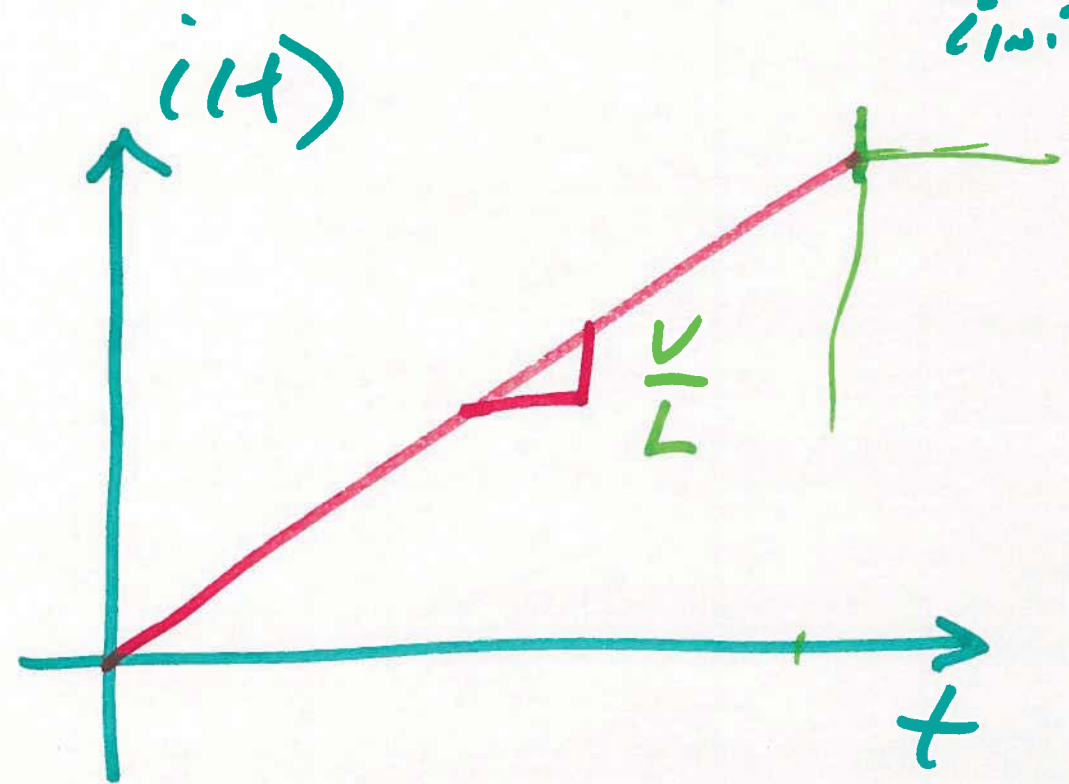
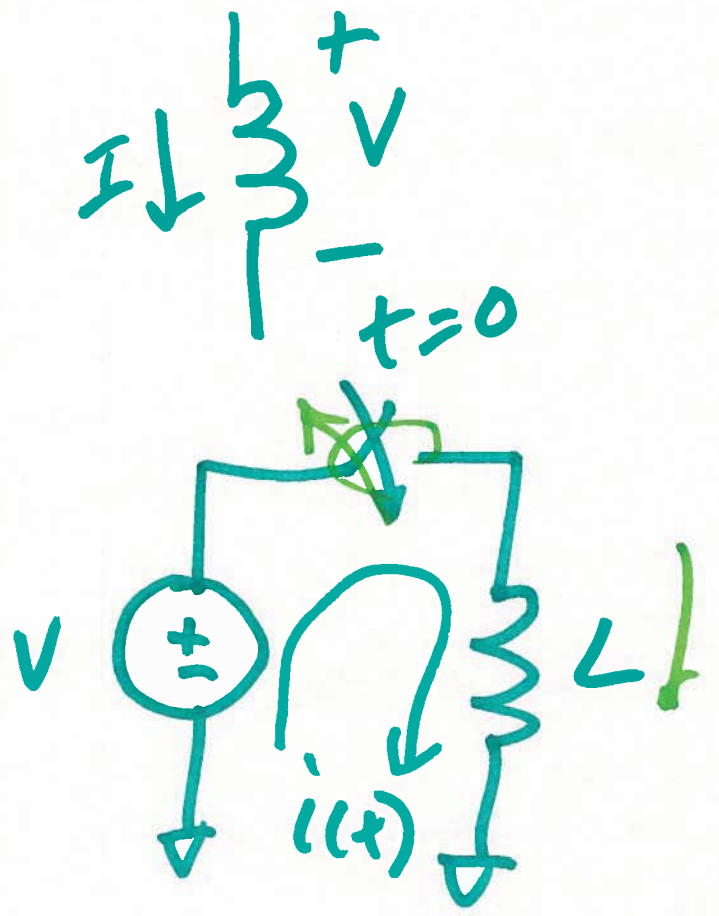
4)



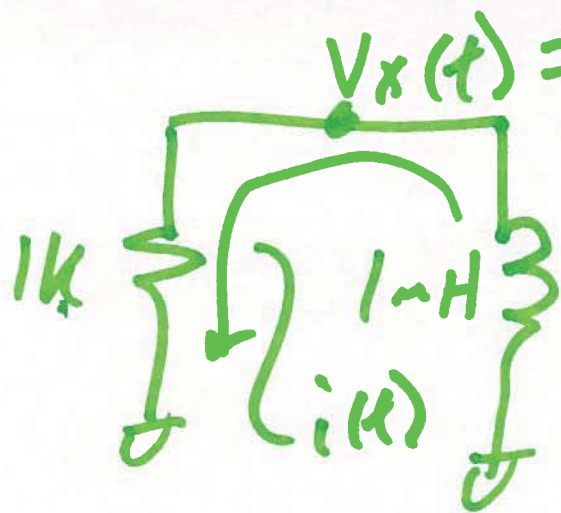
5)

$$v = L \cdot \frac{di}{dt}, \quad I = \frac{1}{L} \int v \cdot dt$$

i_{init}



6)



$$\tau \Rightarrow CR \Rightarrow \frac{L}{R}$$

$$i(0^-) = 1 \text{ A}$$

$$i_i = 1 \text{ A}$$

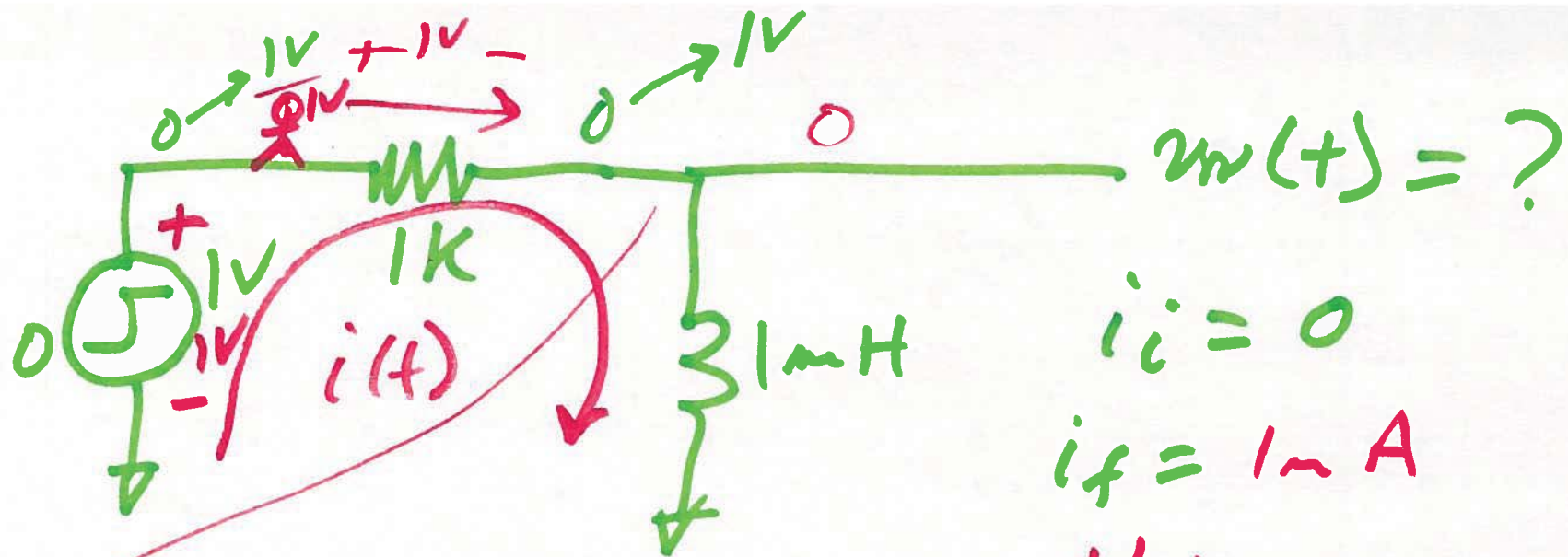
$$i_f = 0$$

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

$$i(t) = 1 \text{ A} e^{-t/4s}$$

$$v_x(t) = i(t) \cdot 1k = 1V e^{-t/4s}$$





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

$$= 1 \text{ mA} (1 - e^{-t/145}) \rightarrow v_{out} = \frac{1 \text{ mA}}{1 \text{ mH}} \int_0^{v_{out}(t)} (1 - e^{-t/145}) dt$$

$$v_{out} = 1 - i(t) \cdot 1 \text{ k} = 1 - 1 \text{ V} (1 - e^{-t/145})$$

$$= \underline{\underline{+1 \text{ V} \cdot e^{-t/145}}}$$

$$v = \frac{1}{L} \int i \cdot dt$$

8)

$$v_{out}(t) = \frac{1 \text{ mA}}{2 \cdot 10^{-3}} \int_{v_i}^{v_f} (1 - e^{-t/1 \mu\text{s}}) dt$$

$$= \int_{v_i}^{v_f} dt - \int_{v_i}^{v_f} e^{-t/1 \mu\text{s}} \cdot dt$$

let $u = \frac{-t}{1 \mu\text{s}}$

$$\int e^x dx = e^x$$

$$du = -\frac{1}{1 \mu\text{s}} \cdot dt \quad -1 \mu\text{s} \cdot \int_{v_i}^{v_f} e^u \cdot du$$

$$dt = -1 \mu\text{s} \cdot du \quad -1 \mu\text{s} \cdot e^u \Big|_{v_i/1 \mu\text{s}}^{v_f/1 \mu\text{s}}$$

$$e^{v_f/1 \mu\text{s}} - e^{v_i/1 \mu\text{s}}$$

9)

$$i(t) = I_m A (1 - e^{-t/\tau})$$

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

$$v(t) = \frac{1}{L} \int v(t) dt \quad v(t) =$$

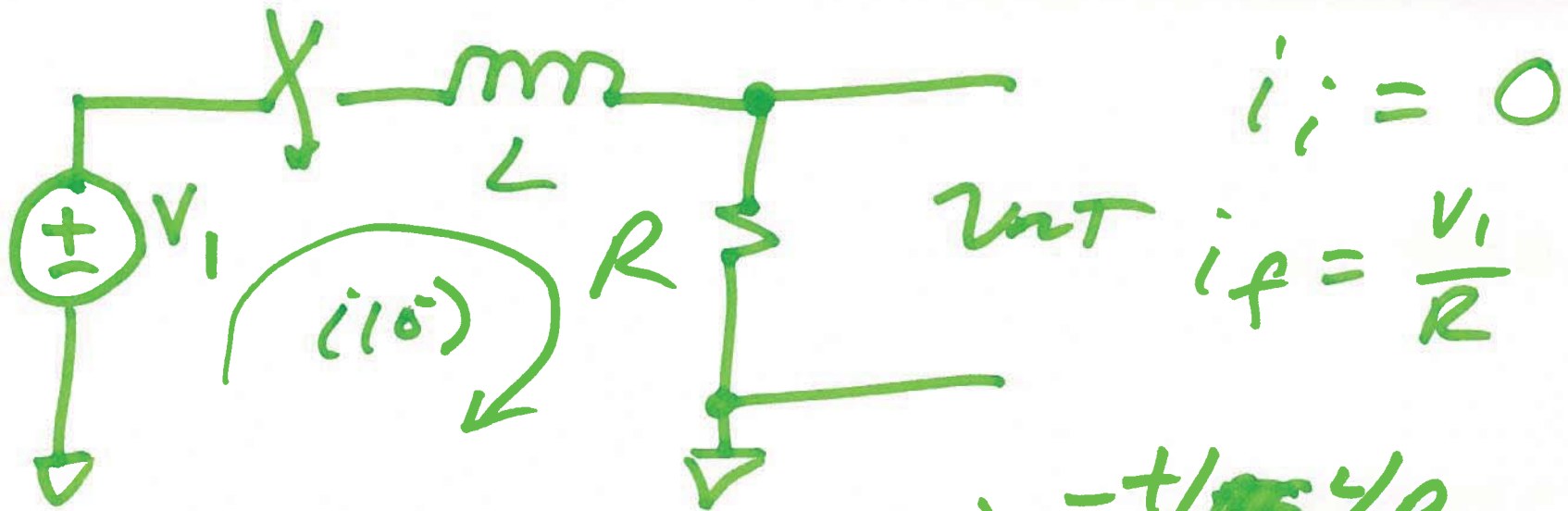
$$\frac{d(-I_m A \cdot e^{-t/\tau})}{dt} = \frac{+I_m A}{\tau} e^{-t/\tau}$$

$$= 10^3 e^{-t/\tau}$$

$$v = 4 \cdot 10^3 e^{-t/\tau}$$

$$10^3$$

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



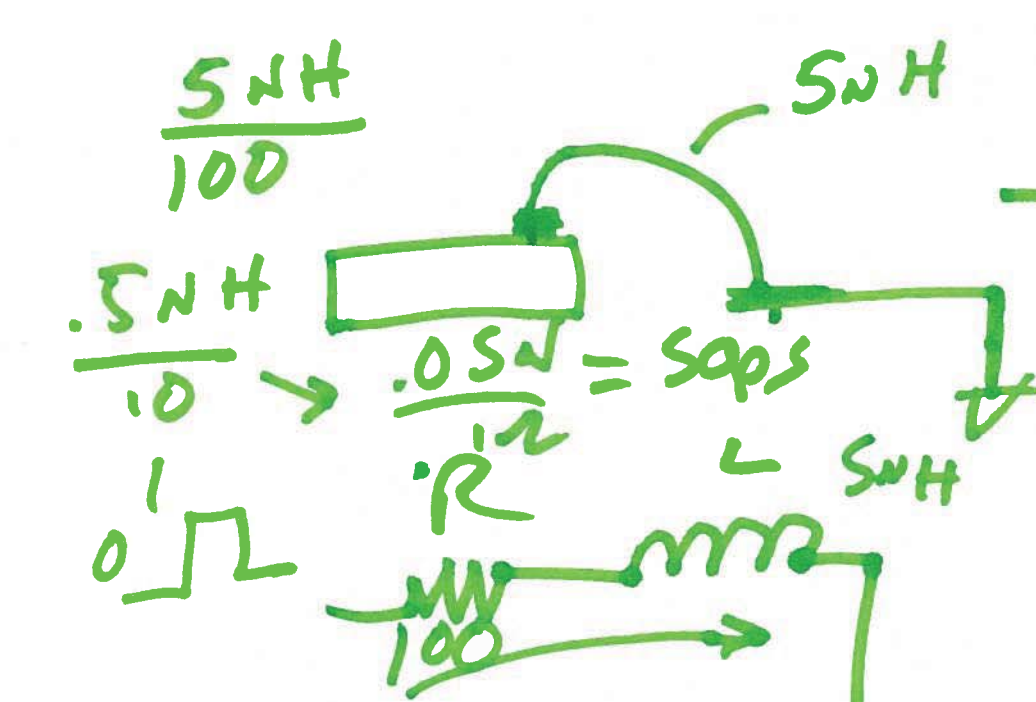
$$i(t) = i_f + (i_i - i_f)e^{-t/\tau}$$

$$= \frac{V_1}{R} + \left(0 - \frac{V_1}{R}\right)e^{-t/\tau}$$

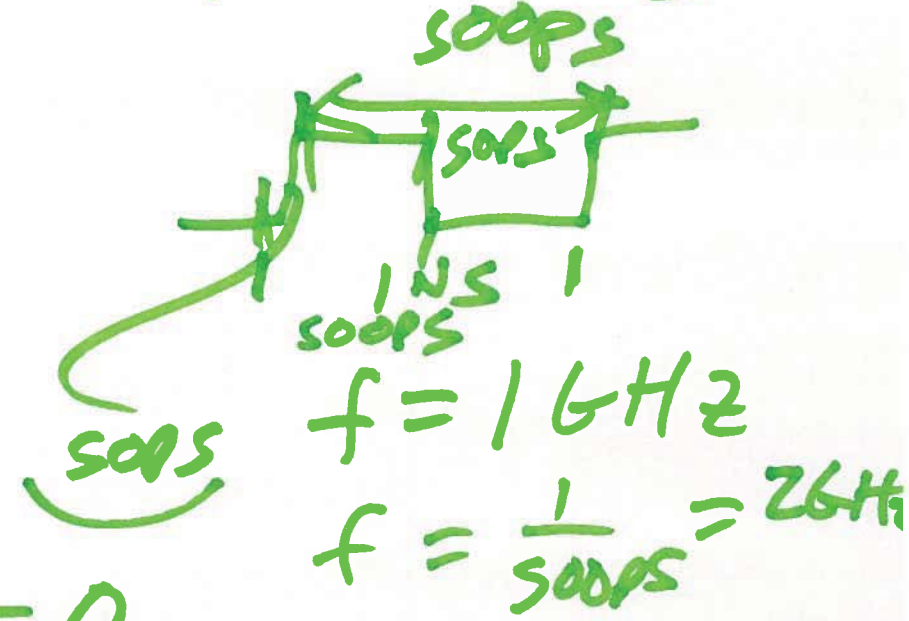
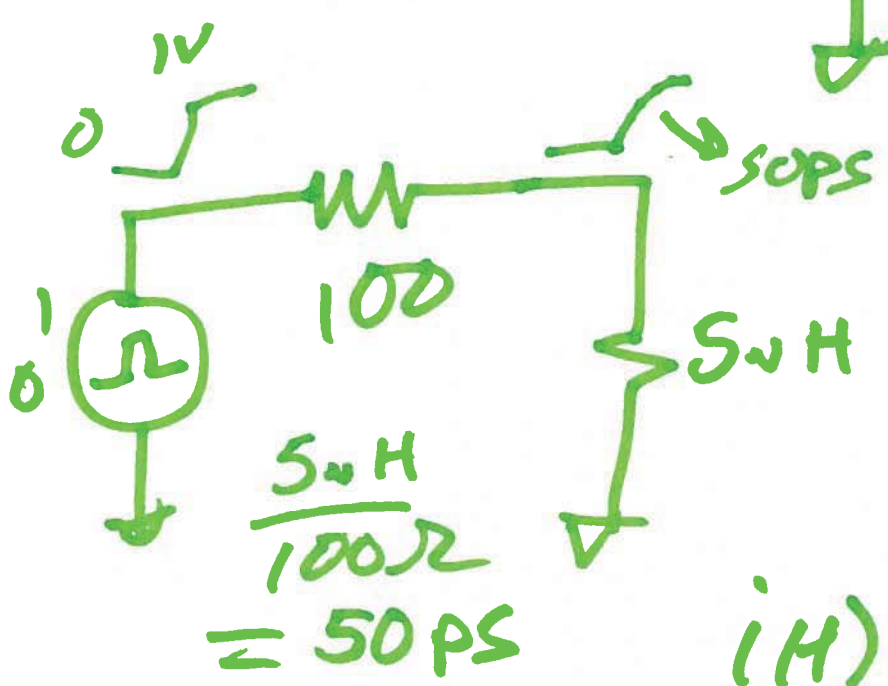
$$i(t) = \frac{V_1}{R} \left(1 - e^{-t/\tau}\right)$$

$$v_{RT} = i(t) \cdot R = V_1 \left(1 - e^{-t/\tau}\right)$$

ii)



$26Gb/s = 2 \times 10^{10} \frac{b}{s}$



$i_i = 0$
 $i_f = \frac{1}{100} = 10nA$

$i(t) = i_f + (i_i - i_f)e^{-t/\tau}$
 $= 10nA(1 - e^{-t/50ps})$

12)