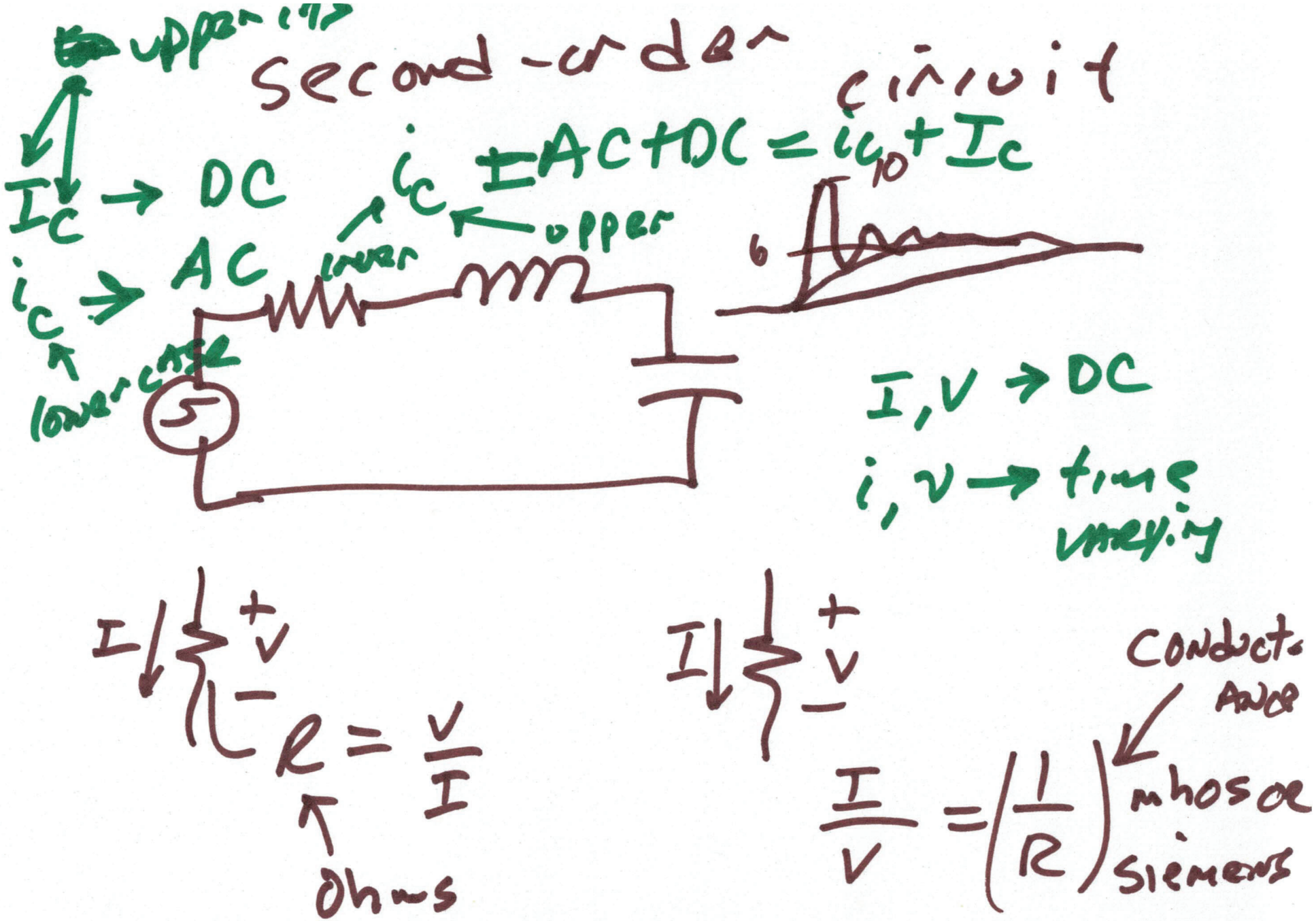
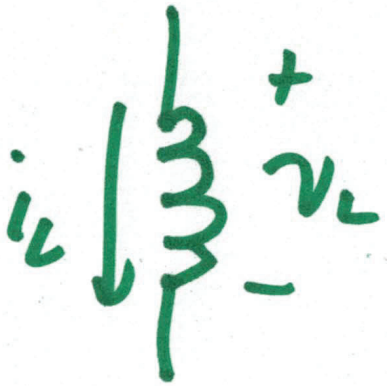
EE 220 circuits 1

NOV. 2, 2020

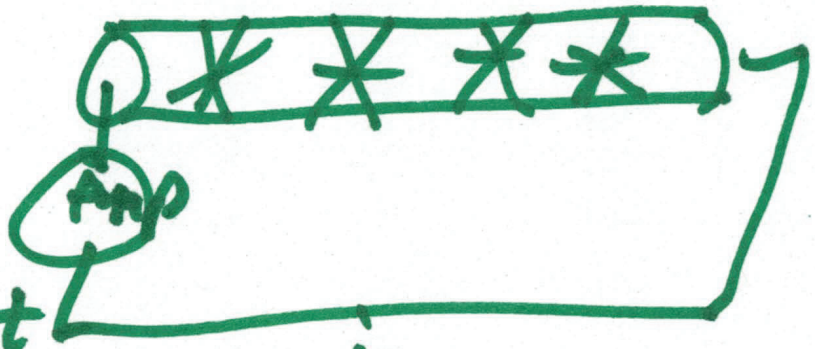
Lecture 19

first-order circuits have one inductor or one capacitor

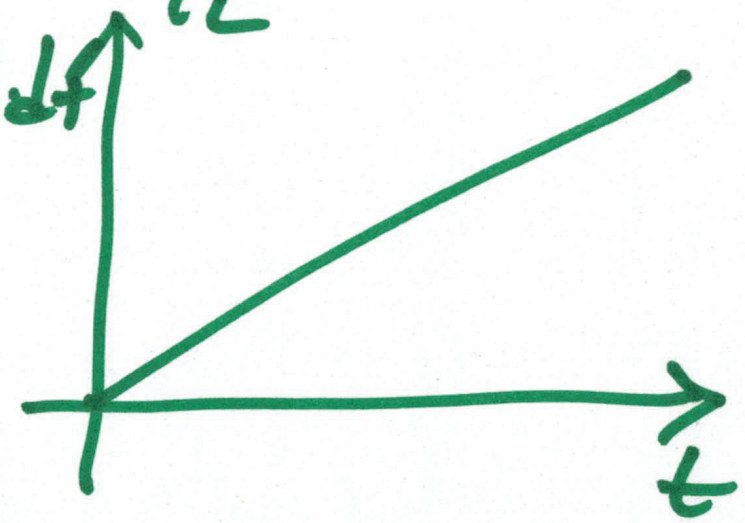

upper case
second-order circuit
I_C → DC
i_c → AC
i_c lower-case
i_c lower
upper
$I_{AC+DC} = i_{c0} + I_c$
6
5
I, V → DC
i, v → time varying
I
+
V
−
R = V/I
Ohms
I
+
V
−
I/V = (1/R)
conductance
mhos or Siemens



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



$$i_L = i_{init} + \frac{1}{L}\int_{t_{init}}^{t} v_L(t)\,dt$$



Energy in an inductor

$$v_L(t) = L \cdot \frac{di_L(t)}{dt}$$

$$E = \int_{t_1}^{t_2} v_L(t) \cdot i_L(t)\, dt$$

$$dt = L \cdot \frac{di_L(t)}{v_L(t)}$$

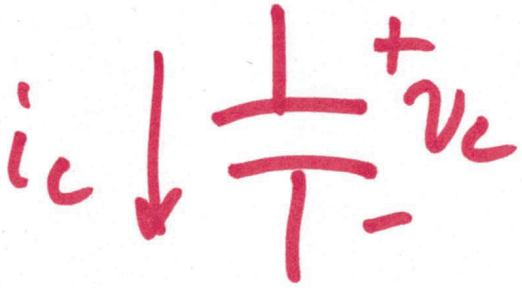
$$E = \int_{t_1}^{t_2} v_L(t) \cdot L \cdot \frac{i_L(t)\, di_L(t)}{v_L(t)}$$

$$E = \int_{t_1}^{t_2} L \cdot i_L \cdot di_L = L \frac{1}{2} i_L^2 \Big|_{t_1}^{t_2}$$

$t_2 \to t \qquad t_1 \to 0$

$$\boxed{E = \frac{1}{2} L \cdot i^2}$$

Capacitors



$C \cdot V = Q$

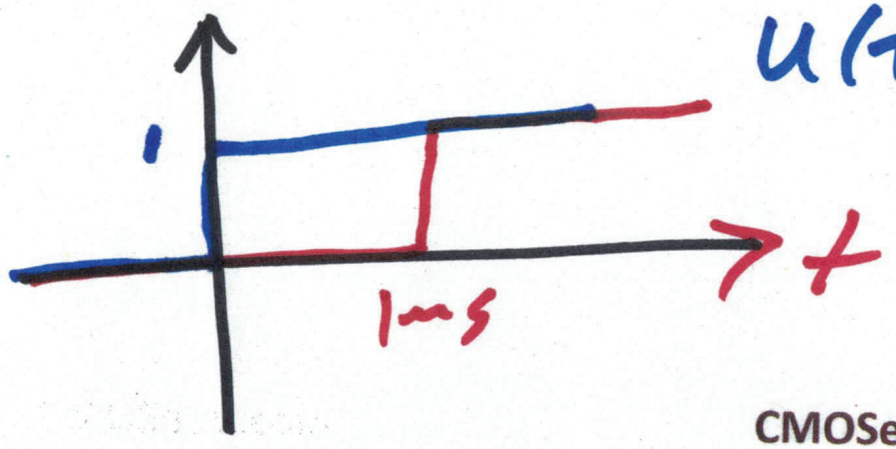
$$i_c = C \cdot \frac{dv_c}{dt}$$

$$v_c(t) = v_i + \frac{1}{C}\int_0^t i_c(t) \cdot dt$$

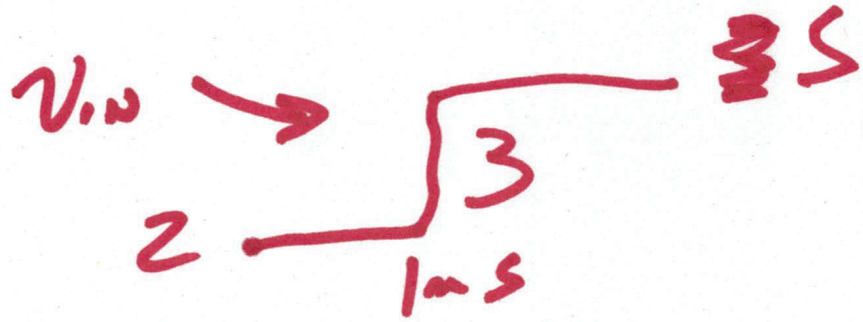
unit step function

$u(t) \rightarrow$

$\mathcal{L}\{u(t)\} = \frac{1}{s}$



$u(t - 1ms)$



$$v_{IN} = 2 + 3 \cdot U(t - 1\,ms)$$

$$E = \int_0^t v_c(t) \cdot i_c(t) \cdot dt \rightarrow i_c(t) = C\frac{dv_c(t)}{dt}$$

$$dt = C \cdot \frac{dv_c(t)}{i_c(t)}$$

$$E = \int_0^t v_c(t) \cdot \cancel{i_c(t)} \cdot C \cdot \frac{dv_c(t)}{\cancel{i_c(t)}}$$

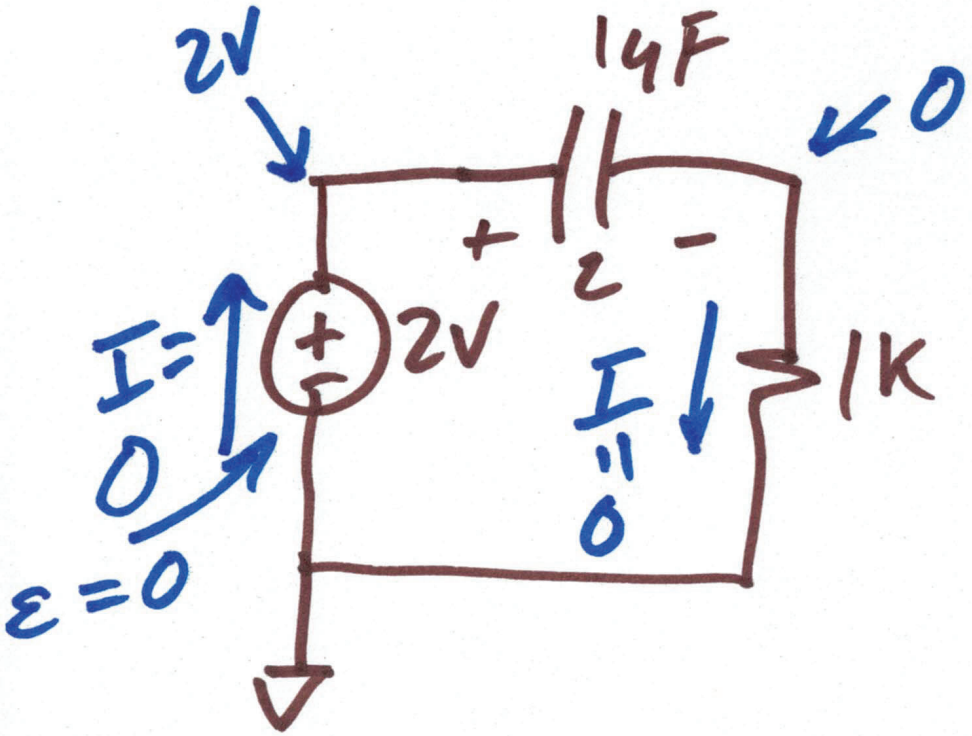
$$E = \frac{1}{2} C V_c^2$$

$$E = \int_0^Q v_c(t) \cdot dt = \frac{1}{2} v_c \cdot t \Big|_0^Q$$

$$= \frac{1}{2} v_c \cdot Q$$

$$CV = Q \rightarrow Q = C v_c$$

$$\boxed{E = \frac{1}{2} C V_c^2}$$

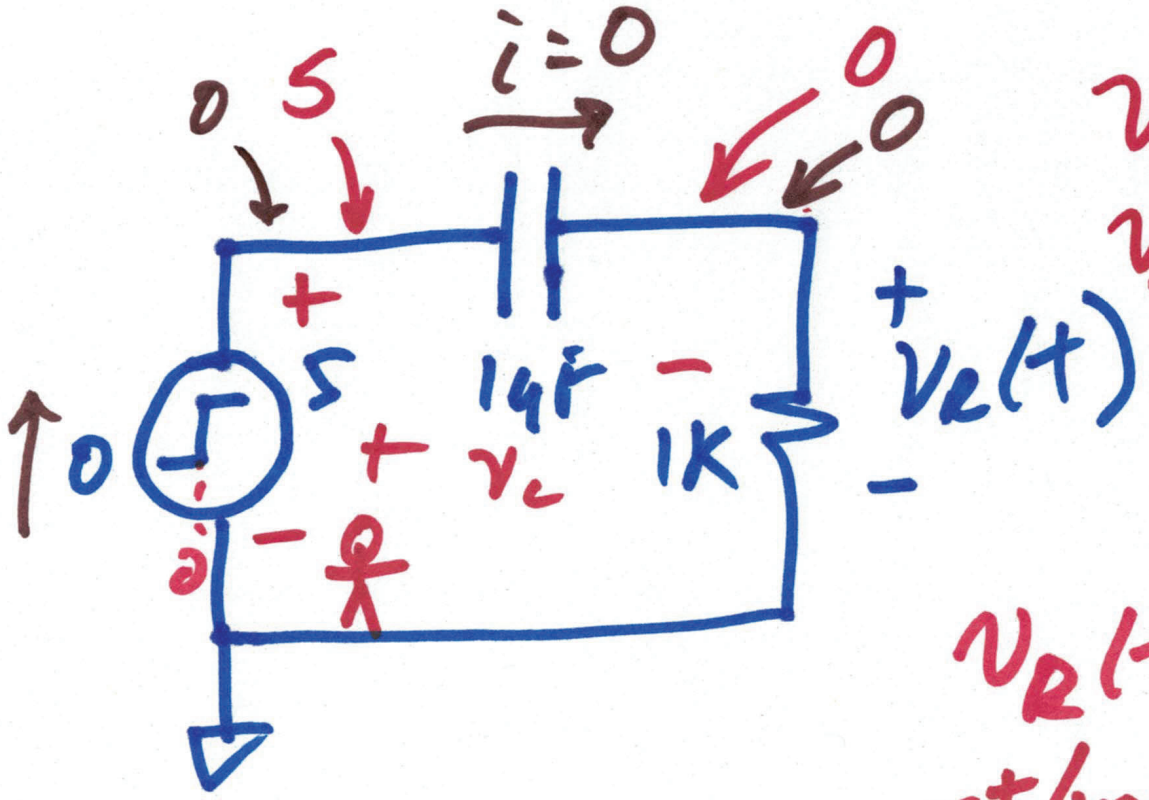


$$\rightarrow P_R = I \cdot V = \frac{V^2}{R} = I^2 \cdot R$$

$$\boxed{P_R = 0}$$

$$\mathcal{E} = \frac{1}{2} 10^{-6} \cdot 2^2$$

$$\boxed{\mathcal{E} = 2\mu J}$$

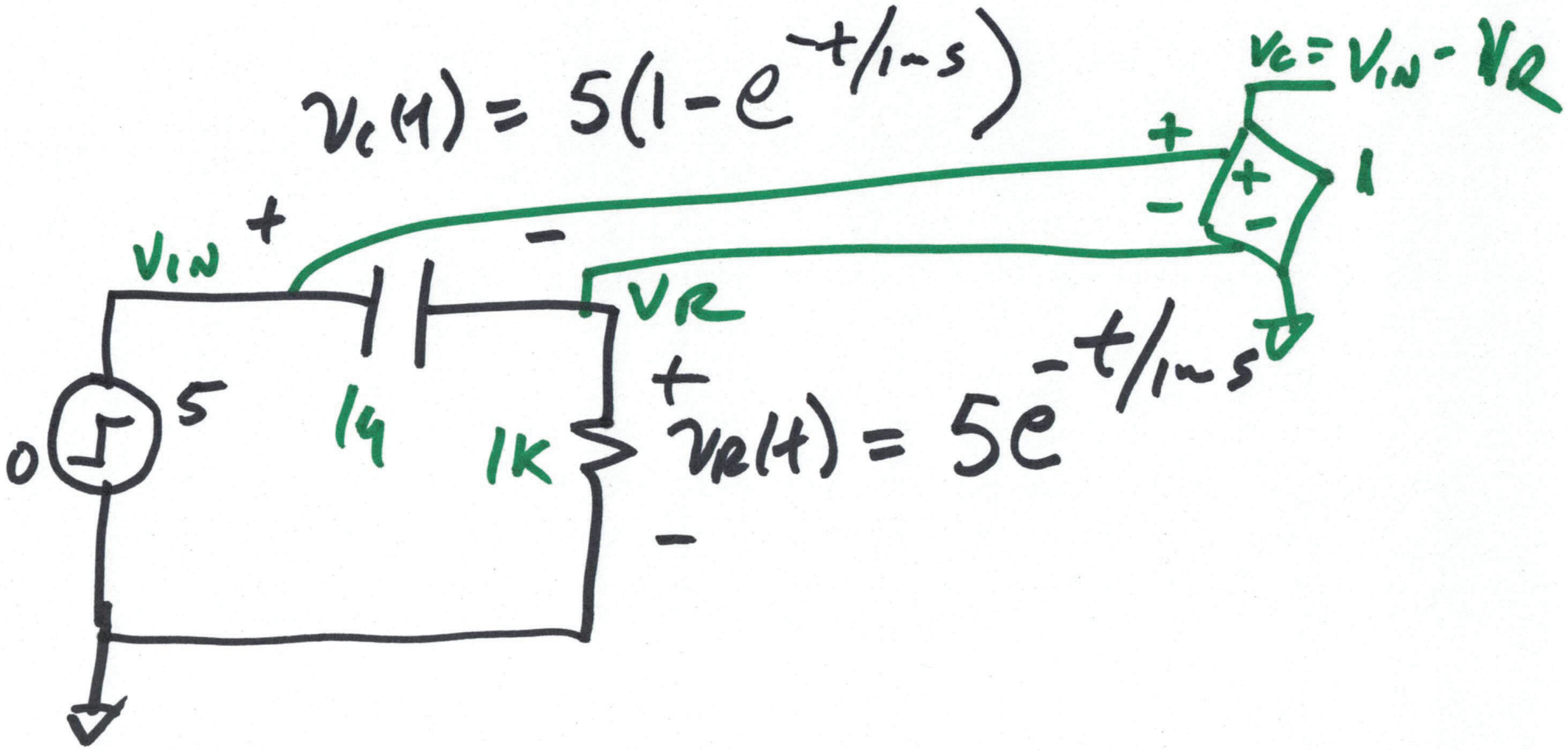


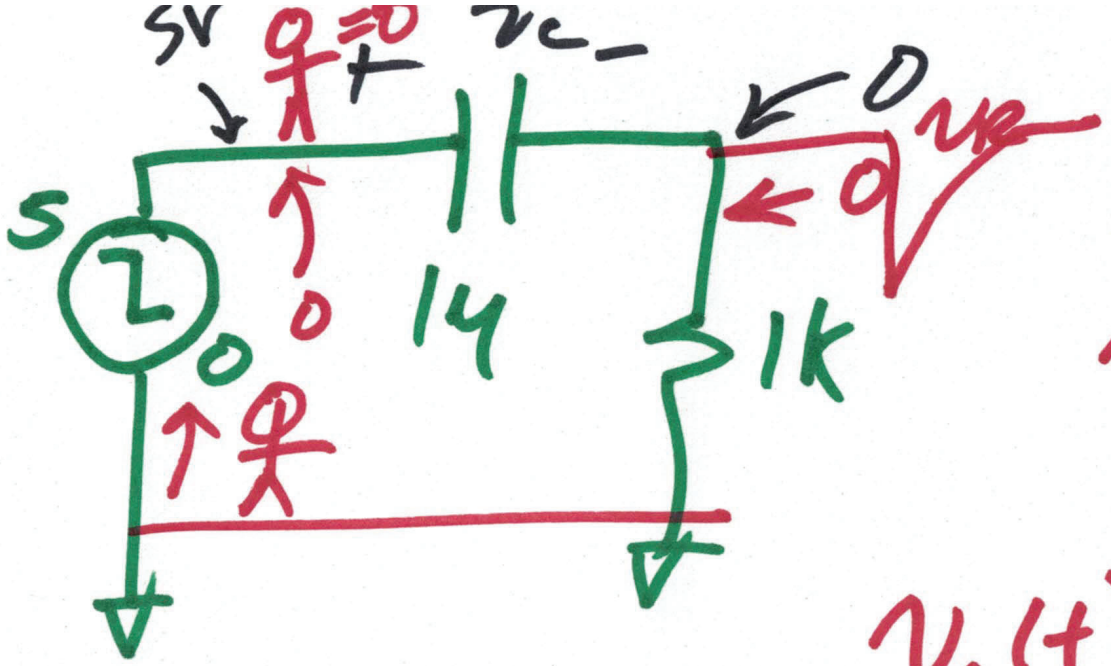
$$v_R(t) = 0 \quad t \le 0$$

$$v_c(t) = 5 + (0-5)e^{-t/1ms}$$

$$\boxed{v_R(t) = 5 - v_c(t) = 5e^{-t/1ms}}$$

10)


$v_c(t) = 5(1 - e^{-t/1ms})$
$v_c = v_{IN} - v_R$
v_{IN}
v_R
$v_R(t) = 5e^{-t/1ms}$
5
1μ
1K
0
1

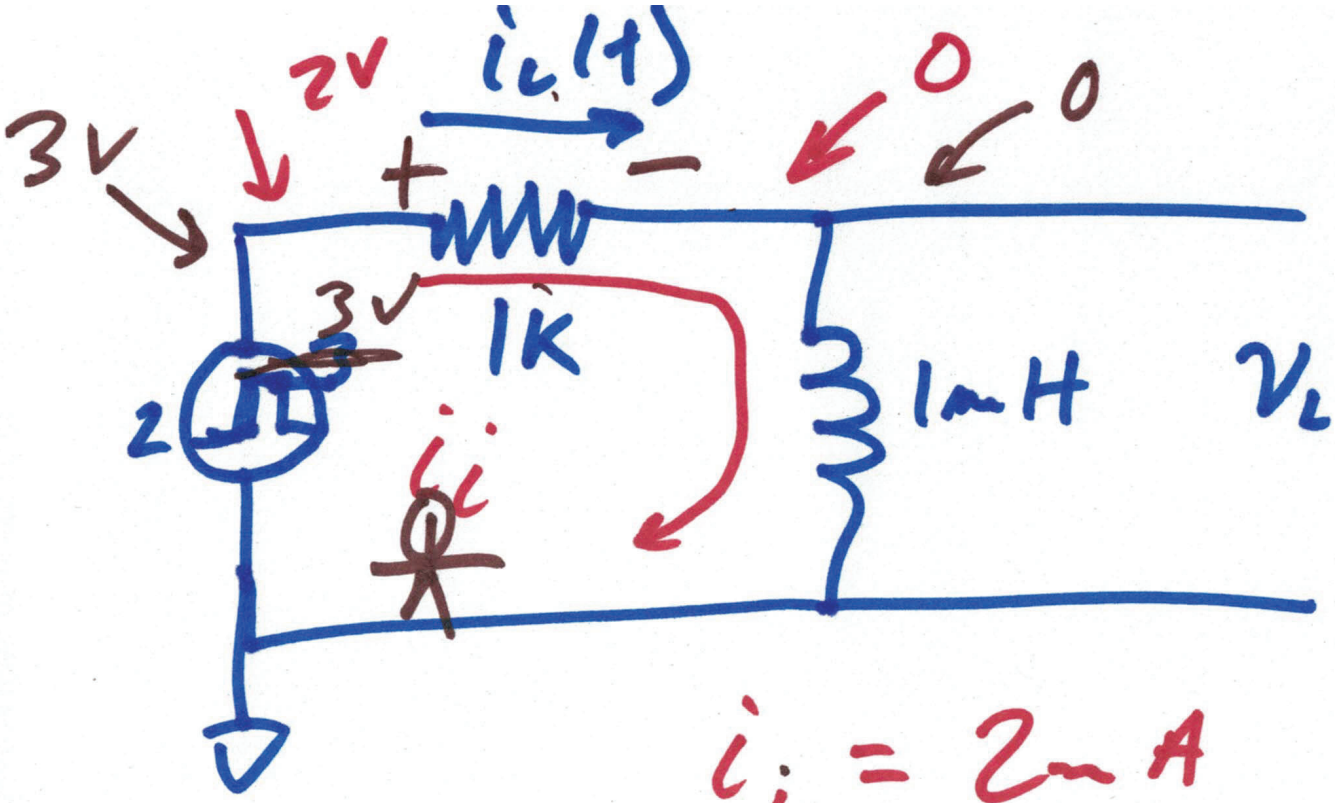


$v_i = 5$

$v_f = 0$

$v_c(t) = 5e^{-t/1ms}$

$-v_c(t) = v_R(t) = -5e^{-t/1ms}$



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

$$i_i = 2mA$$

$$i_f = 3mA$$

$$i_L(t) = 3mA + (2mA - 3mA)e^{-t/1\mu s}$$

$$v_L(t) = 3 - i_L \cdot 1K = 3 - 1K(3mA - 1mAe^{-t/1\mu s})$$