EEC 180A (Prof. V.G. Oklobdzija) **Quiz -4** **Spring 2000**

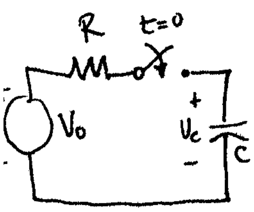
**Your Name:** KEY

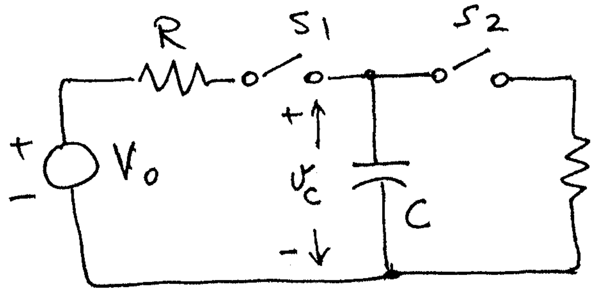
**Problem #1:** Digital CMOS inverter can be approximated as a circuit given in the figure.

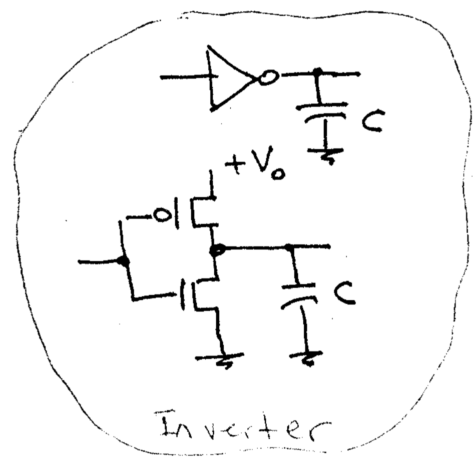
(a.) find the expression for the voltage $V_C$ (as a function of time t) when switch S1 is ON and S2 is off. Assume that the capacitor C was completely discharged before S1 was turned ON. Draw a graph of $V_C(t)$

(b.) find the expression for the voltage $V_C$ (as a function of time t) when (after sufficient time has elapsed to charge the capacitor C fully) the switch S1 is turned off and switch S2 is turned on. Draw a graph: $V_c(t)$

Note: this is the first grade college physics (Sears & Zemansky) problem (for some of you perhaps a high-school problem). (12 th grade)




(a) KCL:

$$C\frac{dV_c(t)}{dt} + \frac{V_c(t) - V_0}{R} = 0$$

(1) $$\frac{dV_c(t)}{dt} + \frac{V_c(t)}{RC} = \frac{V_0}{RC}$$

(2) $$V_c(t) = K_1 + K_2 e^{-t/\tau}$$

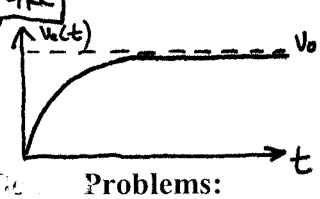
substitute 2 into 1) $$-\frac{K_2}{\tau} e^{-t/\tau} + \frac{K_1}{RC} + \frac{K_2 e^{-t/\tau}}{RC} = \frac{V_0}{RC}$$

$$\Rightarrow K_1 = V_0 \quad \tau = RC$$

$$V_c(t) = V_0 + K_2 e^{-t/RC}$$

initial conditions) $V_c(0) = 0 = V_0 + K_2 \therefore K_2 = -V_0$

$$\boxed{V_c(t) = V_0 - V_0 e^{-t/RC}}$$



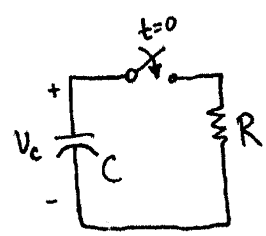

(b) $$C\frac{dV_c(t)}{dt} + \frac{V_c(t)}{R} = 0$$

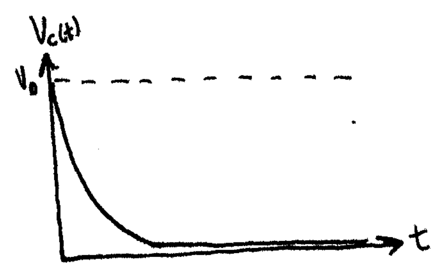
$$V_c(t) = K_1 e^{-t/RC}$$

initial condition

$V_c(0^-) = V_0 = K_1$

$$\boxed{V_c(t) = V_0 e^{-t/RC}}$$




Problems: