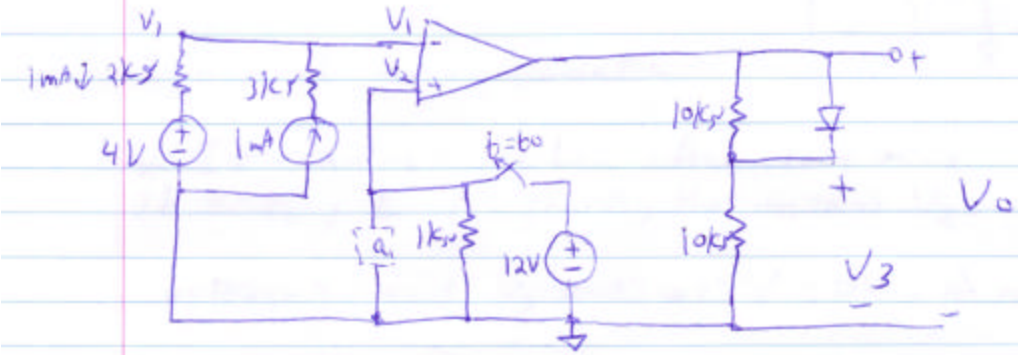
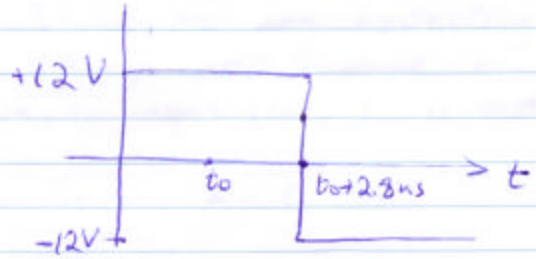
Homework #10 Solutions



Rail voltages = ±12



a) Choose either an R, C, or L to go in box a to produce the $V_o(t)$ shown above.

For V_o to be +12V V_2 should be more than V_1; $V_2 > V_1$. When V_2 drops below V_1, V_o will switch from +12V to -12V.

First we need V_1

note that no current goes into the op amp

so the 1mA current goes into the 2kΩ and 2kΩ resistors so

$V_1 = +4V + 1mA \times 2k\Omega = 6V$

To Find the component:-

* It can not be L after long time
At $t = t_0^-$, L is short, that means V_2 = 0V=+12V??

. A node

cannot have ~~this~~ ~~two~~ voltages. It is not L

* Since we are expecting the voltage at V_2 to change ~~...~~ over time and not instantaneously, it is not a R

* It is a C

$V_c(t_0^-) = +12$

$V_c(t_0^+) = +12V$ (initial value)

$V_c(t_0 \to \infty) = 0V$ (final value)

$\tau = RC = 1k\tau C$

$V_c(t) = V_f + (V_i - V_f)e^{-t/\tau}$

$= 12 \; e^{-t/\tau}$

$= +12\, e^{-t/\tau}$

if we take $t_0 = 0$ s

$V(2.8ms) = +12^{-2.8ms/\tau}$

At 2.8 ms $V_2 = V_1 = 6$ (V_0 switches to -12)

$$\Rightarrow \quad +12e^{\frac{-2.8\,ms}{\tau}} = 6$$

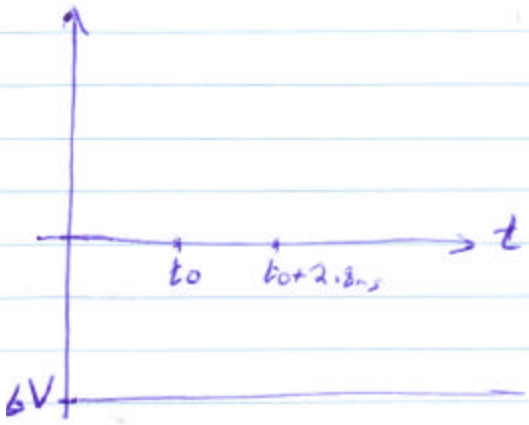
$$\Rightarrow \quad e^{\frac{-2.8\,ms}{\tau}} = \frac{6}{12}$$

$$\frac{-2.8\,ms}{\tau} = \ln\frac{1}{2}$$

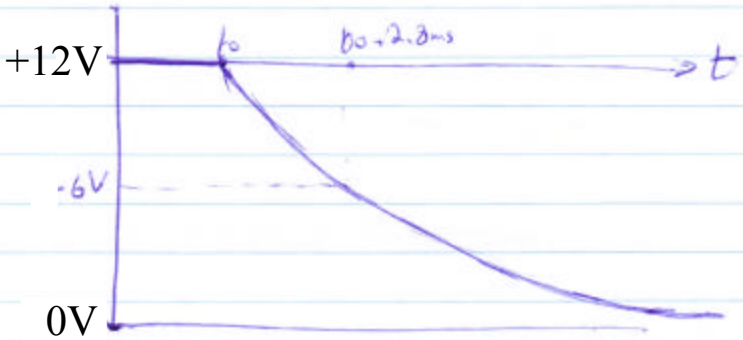
$$\tau = \frac{-2.8\,ms}{-0.693} = 4.04\,ms$$

$$C = \frac{4.04\,ms}{1\,k\Omega} = 4.04\,\mu F$$

b) $V_0(t)$ is not going to change over time



2 a) $V_2(t)$ is going to discharge exponentially from 0 to -12V

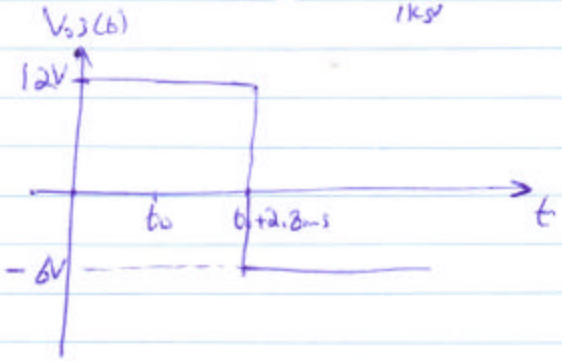


b) $V_3(t)$

when $V_o = 12V$, the diode is forward biased and $V_3 = V_o = 12V$

when $V_o = -12V$, the diode is reverse biased and $V_3 = \frac{1}{2} \times -12 = -6V$

drop across 1kΩ



3. Ix=0□

I1=20exp^(45)/(j6k-j2k)=20exp^(45)/j4k=5mexp^(45-90)□

□

I1=5mexp(-45)A□

□

i1(t) = 5mcos(52t-45)A