Physics 116B 2005 Set 1 solutions © Bobrow, Instructors' Manual
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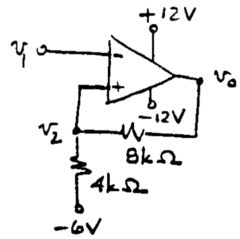
$\boxed{10.70}$



From Example 10.7,

$$V_1 = \frac{R_1}{R_1+R_2}V_{cc} + \frac{R_2}{R_1+R_2}V_r$$

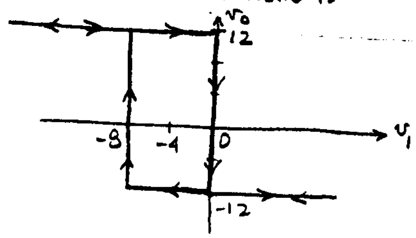
$$V_1 = \frac{4k}{4k+8k}(12) + \frac{8k}{4k+8k}(-6)$$

$$V_1 = \frac{4k}{12k}(12) + \frac{8k}{12k}(-6) = 4-4 = \underline{\underline{0V}}$$

$$V_2 = \frac{R_1}{R_1+R_2}(-V_{cc}) + \frac{R_2}{R_1+R_2}V_r$$

$$V_2 = \frac{4k}{4k+8k}(-12) + \frac{8k}{4k+8k}(-6) = -4-4 = \underline{-8\ V}$$

Hence, the transfer characteristic is

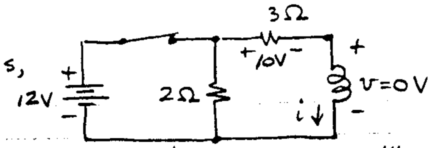


$\boxed{10.78}$ $f_o = \frac{R_2}{4R_1RC}$

(a) $R = R_1 = R_2 = 10k\Omega$, $C = 0.05\mu F$

$$f_o = \frac{10k}{4(10k)(10k)(0.05\mu)} = \underline{\underline{500\ Hz}}$$

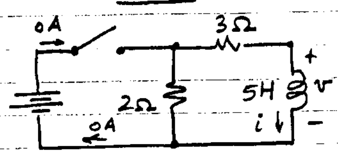
$\boxed{3.29}$ For $t<0s$,



For dc, the inductor is a short circuit. Thus, $v(t) = \underline{0V}$.

By Ohm's law, $i(t) = \underline{\frac{12}{3} = 4A} \Rightarrow i(0) = 4\ A$

For $t \geq 0s$,



By KVL, $v + 2i + 3i = 0$

$v + 5i = 0$

Since $v = 5\frac{di}{dt}$, then

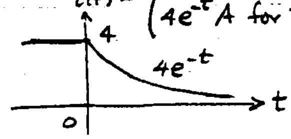
$$5\frac{di}{dt} + 5i = 0$$

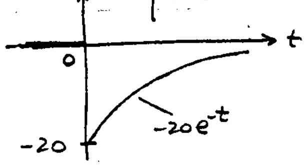
$$\frac{di}{dt} + i = 0 \Rightarrow i(t) = i(0)e^{-t} = \underline{4e^{-t}\ A}$$

Thus, $v(t) = 5\frac{di(t)}{dt} = 5\frac{d}{dt}(4e^{-t}) = \underline{-20e^{-t}\ V}$

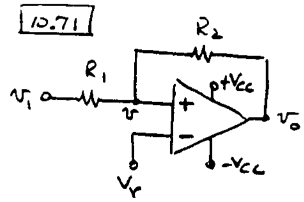
Hence,

$$i(t) = \begin{cases} 4\ A & \text{for } t<0s \\ 4e^{-t}\ A & \text{for } t\geq 0s \end{cases} \qquad v(t) = \begin{cases} 0\ V & \text{for } t<0s \\ -20e^{-t}\ V & \text{for } t\geq 0s \end{cases}$$





$\boxed{10.71}$



By KCL at node v,

$$\frac{v-v_1}{R_1} + \frac{v-v_o}{R_2} = 0$$

$$R_2v - R_2v_1 + R_1v - R_1v_o = 0$$

$$(R_1+R_2)v = R_1v_o + R_2v_1$$

$$\underline{\underline{v = \frac{R_1}{R_1+R_2}v_o + \frac{R_2}{R_1+R_2}v_1}}$$

Suppose that $V_r = 0V$.

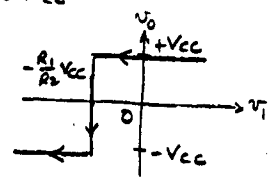
When $v_o = +V_{cc}$, then v_o remains $+V_{cc}$ for $v > V_r = 0V$, i.e., for

$$v = \frac{R_1}{R_1+R_2}(V_{cc}) + \frac{R_2}{R_1+R_2}v_1 > 0$$

$$R_1V_{cc} + R_2v_1 > 0$$

$$R_2v_1 > -R_1V_{cc}$$

$$v_1 > -\frac{R_1}{R_2}V_{cc}$$



Thus, when $v_1 < -\frac{R_1}{R_2}V_{cc}$, then v_o changes to $-V_{cc}$.

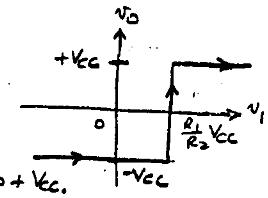
When $v_o = -V_{cc}$, then v_o remains at $-V_{cc}$ for $v < V_r = 0V$, i.e., for

$$v = \frac{R_1}{R_1+R_2}(-V_{cc}) + \frac{R_2}{R_1+R_2}v_1 < 0$$

$$-R_1V_{cc} + R_2v_1 < 0$$

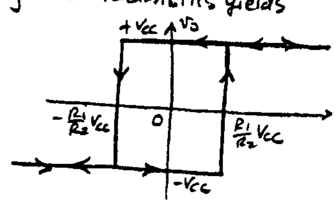
$$R_2v_1 < R_1V_{cc}$$

$$v_1 < \frac{R_1}{R_2}V_{cc}$$

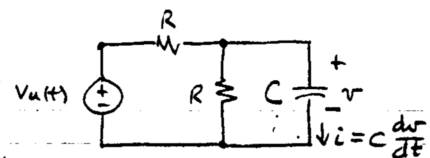


Thus, when $v_1 > \frac{R_1}{R_2}V_{cc}$, then v_o changes to $+V_{cc}$.

Combining the characteristics yields



$\boxed{3.42}$



By KCL,

$$\frac{v - Vu(t)}{R} + \frac{v}{R} + C\frac{dv}{dt} = 0$$

$$v - Vu(t) + v + RC\frac{dv}{dt} = 0$$

$$\frac{dv}{dt} + \frac{2}{RC}v = \frac{V}{RC}u(t)$$

For $t<0s$, $v(t) = \underline{0V}$ and $i(t) = \underline{0A}$

$\therefore v(0) = 0\ V$

For $t \geq 0s$,

$$\frac{dv}{dt} + \frac{2}{RC}v = \frac{V}{RC} \Rightarrow v(t) = \frac{V/RC}{2/RC} + Ae^{-2t/RC} = \frac{V}{2} + Ae^{-2t/RC}$$

$$v(0) = \frac{V}{2} + Ae^{-0} = 0 \Rightarrow A = -\frac{V}{2}$$

$$\therefore v(t) = \frac{V}{2} - \frac{V}{2}e^{-2t/RC} = \underline{\frac{V}{2}(1-e^{-2t/RC})}$$

Thus, $i(t) = C\frac{dv(t)}{dt} = C\frac{d}{dt}\left[\frac{V}{2} - \frac{V}{2}e^{-2t/RC}\right] = C\left(-\frac{V}{2}\right)\left(-\frac{2}{RC}e^{-2t/RC}\right)$

$$i(t) = \underline{\frac{V}{R}e^{-2t/RC}}$$

Hence, $v(t) = \underline{\underline{\frac{V}{2}(1-e^{-2t/RC})u(t)}}$ $\quad i(t) = \underline{\underline{\frac{V}{R}e^{-2t/RC}u(t)}}$