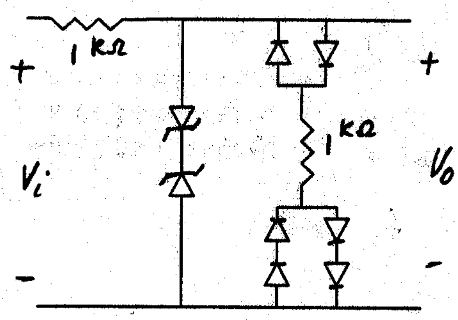
1-30 Points) Draw the transfer characteristic of the circuit shown for $-10<v_i<10$ and calculate the break points values.
$V_z=3$ volts and $V_{d(on)}=0.7$ volts.

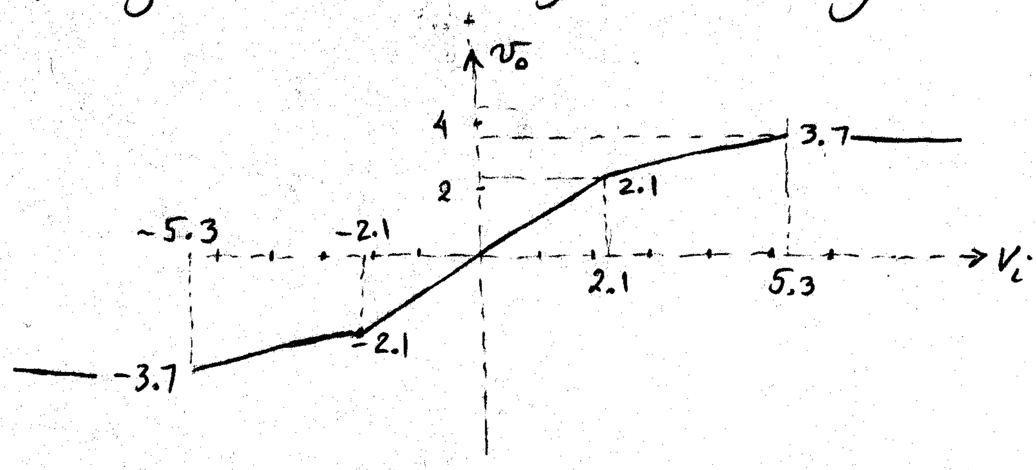



solution:

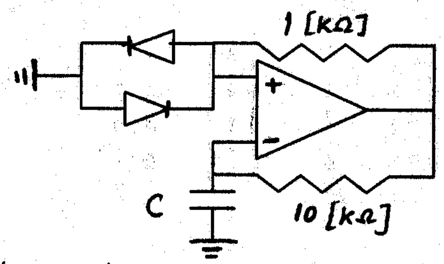
Before the input reaches to $3V_D(on) = 2.1^V$ all diodes are off and $V_o = V_i$ or the slope of the transfer characteristic is $\underline{1}$.

when $V_i > 2.1$, diodes conduct and the slope $= 1/2$

when the output reaches $V_z + 0.7 = 3.7$ [V], it will stay at that voltage. The Curve has Symmetric Property.



2- 35 Points) In the square/triangular waveform generator shown, find the vale of C so that the frequency of oscillation is 10 KHZ.
Vd(on)=0.7 [V] and L+ =-L- =10 [V].




$L_+ = -L_- = 10\,[V]$ $V_D(on) = 0.7\,[V]$

Solution :

The Capacitor Voltage has the general equation

$$V_C = A + B\,e^{-t/RC} \quad \text{where } R = 10^{k\Omega}$$

The Capacitor charge and discharge up to $V_D$ and $-V_D$.

$$\begin{cases} V_c(t=0) = -V_D = -0.7\,[V] \\ A + B = -0.7\,[V] \end{cases} \quad \begin{cases} V_c(t=\infty) = L_+ = 10^V \\ A = 10^V \end{cases} \Rightarrow B = -10.7\,[V]$$

Thus

$$V_C = 10 - 10.7\,e^{-t/RC}$$

the Capacitor voltage should reach 0.7 [V] at $\frac{T}{2}$ time

$$\begin{cases} t = \frac{T}{2} \\ V_c = 0.7 \end{cases} \quad 0.7 = 10 - 10.7\,e^{-t/RC}$$

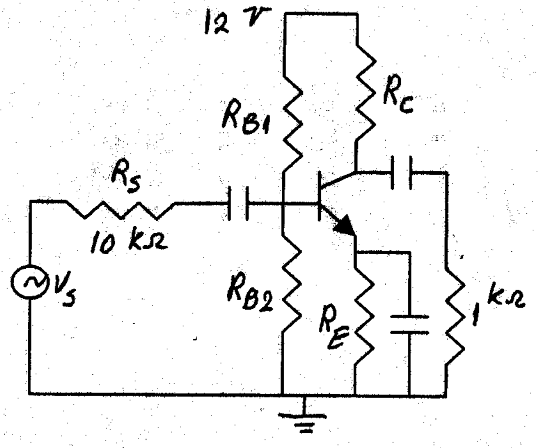
$$-10.7\,e^{-t/RC} = -9.3$$

$$\frac{t}{RC} = 0.14 \qquad \frac{T/2}{RC} = 0.14$$

$$T = 0.28\,RC \qquad C = \frac{1}{0.28\,Rf} = \frac{1}{0.28 \times 10^4 \times 10^4}$$

$$\boxed{C = 35.7\,nF}$$

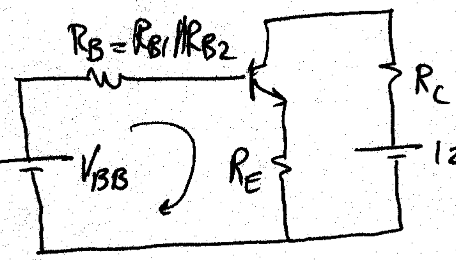
3-35 Points) In the circuit shown, Find $R_{B1}$, $R_{B2}$ $R_E$ and $R_C$ so that the $I_{CQ}$ =2 mA and $V_{CEQ}$=2 [V]
Note: Capacitors are open for DC.
Vcc=12 [V] and beta=100.




solution :

as a reasonable choice

We choose $V_{BB} = \frac{1}{3} V_{cc} = 4\ [V]$




and the Current in $R_{B1}$, $R_{B2}$ Branch

$= \frac{1}{10} I_{CQ} = 0.2$ mA

$$R_{B1} + R_{B2} = \frac{V_{cc}}{I} = \frac{12}{0.2} = 60\,[k\Omega]$$

$R_{B1} + R_{B2} = 60\,k$ (1)

$$V_{BB} = \frac{R_{B2}}{R_{B1}+R_{B2}} V_{cc} = \frac{1}{3} V_{cc} \qquad \frac{R_{B2}}{R_{B1}+R_{B2}} = \frac{1}{3} \qquad R_{B1} = 2R_{B2} \quad (2)$$

from (1) and (2) $\Rightarrow \begin{cases} R_{B1} = 40\,[k\Omega] \\ R_{B2} = 20\,[k\Omega] \end{cases}$

writing a KVL at the input loop

$4 = 13.33\, I_B + 0.7 + R_E I_{CQ}$ $\qquad I_{CQ} = 2\,mA \quad I_B = 0.02\,mA$

Then $\boxed{R_E = 1.5\,k}$

from $V_{CEQ}$ we obtain $R_C$

$V_{CEQ} = V_{cc} - I_c(R_c + R_E)$ $\qquad 2 = 12 - 2(R_c + 1.5)$

$\boxed{R_c = 3.5\,k}$