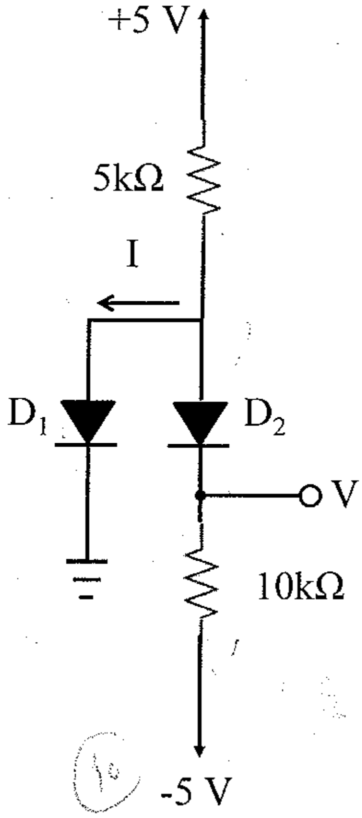
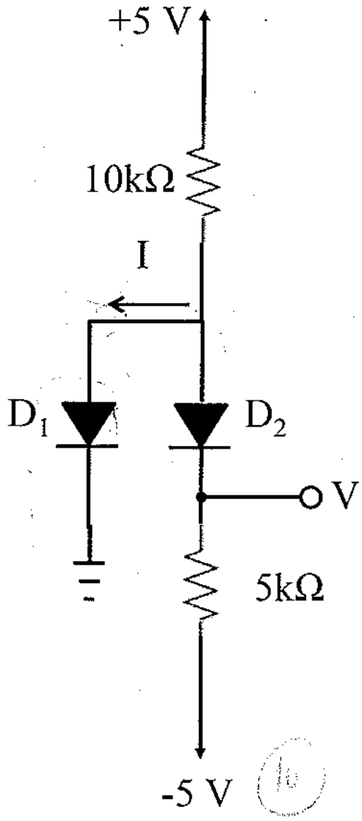
Problem 1

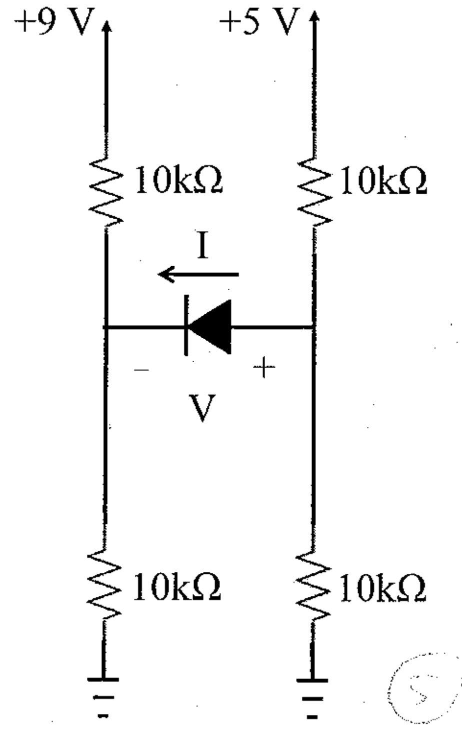
Assuming that the diodes in the circuits below are ideal, find the values of the labeled voltages and currents.



(a)

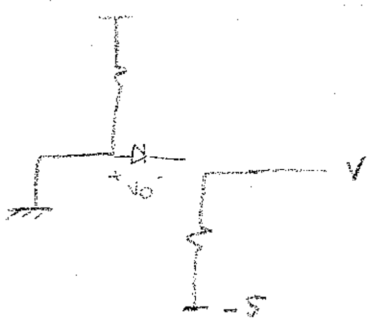


(b)



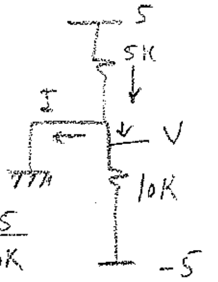
(c)

part a assume D_1 ON D_2 off



$V_{D_2} = -5$ wrong assu

both ON



$\boxed{V = 0V}$

$I = \frac{5}{5K} - \frac{0+5}{10K}$

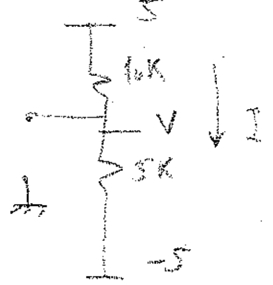
$= 1 - 0.5$

$\boxed{I = 0.5\,mA}$

$I_{D_1} > 0$, $I_{D_2} = 0.5\,mA > 0$

(b) assume D_2 ON, D_1 off

$\boxed{I = 0}$



$V = \frac{5 \cdot 5}{15} - \frac{5 \times 10}{15}$

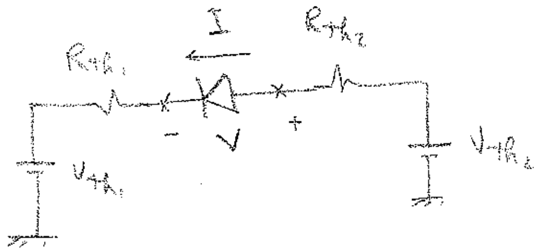
$= -\frac{5}{3}\,V$

$\boxed{V = -1.67V}$

$\boxed{I_{D_1} = 2/3\,mA} > 0$

$V_{D_1} = -1.67 < 0$

(c) using thev.



$R_{th_1} = R_{th_2} = 10K // 10K$

$= 5K\Omega$

$V_{Th_1} = 9 \frac{10}{10+10} = 4.5V$

$V_{th_2} = 5 \frac{10}{10+10} = 2.5V$

$\because V_{th_2} < V_{th_1} \therefore$ D is off

$\therefore I = 0 \qquad V = V_{th_2} - V_{th_1} = 2.5 - 4.5 = -2V < 0$

* $V_D < 0$ assumption is verified

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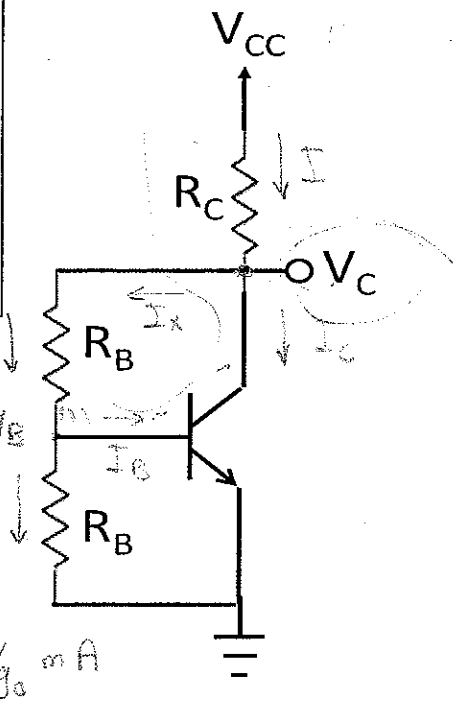
Problem 2

Using a 5-V power supply, V_{CC}, the feedback bias circuit in the figure shown below provides $I_C = 1\text{mA}$ and $V_C = 2\text{V}$ for $\beta_F = 90$.

(i) Find R_C and R_B.

(ii) Find V_C and I_C for very large value of β_F (i.e., $I_C \approx I_E$). In which mode does the transistor operate? What is the ideal value of β_F?



$\therefore V_{CE} = 2V > 0.2 \quad Q$ is active

(i)

$$I = \frac{5 - 2V}{R_C} = \frac{3}{R_C}$$

$$V_{BE} = 0.7\,V$$

$$V_B = 0.7\,V \quad , \quad I_B = \frac{I_C}{\beta} = 1/90 \text{ mA}$$

KCL at (1).

$$\frac{V_C - V_B}{R_B} = \frac{V_B}{R_B} + I_B$$

$$\frac{1}{R_B}\left[V_C - 2V_B\right] = I_B \qquad R_B = \frac{V_C - 2V_B}{I_B} = 54K\Omega$$ (5)

$$\therefore I_X = \frac{V_C - V_B}{R_B} = \frac{2 - 0.7}{54} = \frac{13}{540}\text{ mA} = 0.0241\text{ mA}$$

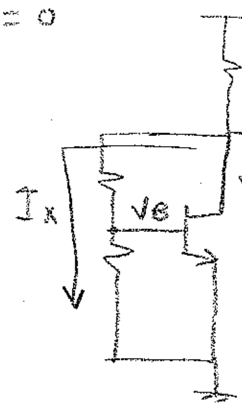
$$\therefore I = I_C + I_X = 1.0241\text{ mA}$$

$$R_C = \frac{V_{CC} - V_C}{I} = 2.929 \cong 3K\Omega$$ (5)

(ii) if B is large $\therefore I_E \cong I_C \quad , \quad I_B = 0$

assume Active

$$V_{BE} = 0.7\,V \quad , \quad V_B = 0.7\,V$$



$$I_X = \frac{V_B}{R_B} = \frac{7}{540}\text{ mA} = 0.1296\text{ mA}$$

$$\therefore \boxed{V_C = I_X \times 2R_B = 1.4\,V}$$ (4)

$$\therefore \quad I = \frac{V_{CC} - V_C}{R_C} = 1.2\,mA$$

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$$\boxed{I_C = 1.07\,mA = I_E}$$

Check $V_{CE} = 1.4V > 0.2$

Assumption is collect

Q is Active

* for Ideal value of $\beta_f = \infty$ $\boxed{2}$

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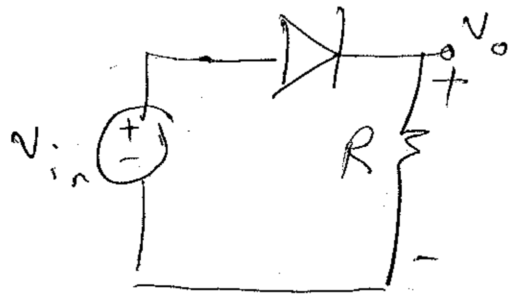
Problem 3-(b)

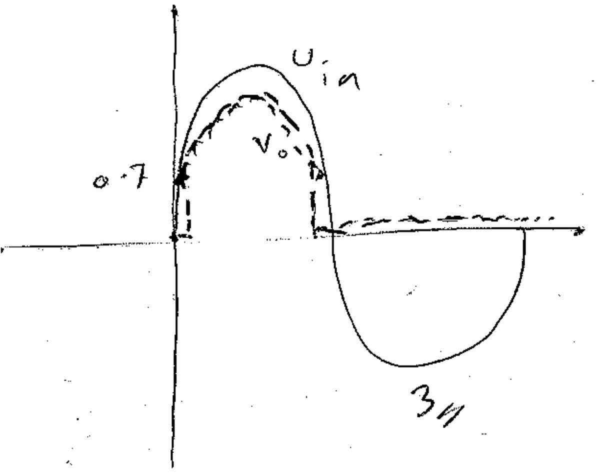
(i)

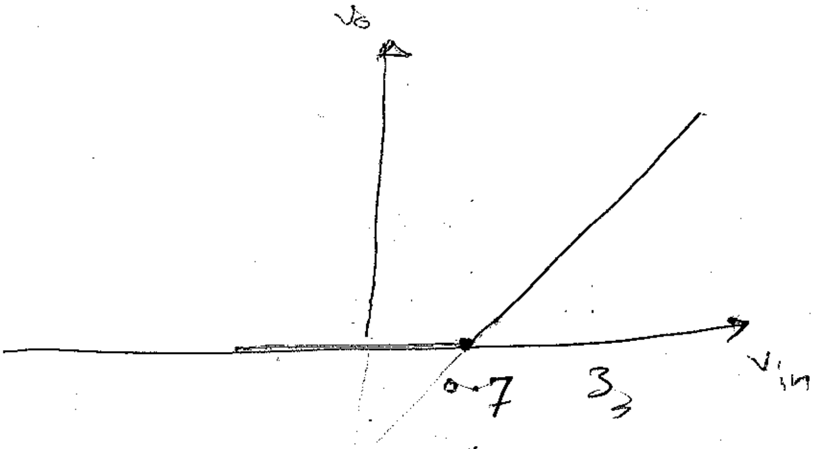


→ For $V_{in} < 0.7$

$V_o = 0$

→ For $V_{in} > 0.7 \Rightarrow V_o = V_{in} - 0.7$



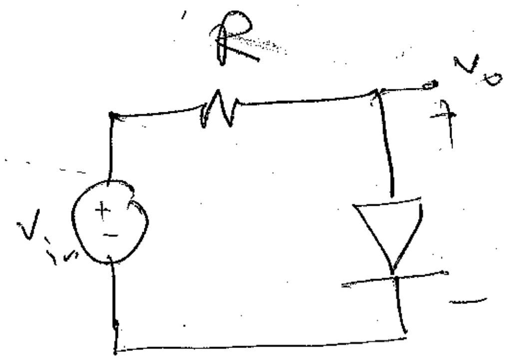


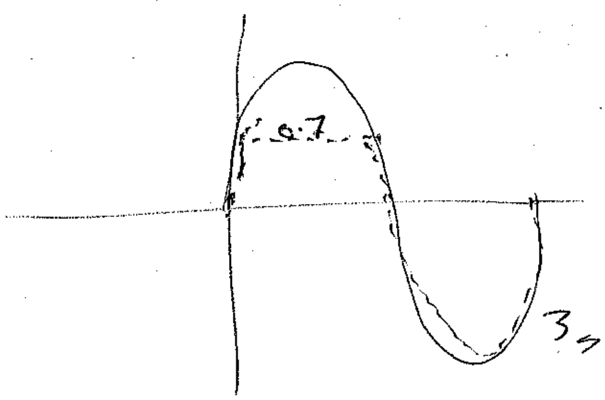
(ii) → For $V_{in} < 0.7$

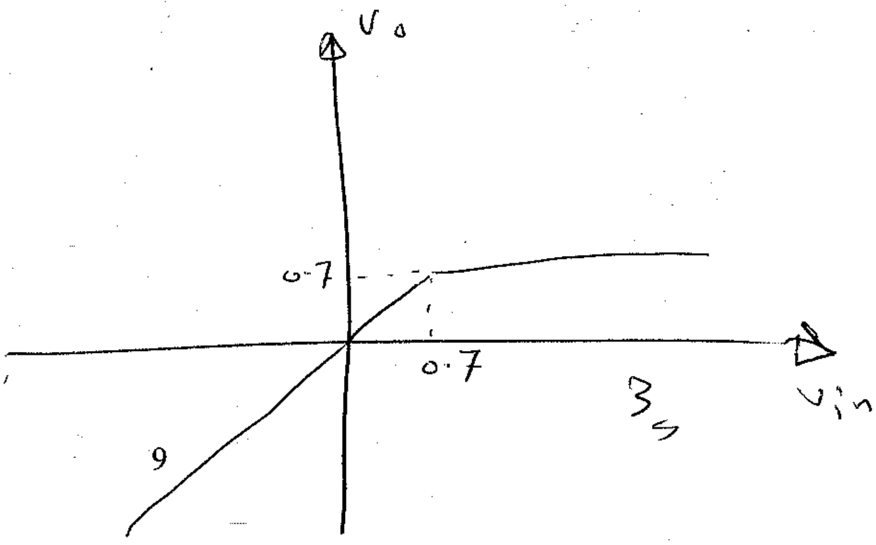
$V_o = V_{in}$

→ For $V_{in} > 0.7$

$V_o = 0.7$



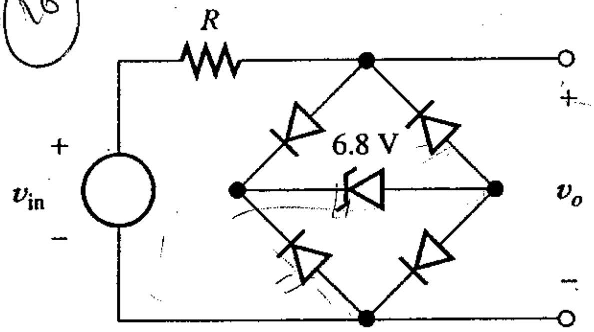




Problem 4

[a]

Consider the circuit in the figure shown. Allow 0.6V for the forward drops of the diodes. Sketch the transfer characteristics v_o versus v_{in}.



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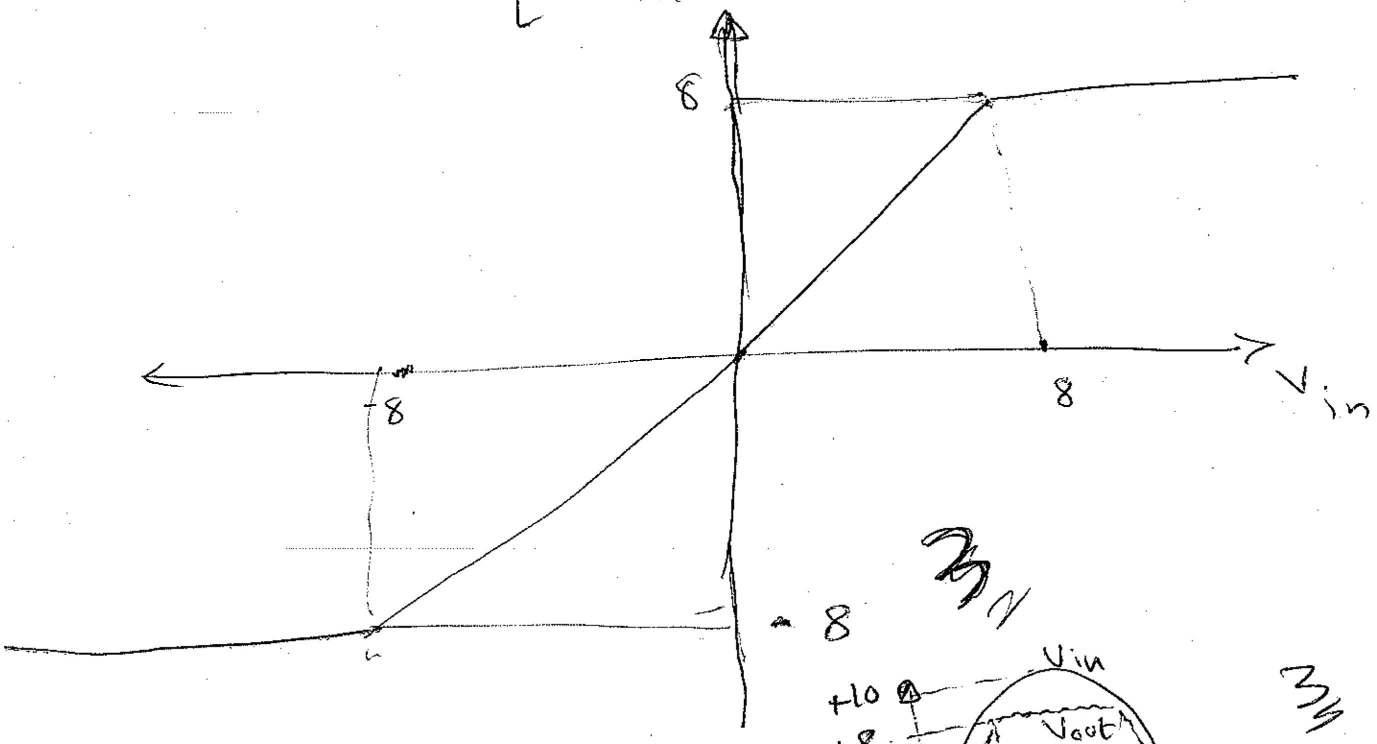
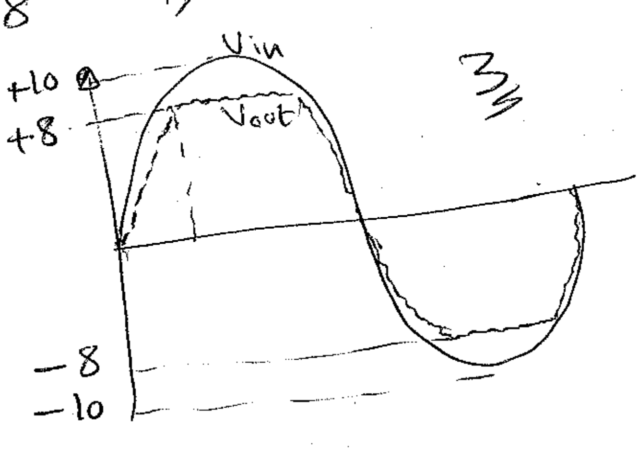
(i) $V_{in} > 0$
- $V_{in} < 8 \Rightarrow V_o = V_{in}$
- $V_{in} > 8 \Rightarrow V_o = 8V$

(ii) $V_{in} < 0$
- $V_{in} > -8 \Rightarrow V_o = V_{in}$
- $V_{in} < -8 \Rightarrow V_o = -8V$





[4][b]

[i] $V_B = -0.1\ V$

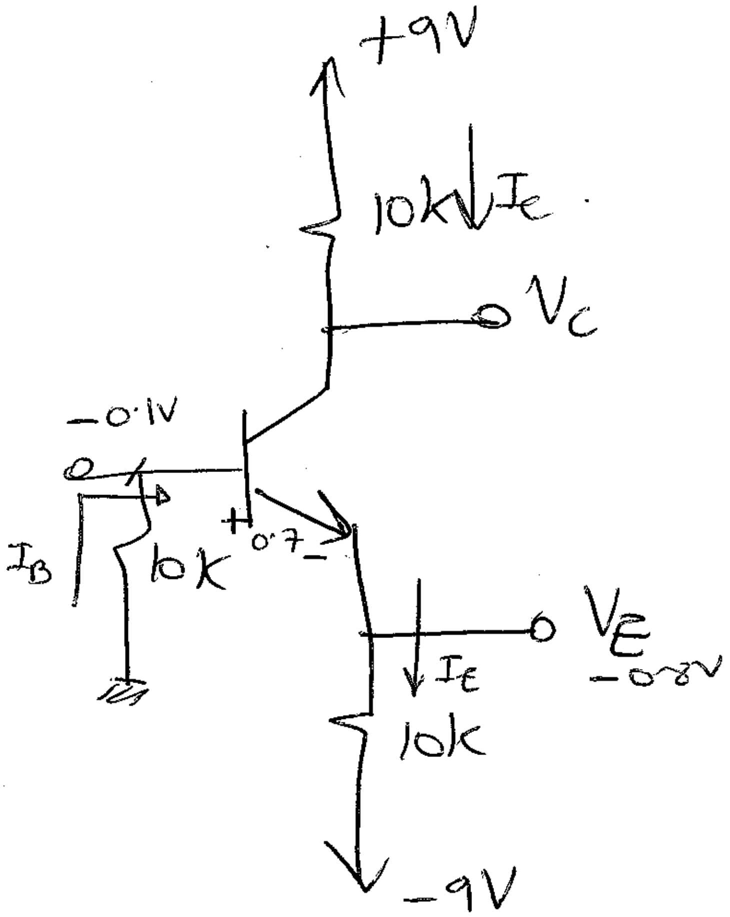
$V_{BE} = 0.7$

$V_B = -0.1$

$\therefore V_E = -0.8V$

$$I_E = \frac{-0.8-(-9)}{10k}$$

$$= 0.82\,mA$$



$$I_B = \frac{0-(-0.1)}{10k} = 0.01\,mA$$

$I_C = I_E - I_B = 0.81\,mA$

$V_C = 9 - 10k(I_c) = 0.9V$

$V_{CE} = 0.9 - (-0.8) = 1.7V$

$V_{CE} > 0.2 \quad \therefore$ active.

$$\beta = \frac{I_C}{I_B} = \frac{0.81mA}{0.01mA} = 81$$

[ii] $\beta = \infty$

$\therefore I_B = 0 \quad , \quad V_B = 0$

$V_E = -0.7\,V$

$$I_E = \frac{-0.7 - (-9)}{10k} = 0.83\,mA$$

$\because I_B = 0 , \quad \therefore I_E = I_C = 0.83\,mA$

$\therefore V_C = 9 - 10k\,(0.83m)$

$= 9 - 8.3 = 0.7\,V$

$V_{CE} = 1.4V > 0.2$ $\quad \therefore$ active.