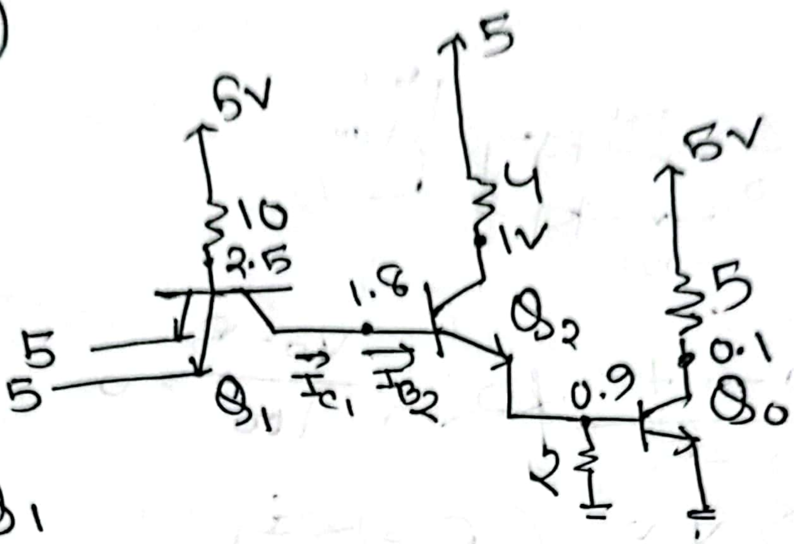
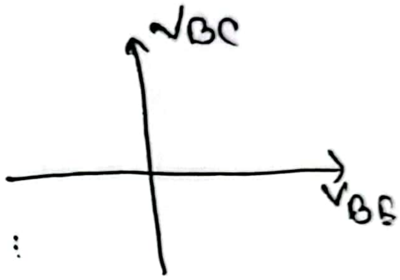
1.(a)



For Q1

$V_{BC}>0$, $V_{BE}<0$ } Rev Active



Let's assume Q_2 & Q_0 in ~~SAT~~ saturation mode:

~~for~~ $V_{B0}=0.9$, $V_{C0}=0.1V$

$V_{B2}=0.9+0.9=1.8V$

$V_{C2}=0.9+0.1=1V$

In rev active

$V_{BC}=0.7V$ ∴ $V_{B1}=1.8+0.7=2.5V$

∴ $I_{B1}=\frac{5-2.5}{10}=0.25$

$I_{ER}=\beta_R\times I_{B1}=0.025$

$I_{E1}=I_{ER}+I_{E}=0.05$

$I_{C1}=I_{B1}+I_{E1}=0.3$

$I_{C1}=I_{B2}=0.3$

$I_{C_2} = \frac{5-1}{4} = 1V$

$\cancel{I_{C_0}} = I_{E_2} = I_{B_2} + I_{C_2}$
$= 1.3$

$I_B = \frac{0.9}{2} = 0.45$

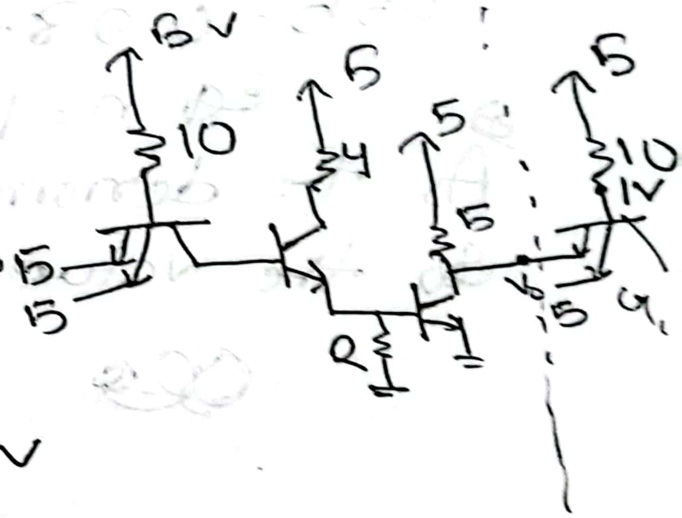
$I_{B_0} = I_{E_2} - I_B = 0.85$

$I_{C_0} = \frac{5-0.1}{5} = 0.98$

$\therefore$ For Q_0, $\frac{I_{C_0}}{I_{B_0}} = 1.15 < \beta_F$

$\therefore Q_0$ in saturation

b



$V_0 = 0.1$

Q_1 in saturation mode

$V_{BE} = 0.9$

$V_B = 0.9 + 0.1 = 1V$

$V_C = 0.1 + 0.1 = 0.2V$

$I_{BQ_1} = \frac{5-1}{10} = 0.4$

$I_{EQ_1} = I_{BQ_1} = 0.4$

$I_{C_0} = 0.98$

$I_{C_{max}} = I_{B_0} \times \beta_F$
$= 0.85 \times 30$
$= 25.5$

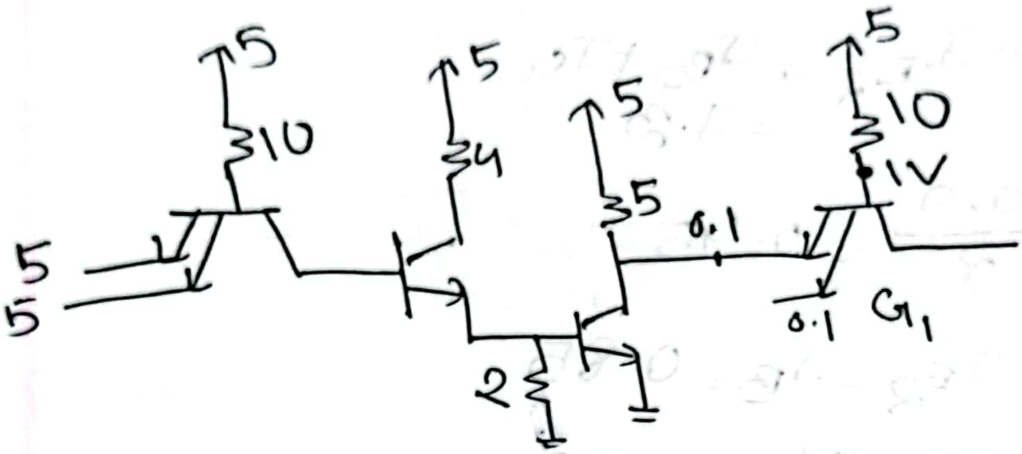
$I_{C_{max}} = I_{C_0} + n \times I_{EQ_1}$

$25.5 = 0.98 + n \times 0.4$

$n = 61.3$

$\lfloor n \rfloor = 61$

c



$$I_L = \frac{0.4}{2} = 0.2$$

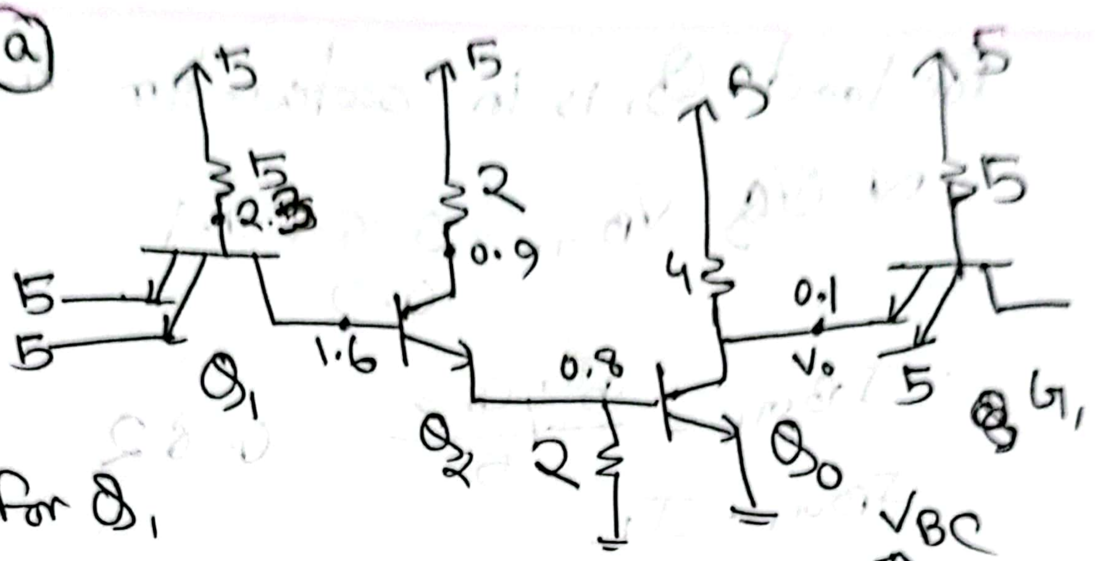
$I_{cmax} = I_{co} + n \times I_L$

$\therefore 25.5 = 0.98 + n \times 0.2$

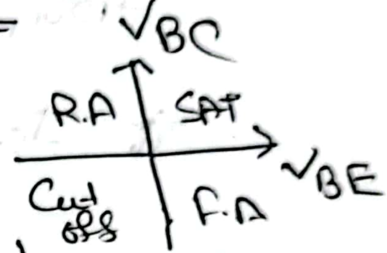
$n = 122.6$

As the denominator I_L is decreased so the value of n has increased.

2. (a)



As for Q_1



$V_{BE} < 0$

$V_{CE} > 0$

so in reverse active mode

Q_2 & Q_0 is ~~sat~~ in saturation mode.

$\underline{Q_0}$ $V_{B_0} = 0.8$, $V_{C_0} = 0.1$

$\underline{Q_2}$ $V_{B_2} = 0.8 + 0.8 = 1.6$ | $V_{C_2} = 0.8 + 0.1 = 0.9$

$\underline{Q_1}$ ·Rev active

$V_{BC} = 0.7$ ∴ $V_B = 0.7 + 1.6 = \cancel{2.5}\ 2.3$

$I_{B_1} = \dfrac{5 - 2.3}{5} = 0.54$

$I_{ER} = B_{rev} \times 0.54 = 0.054$

$I_E = 0.108$

∴ $I_{C_1} = 0.108 + 0.54 = \cancel{0.6} - I_{B_2} = 0.648 = I_{B_2}$

$I_{C_2} = \dfrac{5 - 0.9}{2} = 2.05$

$I_{E_2} = 2.698$ | $I_{B_0} = \cancel{2.65} - 0.4 = 2.698 - 0.4 = \cancel{2.258}\ 2.298$

$I_B = \dfrac{0.8}{2} = 0.4$ | $I_{C_0} = 1.225$

For load Q_1 is in saturation mode

$V_{BQ_1} = 0.8 + 0.1$

$= 0.9$

$\therefore I_{BQ_1} = \frac{5-0.9}{5} = 0.82$

$I_{BQ_1} = I_L$

$\therefore I_{cmax} = I_{B_0} \times 40$

$= 91.92$

$\frac{91.92}{\cancel{20}} = 1.225 + n \times 0.82$

$n = 110.60$

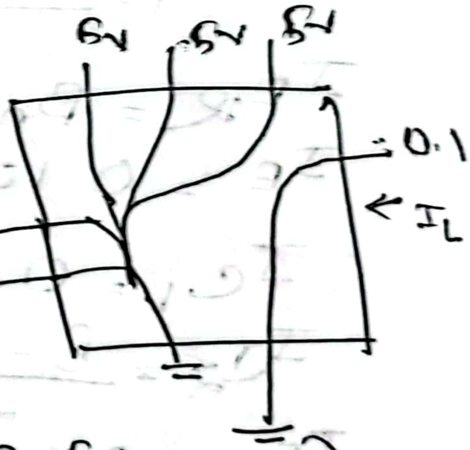
$\therefore \lfloor n \rfloor = 110$

b

$I_{L_1} = 0.82$

$\therefore I_L = 0.82 \times 25 = 20.5$

~~$I_{C_0} = I_L + I_C$~~



$P = (5-0) \times (I_x + I_y + I_1 + I_2 + I_3) + 0.1 \times I_L$

$= 5 \times (0.54 + 0.054 + 0.54 + 2.05 + 1.225) + 0.1 \times 20.5$

$= 21.665\ mW$

e

$$\beta = \frac{I_{CO} + n I_L}{I_{B0}}$$

$$= \frac{1.2215 + 110 \times 0.82}{2.298}$$

$$= 39.78.$$