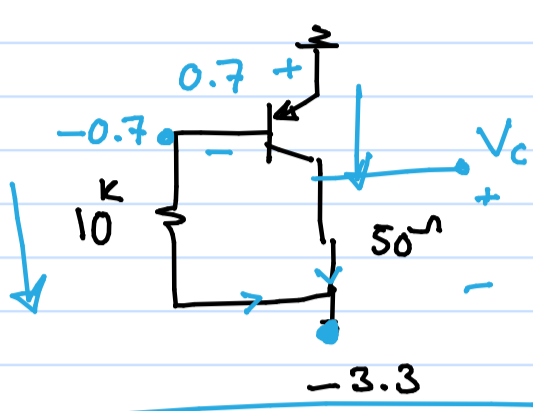
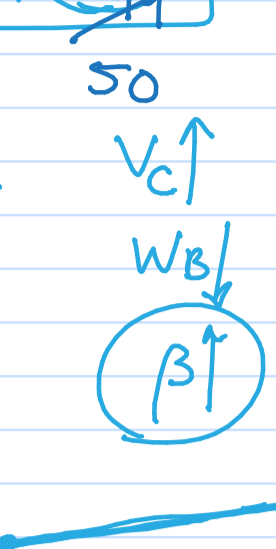
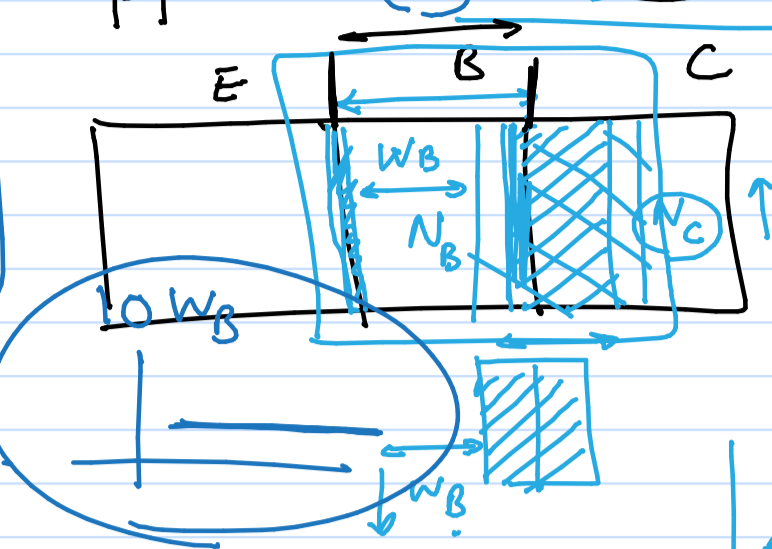
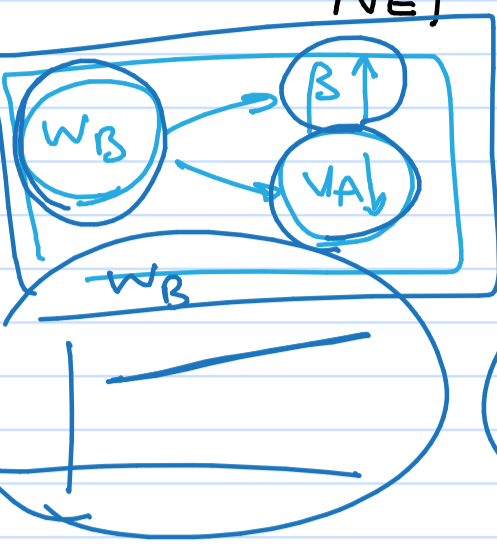
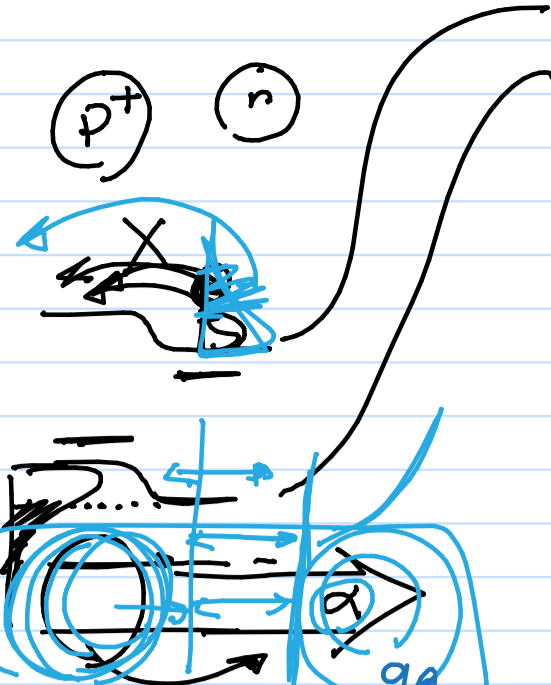
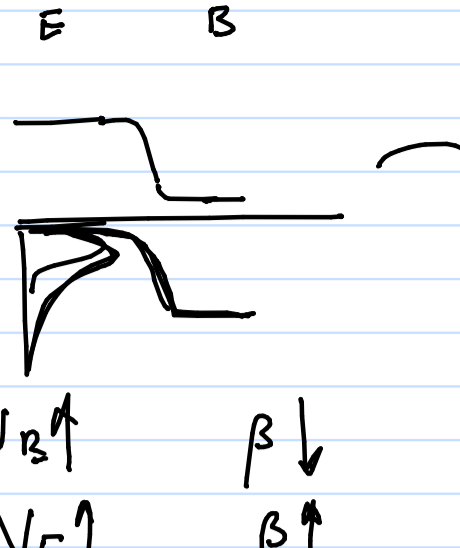
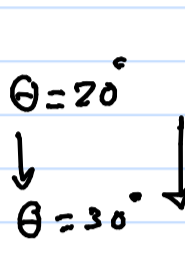
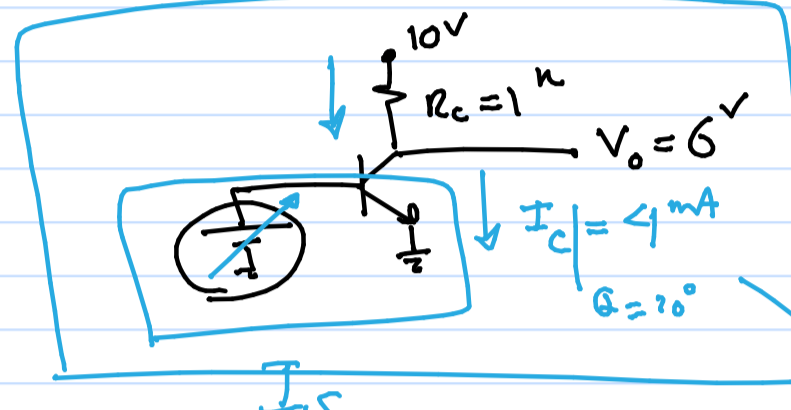


$$\frac{I_c}{I_E} = \alpha = \frac{\beta}{1+\beta}$$



$$I_B = \frac{3.3 - 0.7}{10^4} = 0.26 \text{ mA}$$

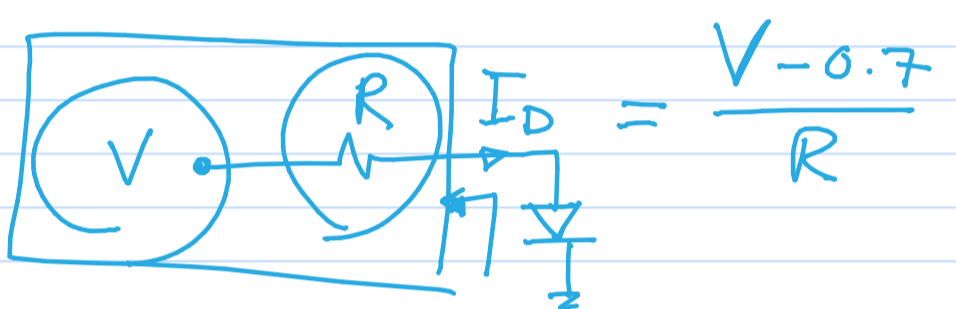
$$\beta I_B = I_C = I_E = 26 \text{ mA}$$



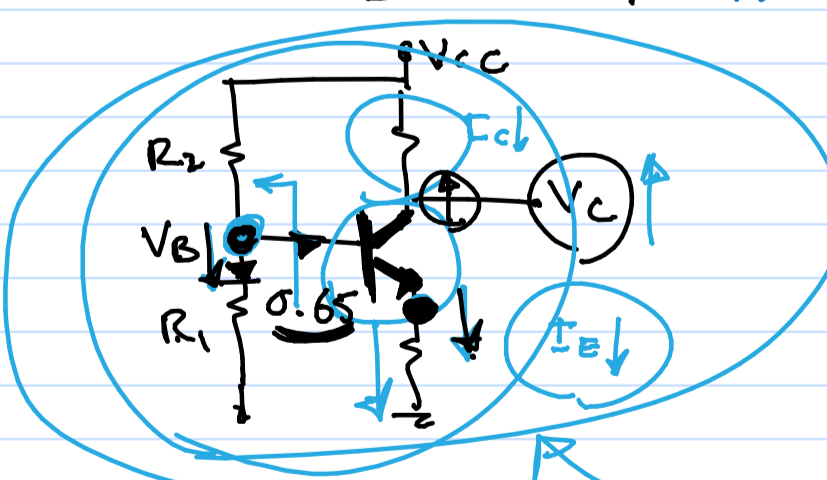
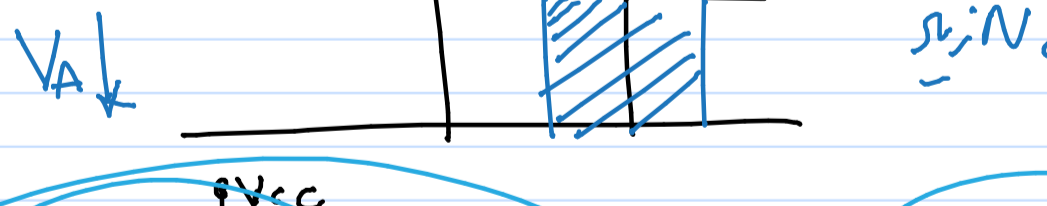
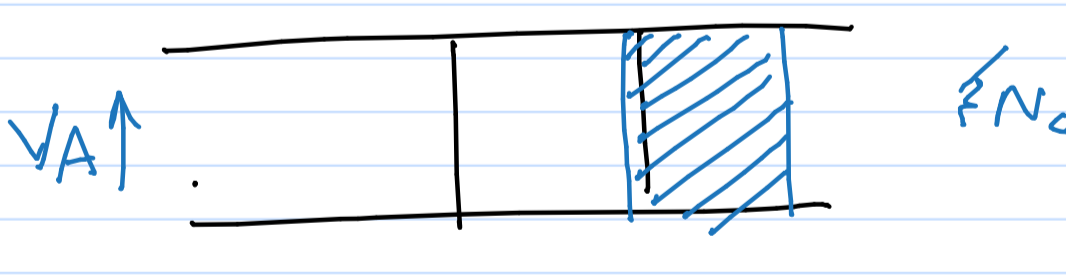
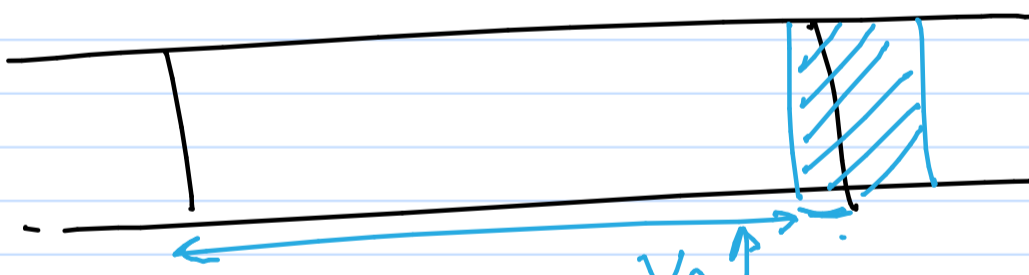
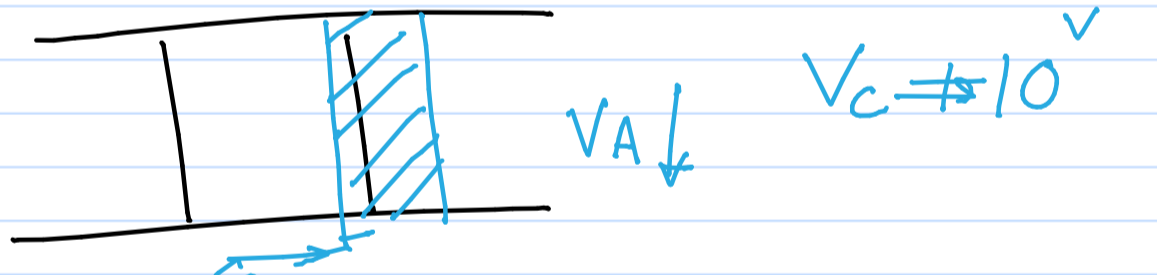
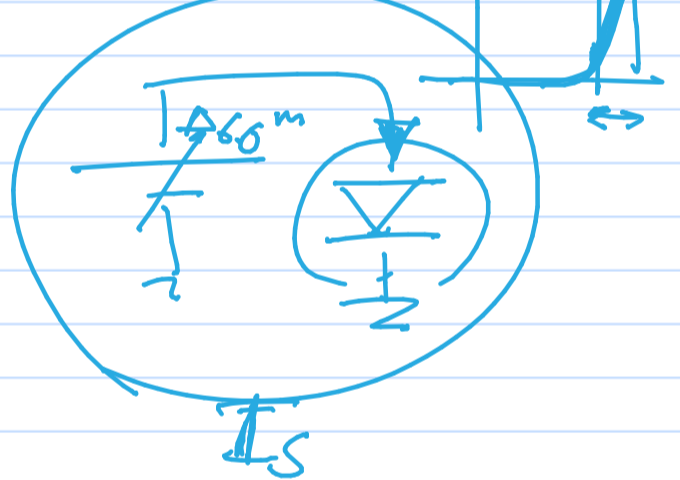
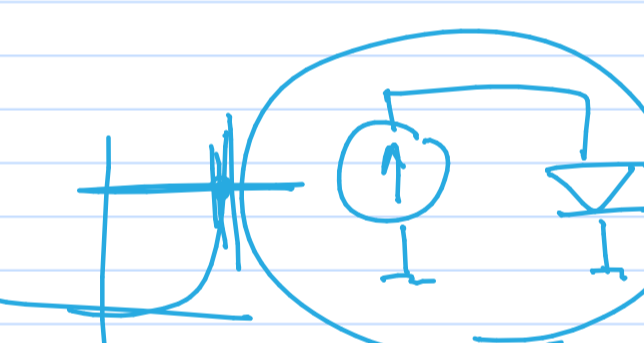
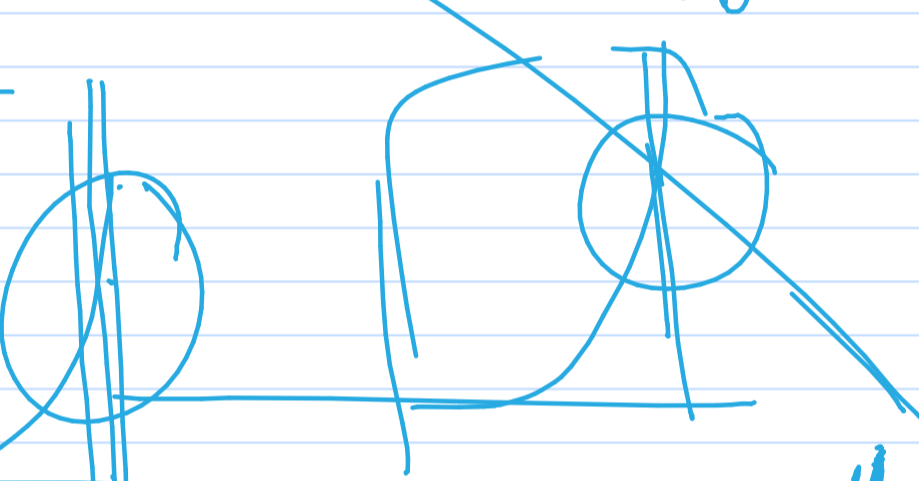
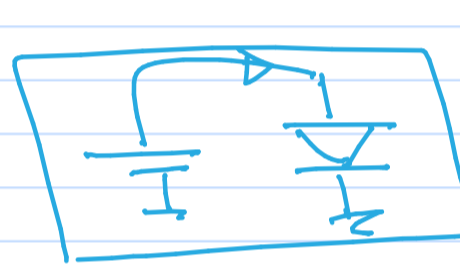
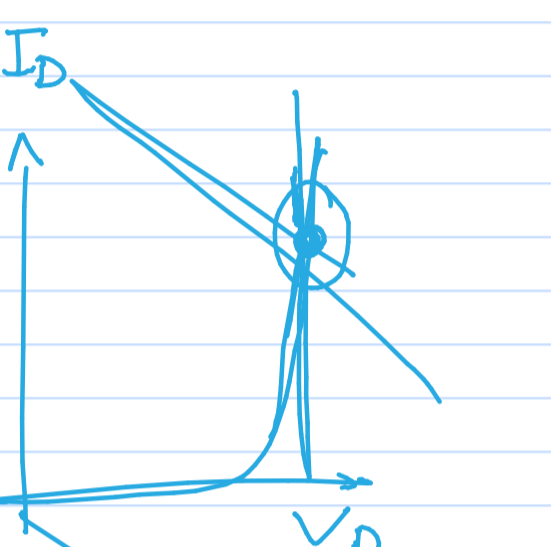
$$I_C = 8 \text{ mA}$$

$$V_o = 2 \text{ V}$$

$$I_C = I_S (e^{V_{BE}/V_{th}} - 1) \approx I_S e^{V_{BE}/V_{th}}$$



$$I_D = \frac{V - 0.7}{R}$$



$$V_{BE} = 0.7$$

$$I_B = 0.1$$

$$I_E = 0.1$$

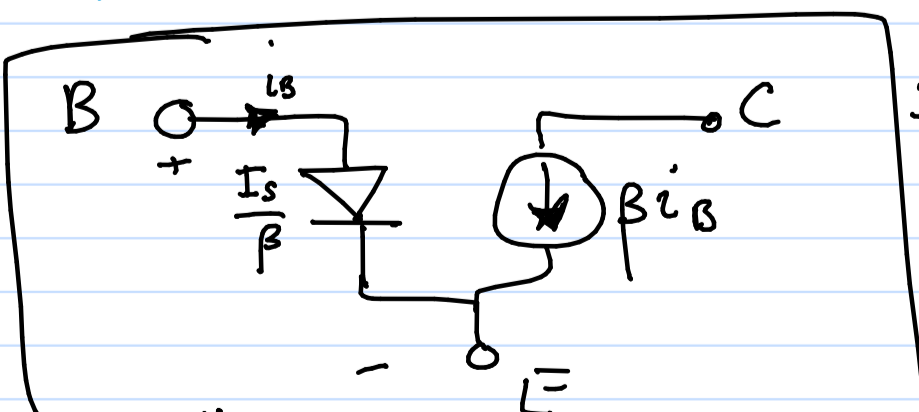
$$I_B = 0.1$$

$$\beta = 100$$

$$I_C = I_S e^{V_{BE}/V_{th}}$$

$$I_B = \frac{1}{\beta} I_C$$

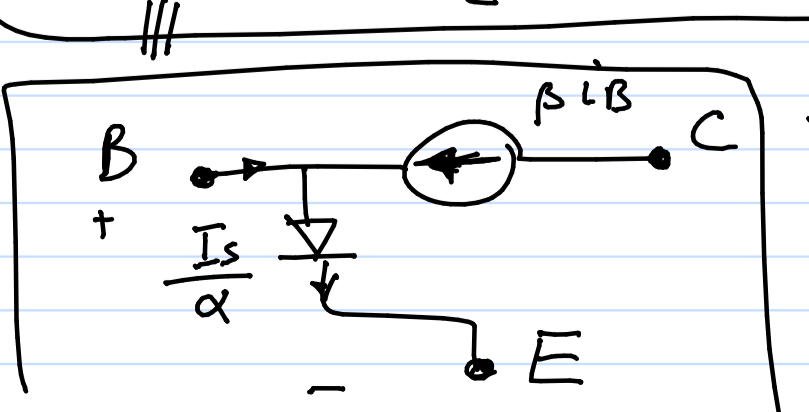
$$I_E = I_C + I_B$$



$$I_B = \frac{I_S}{\beta} e^{V_{BE}/V_{th}}$$

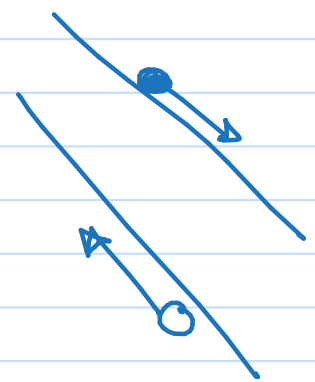
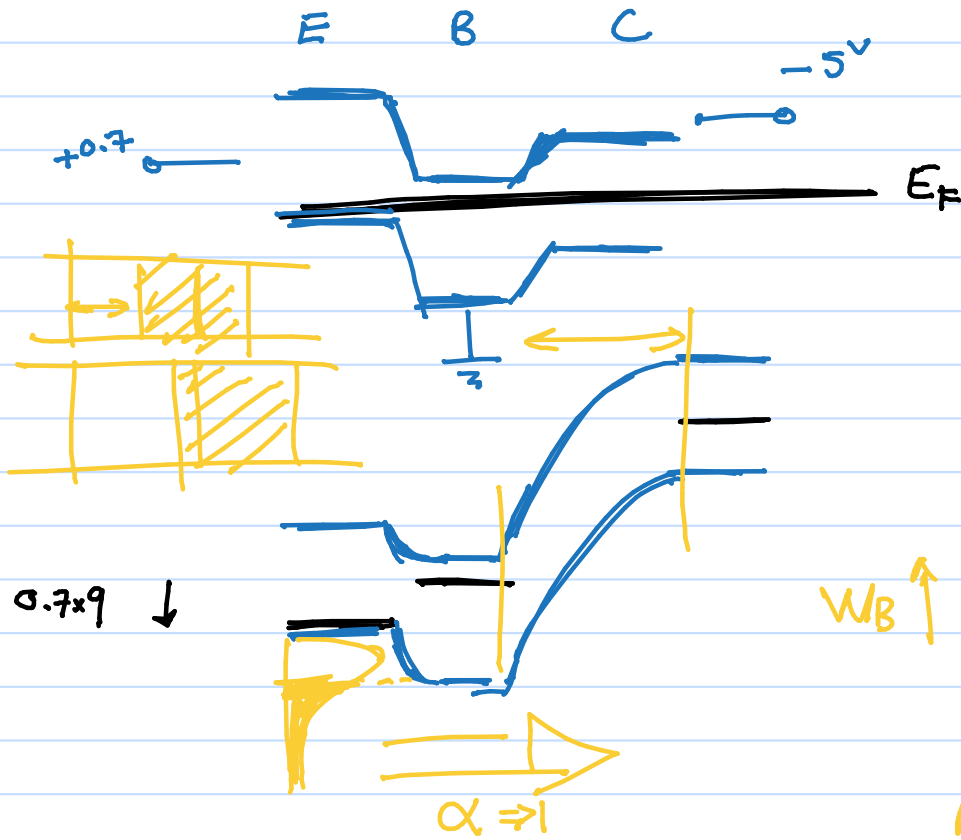
$$I_C =$$

$$I_C = \alpha I_E$$



$$I_C = I_S e^{V_{BE}/V_{th}}$$

$$\alpha = \frac{\beta}{1+\beta}$$



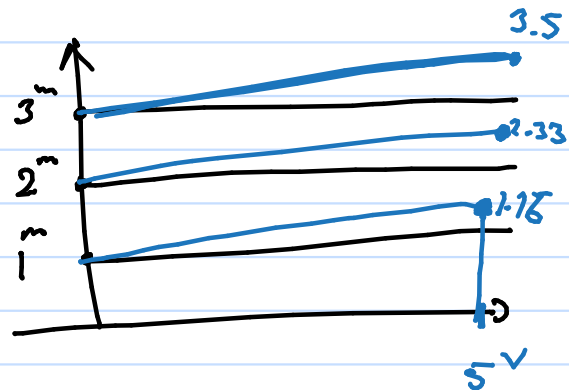
$W_B \uparrow$ $\alpha \downarrow$ $\beta \downarrow$ $V_A \uparrow$
 \ominus \oplus
 $N_C \uparrow \rightarrow V_A \downarrow$

$$I_s = 10^{-5} \text{ A} = 10^{-8} \text{ mA}$$

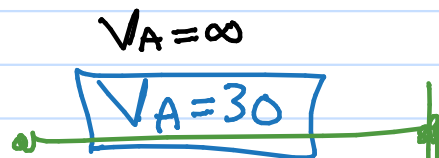
$$V_A = 30 \text{ V}$$

$$V_{th} = 25.8 \text{ V}$$

I_c	V_{BE}
1 ^m	633
2 ^m	650
3 ^m	661



$$I_s e^{V_{BE}/V_{th}} \left(1 + \frac{V_{CE}}{V_A}\right)$$



$$\times (1.66)$$

[1-20] $V_{BE} = V_{th} \ln\left(\frac{I}{I_s}\right)$

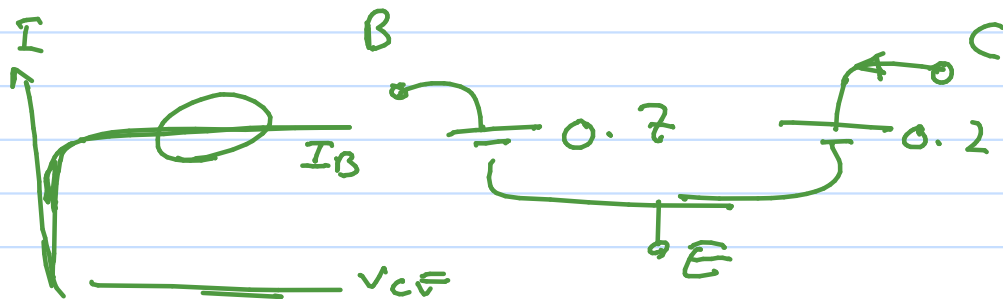
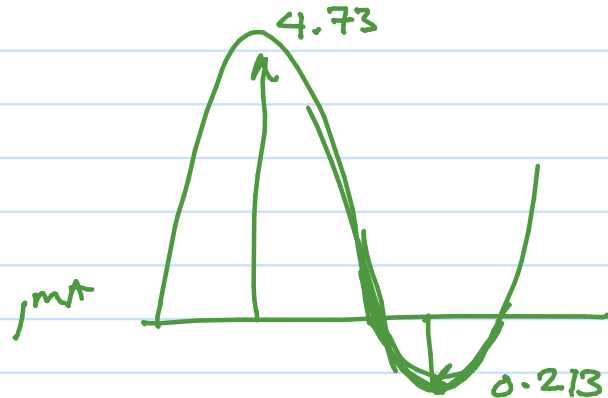
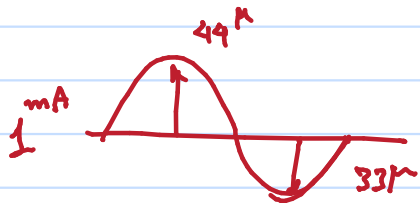
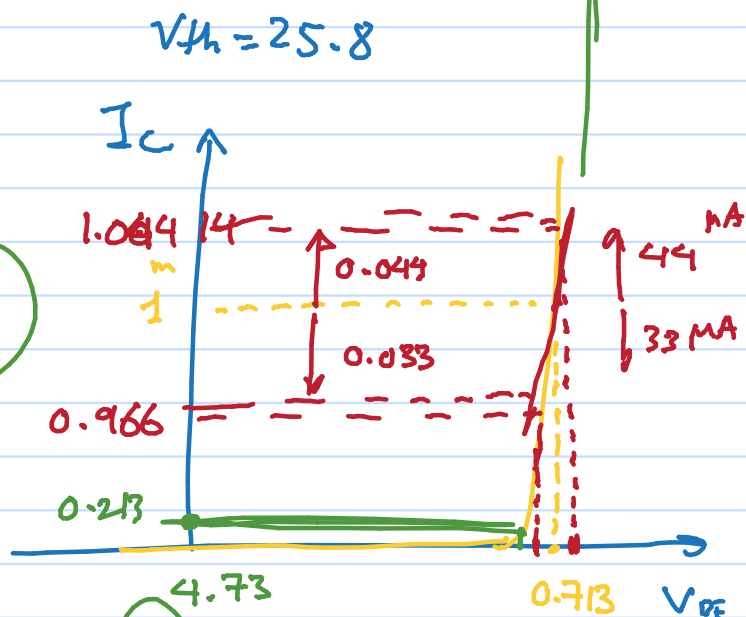
$$= 0.713$$

$$V_{BE_{max}} = 714 \text{ mV} \rightarrow I = I_s e^{V_{BE}/V_{th}} = 1.044 \text{ mA}$$

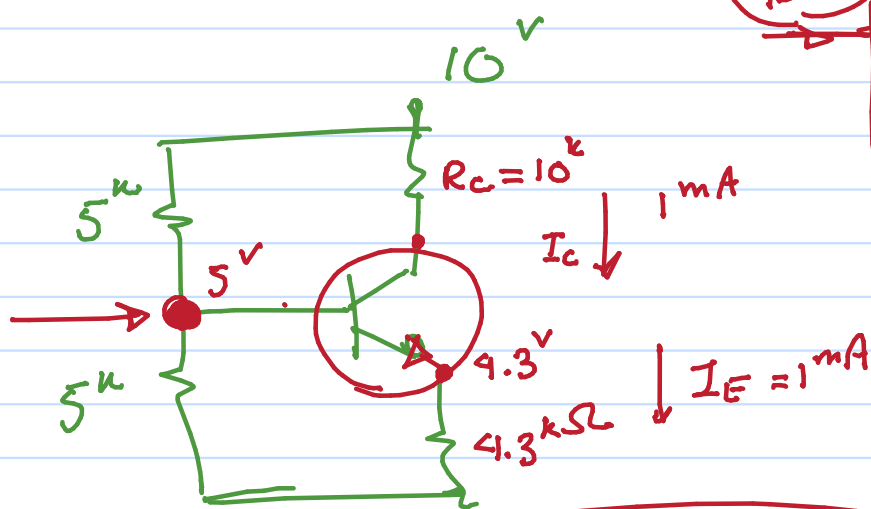
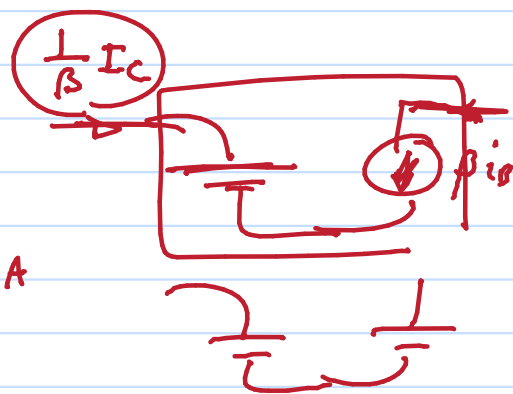
$$V_{BE_{min}} = 712 \text{ mV} \rightarrow I = 0.966 \text{ mA}$$

$$V_{BE_{max}} = 753 \text{ mV} \rightarrow I = 4.73 \text{ mA}$$

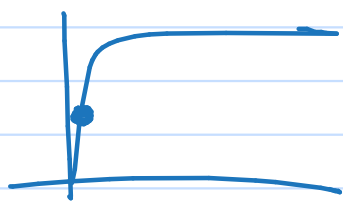
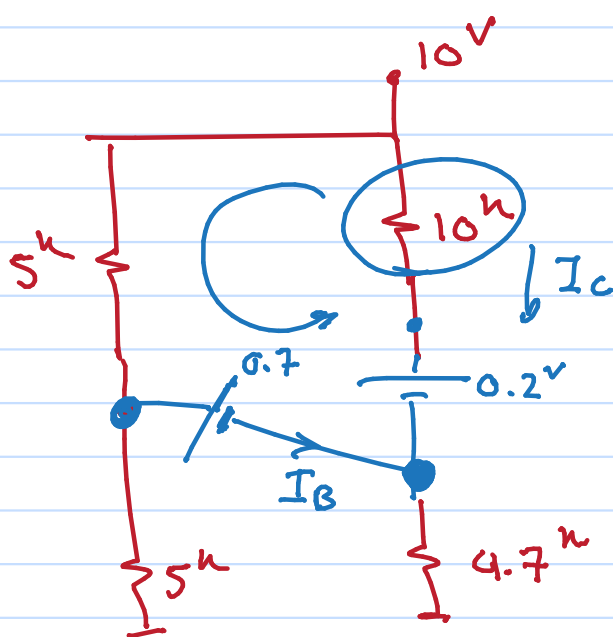
$$V_{BE_{min}} = 673 \text{ mV} \rightarrow I = 0.213 \text{ mA}$$



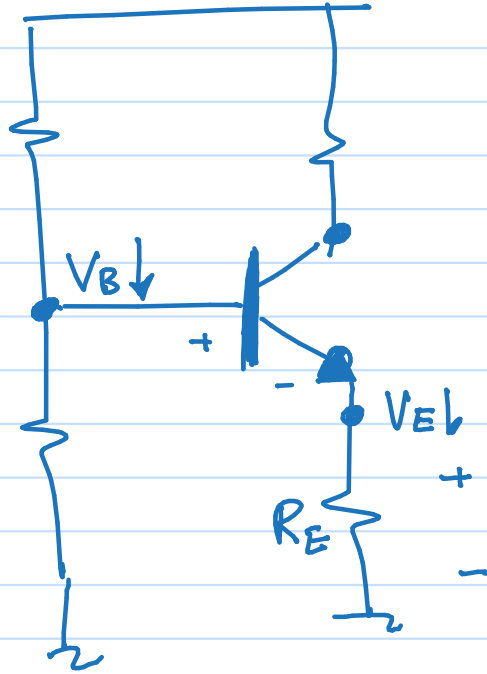
$$I_c \approx \beta I_B$$



$$d_{\beta} \leftarrow R_c < 5k$$



$\beta = 100 \longrightarrow 500$



0.99

$$I_C = \alpha I_E$$

$$I_B = \frac{I_C}{\beta}$$

$\frac{1}{100}$

