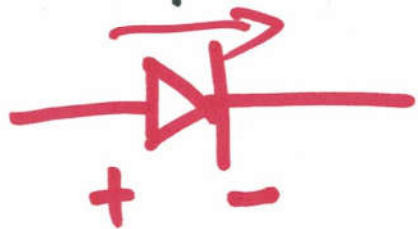
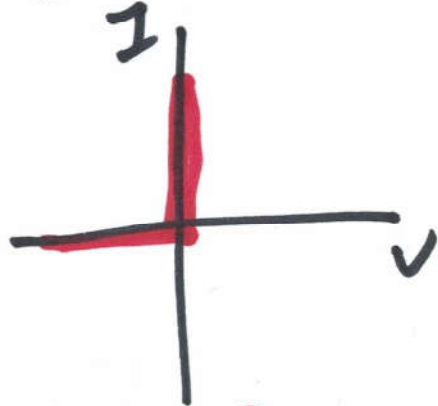
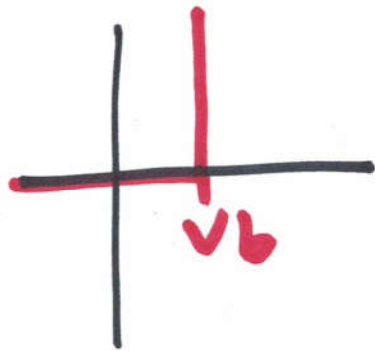


# Diode Terminal Characteristics

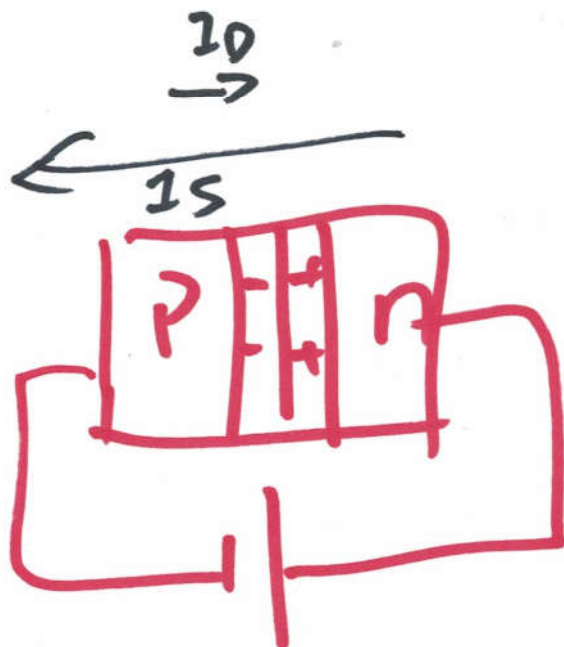
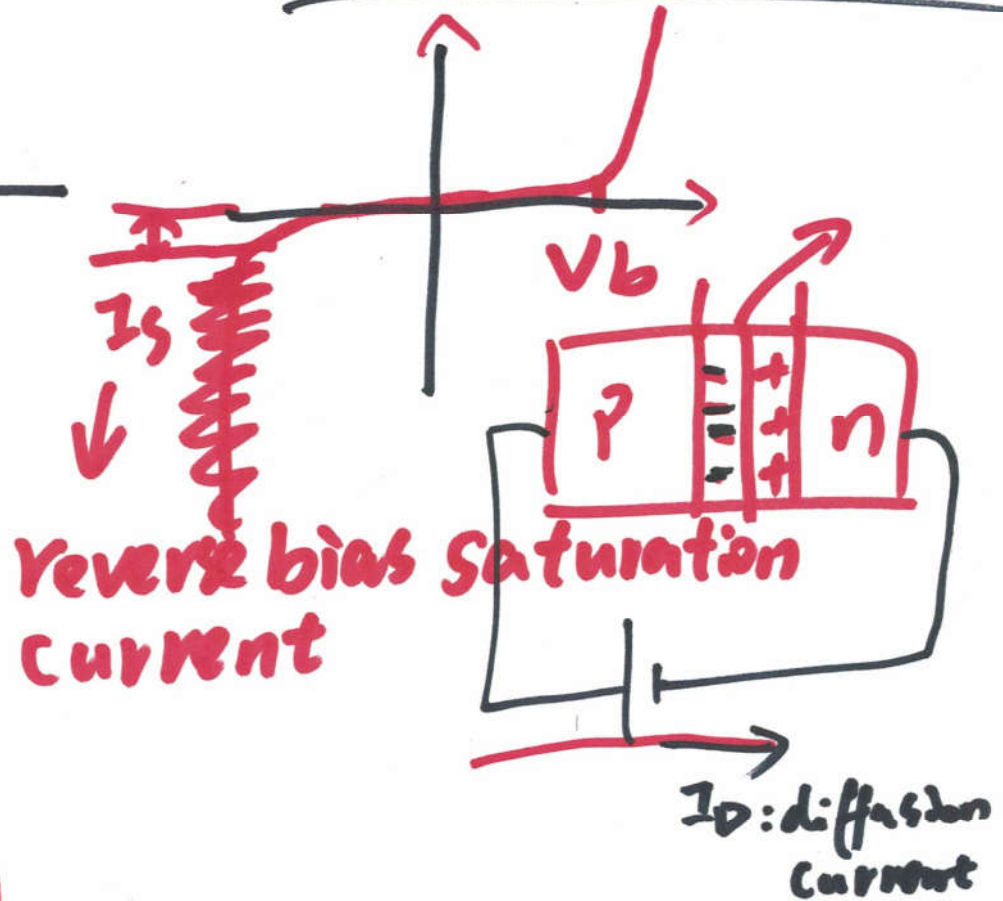
ideal diode



ideal diode with  $V_b$



real diode with  $V_b$   
no reverse breakdown



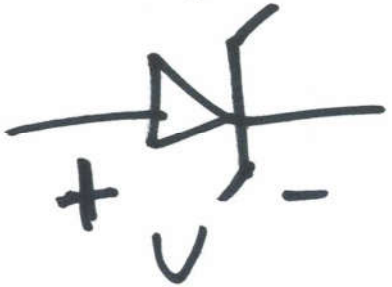
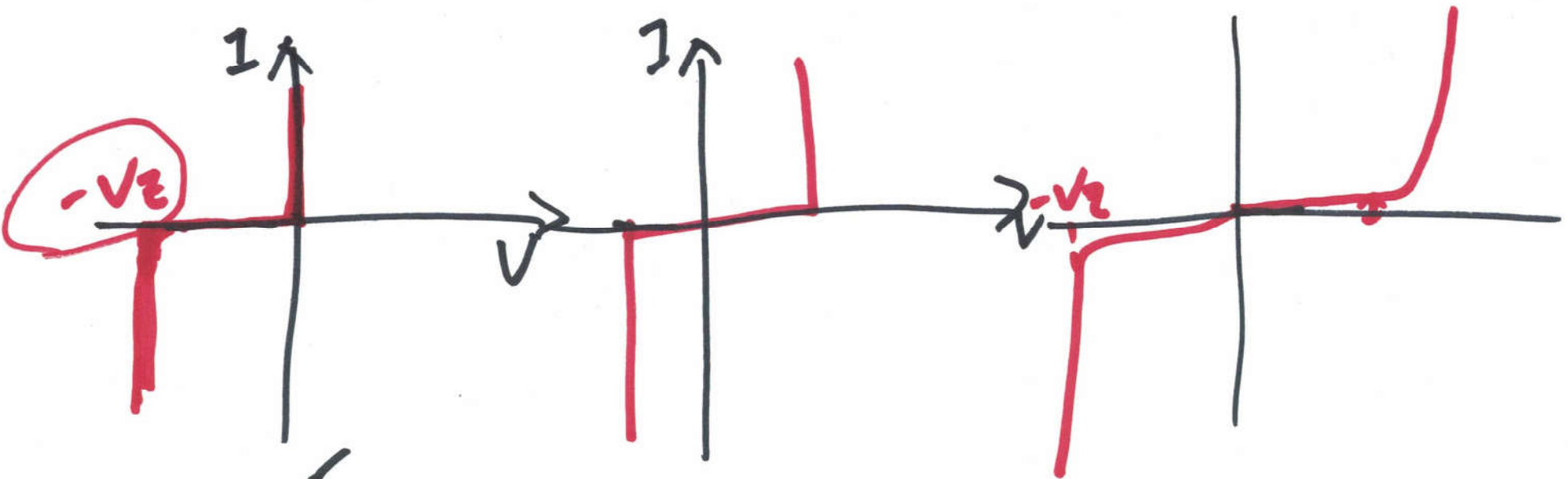
$I_s$ :

# Zener Diode

ideal

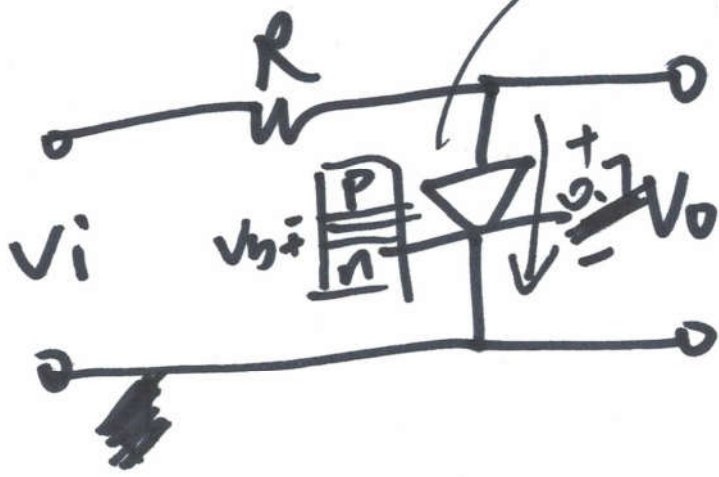
ideal with  $V_b$

real zener, with  $V_b$

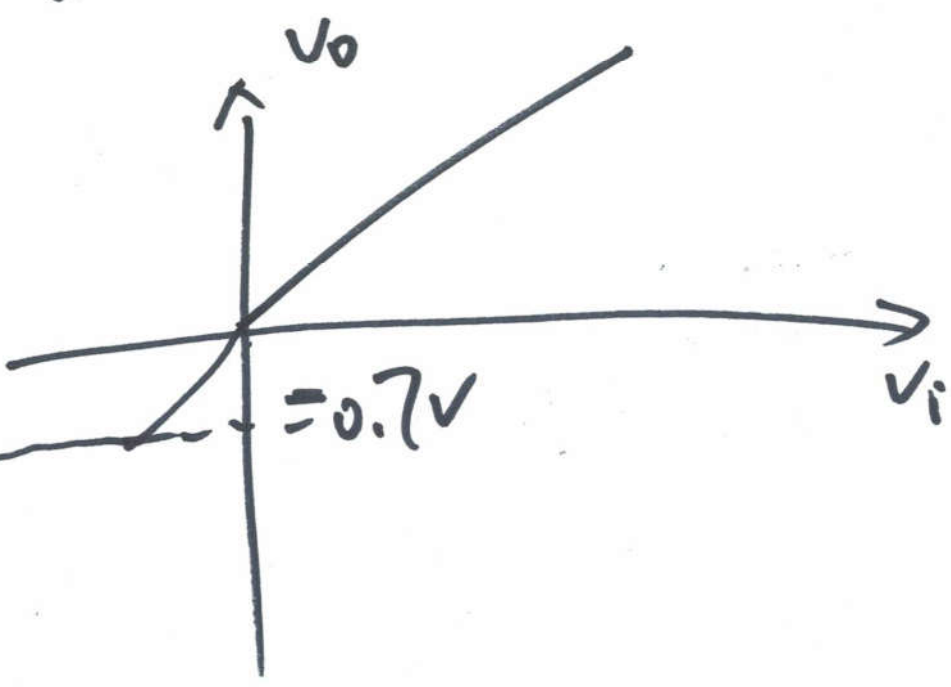
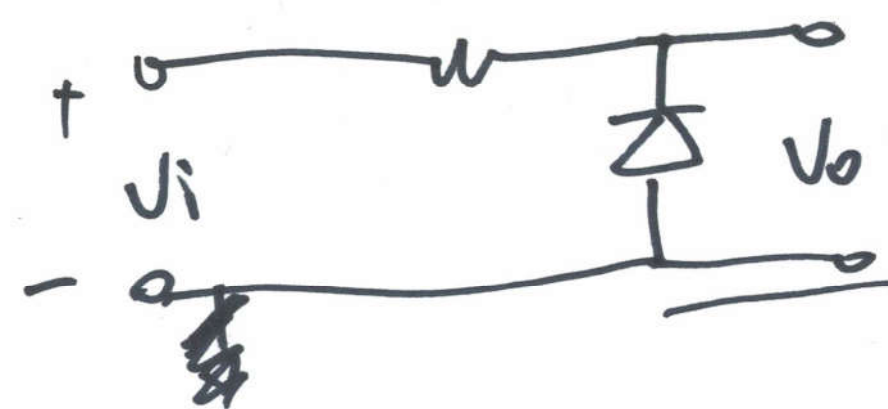
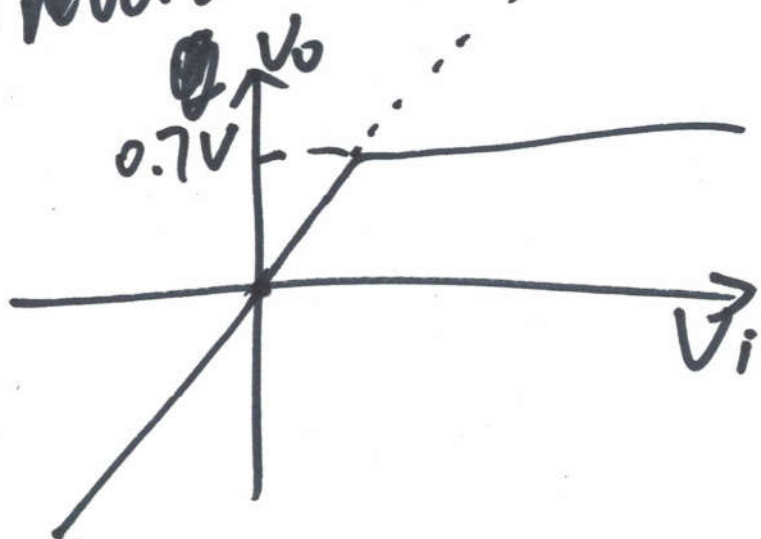


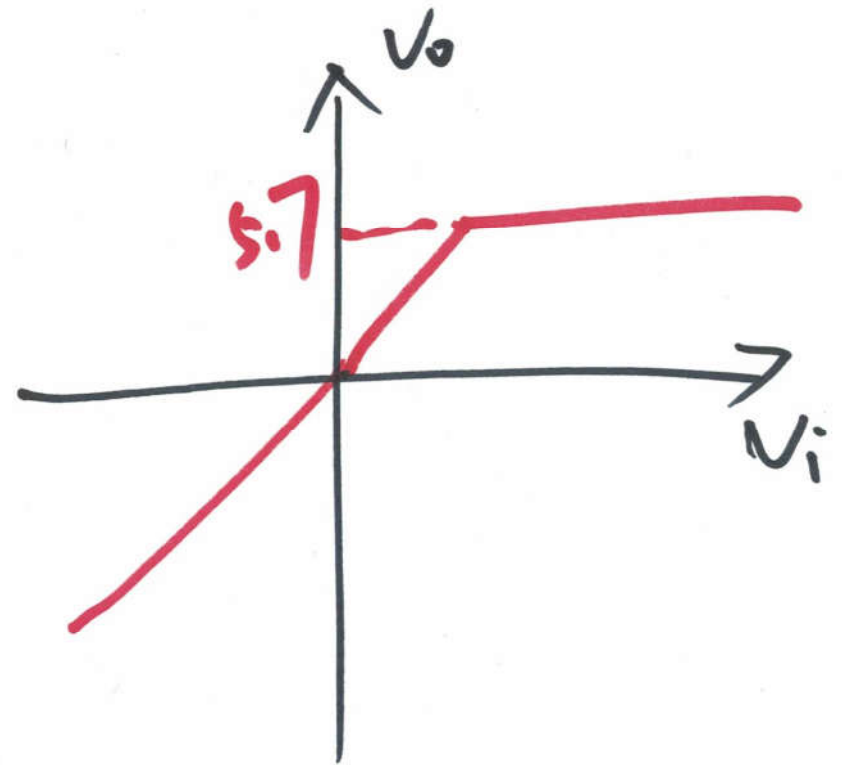
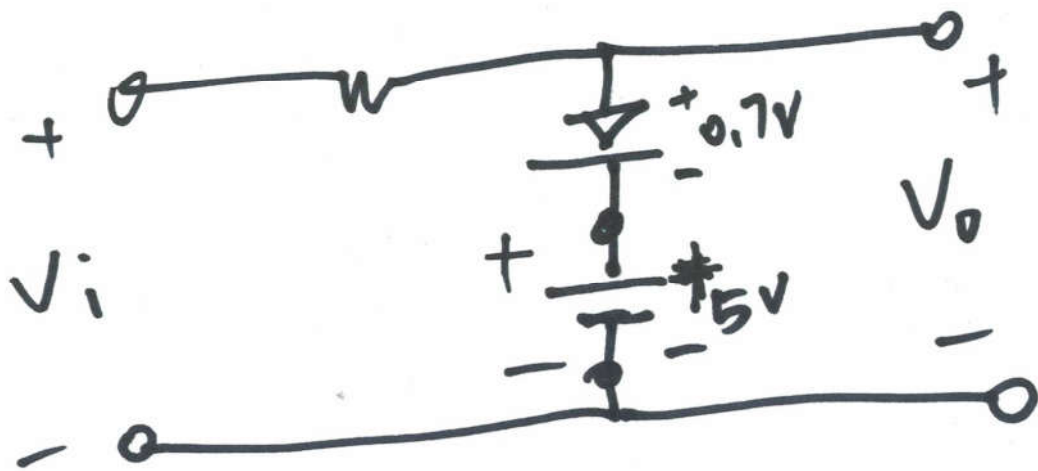
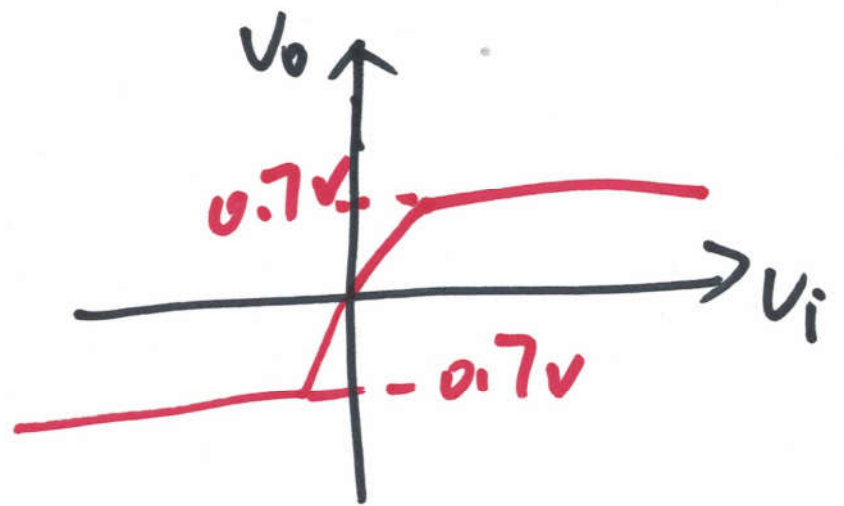
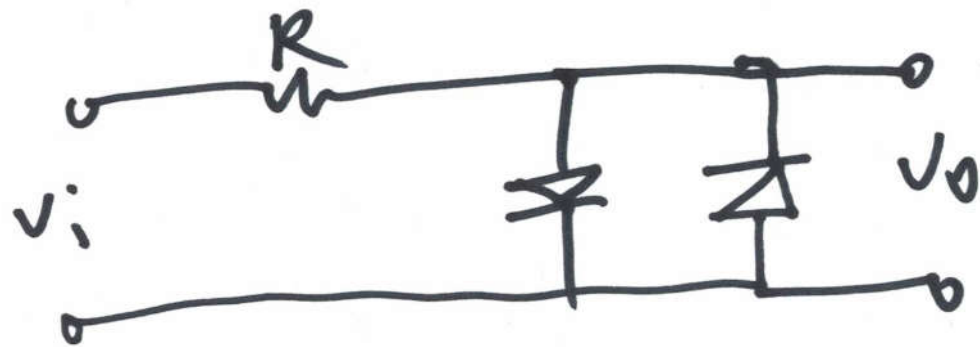
(2)

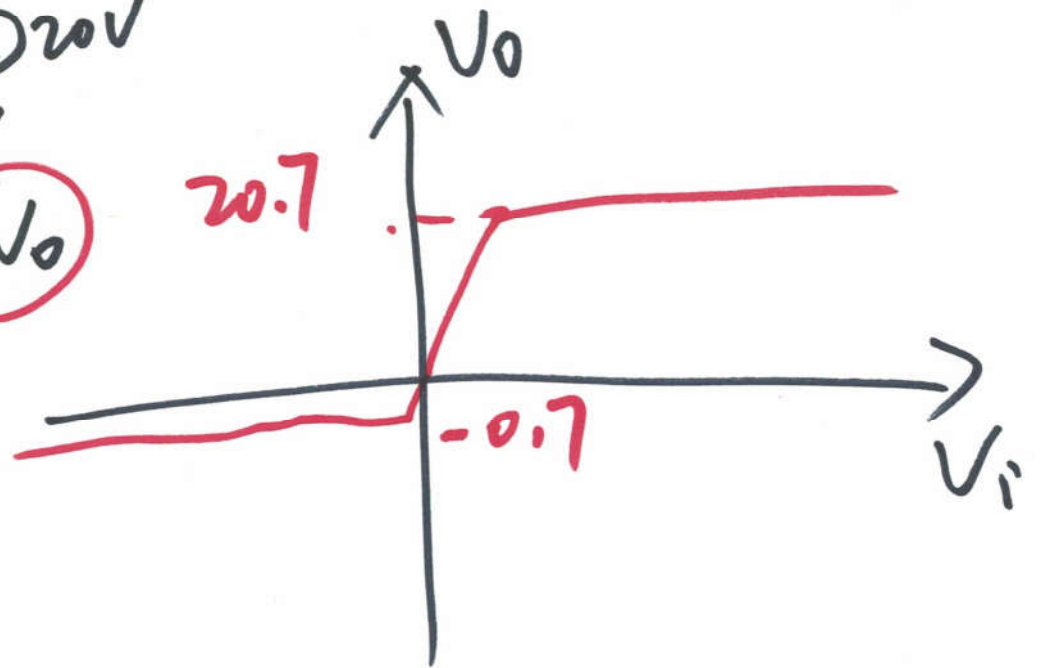
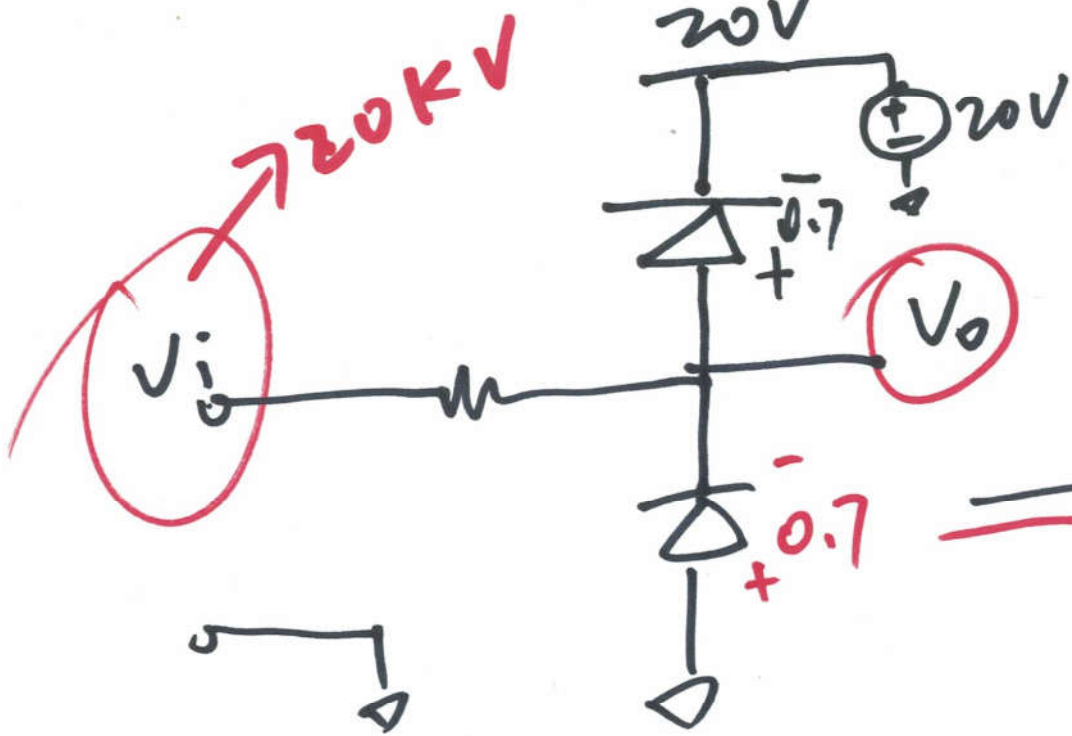
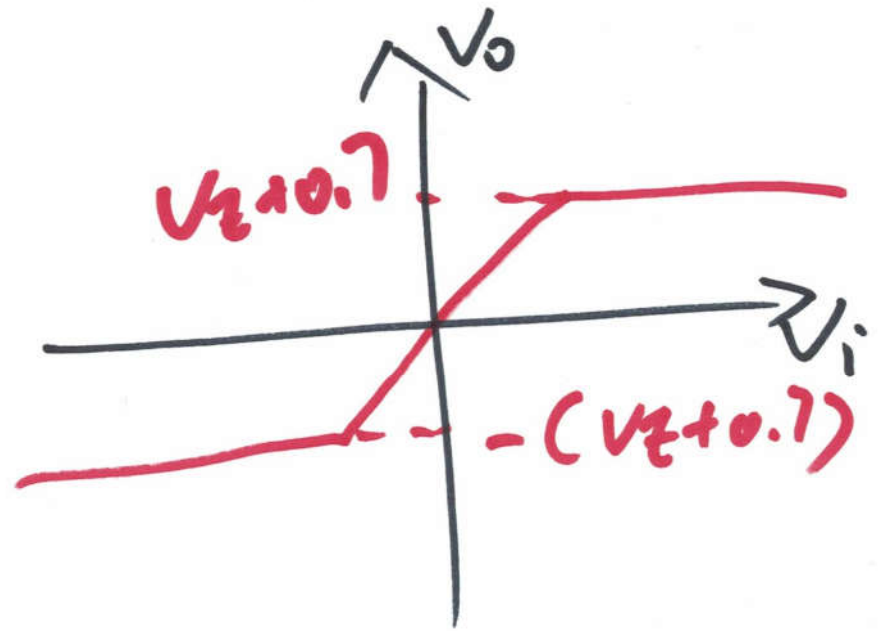
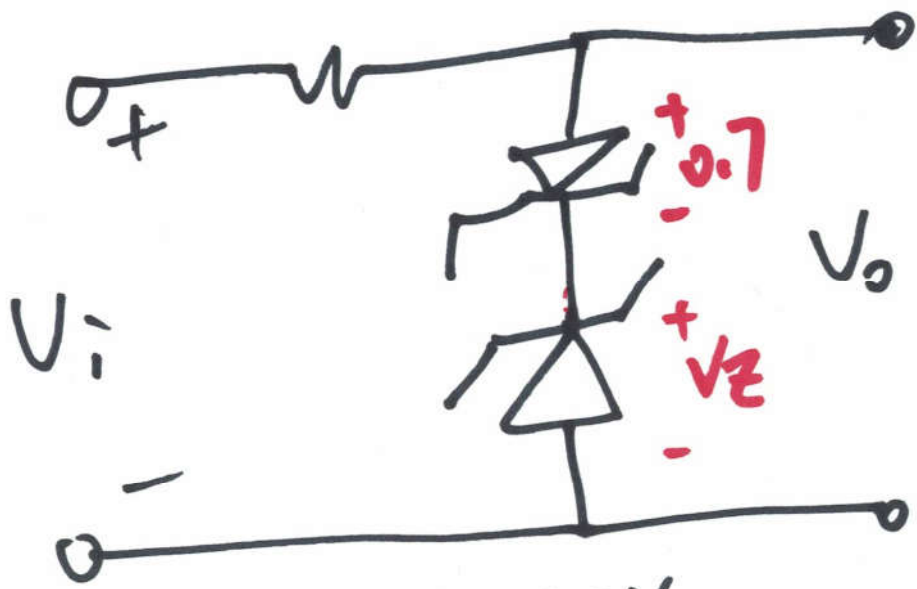
# Examples:



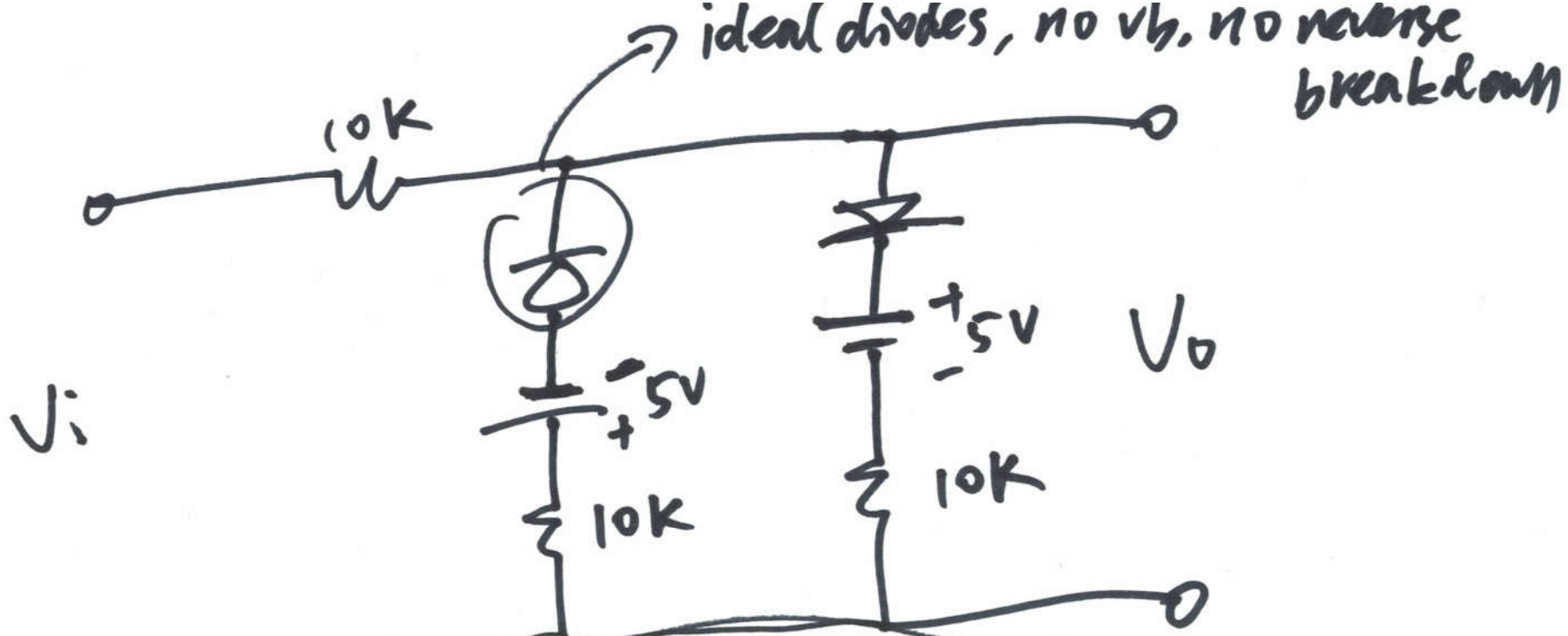
real diode (with a  $v_b$ )  
no reverse break down



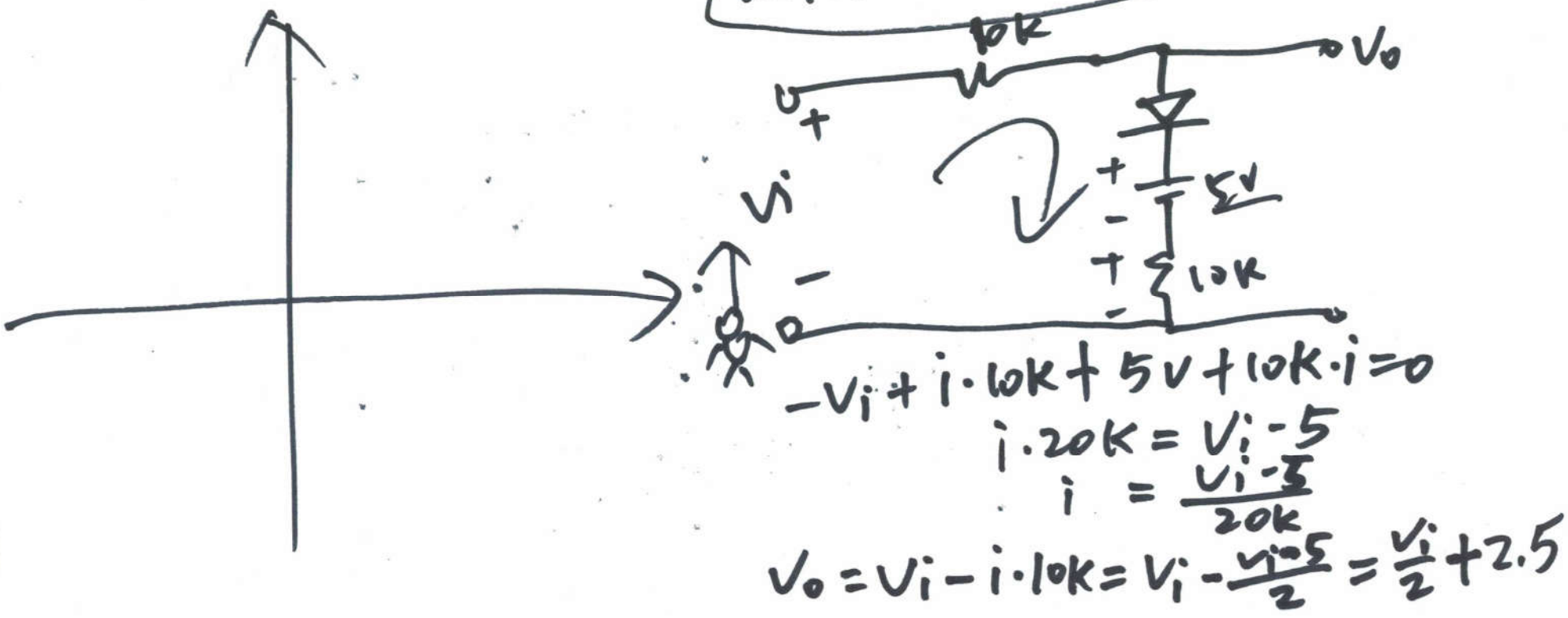




5

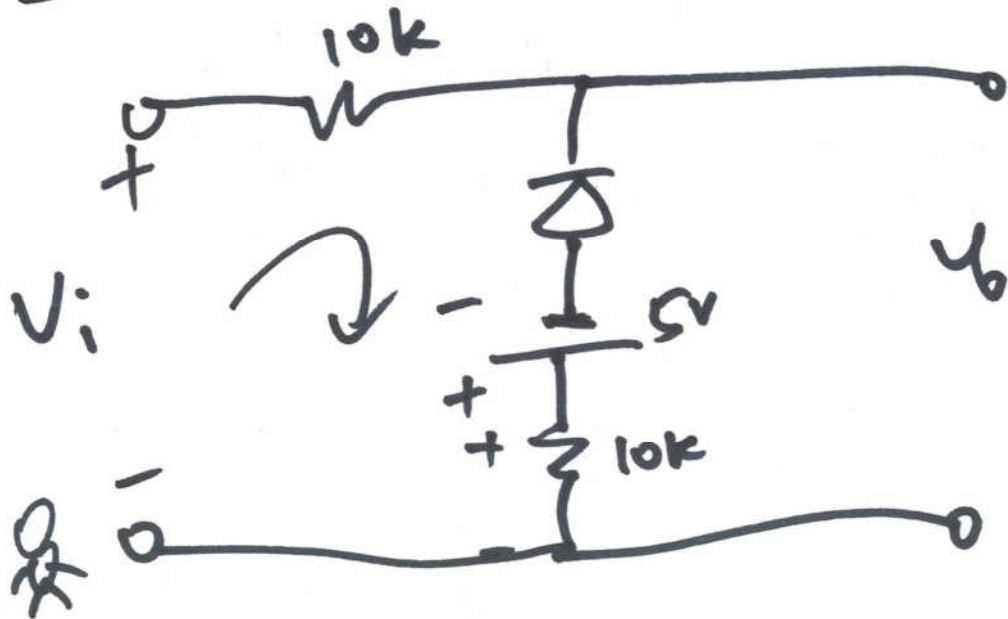


when  $V_i > 5V$



(b)

if  $V_i \leq 5V$



$$-V_i + i \cdot 10k - 5 + i \cdot 10k = 0$$

$$i \cdot 20k = V_i + 5$$

$$i = \frac{V_i + 5}{20k}$$

$$V_o = V_i - i \cdot 10k = V_i - \frac{V_i + 5}{20k} \cdot 10k$$

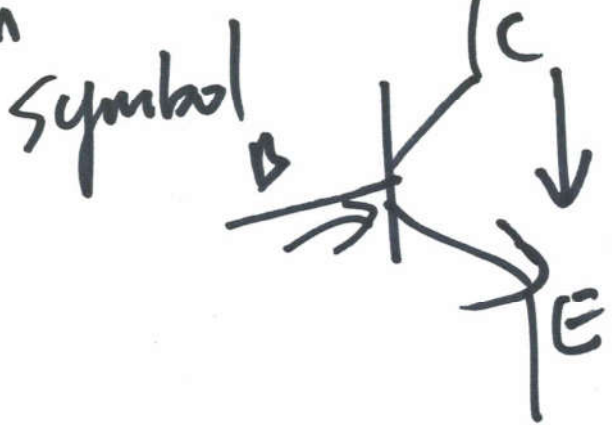
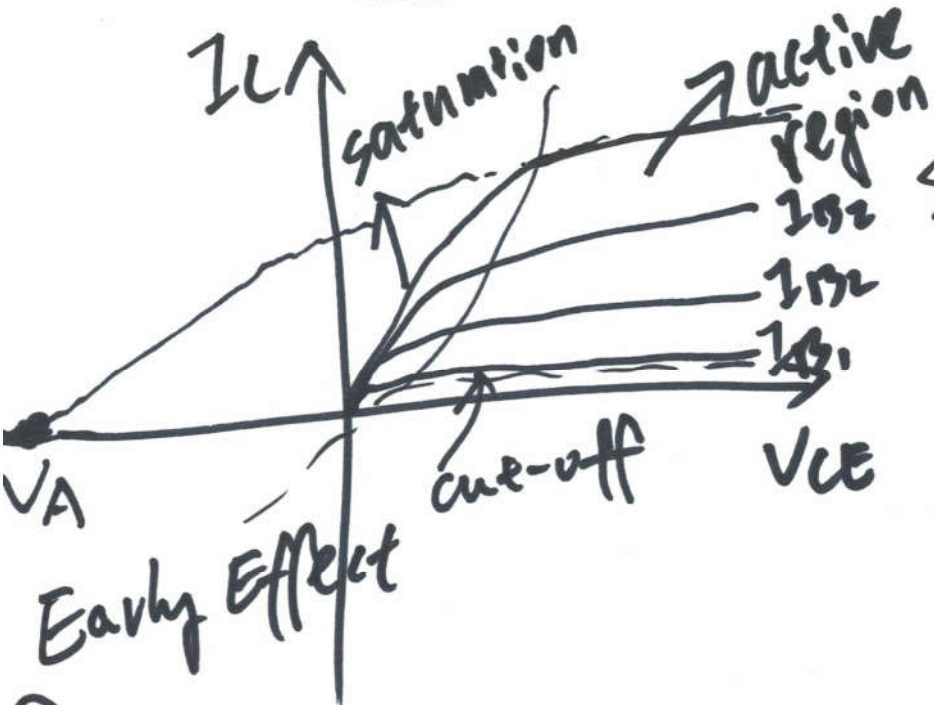
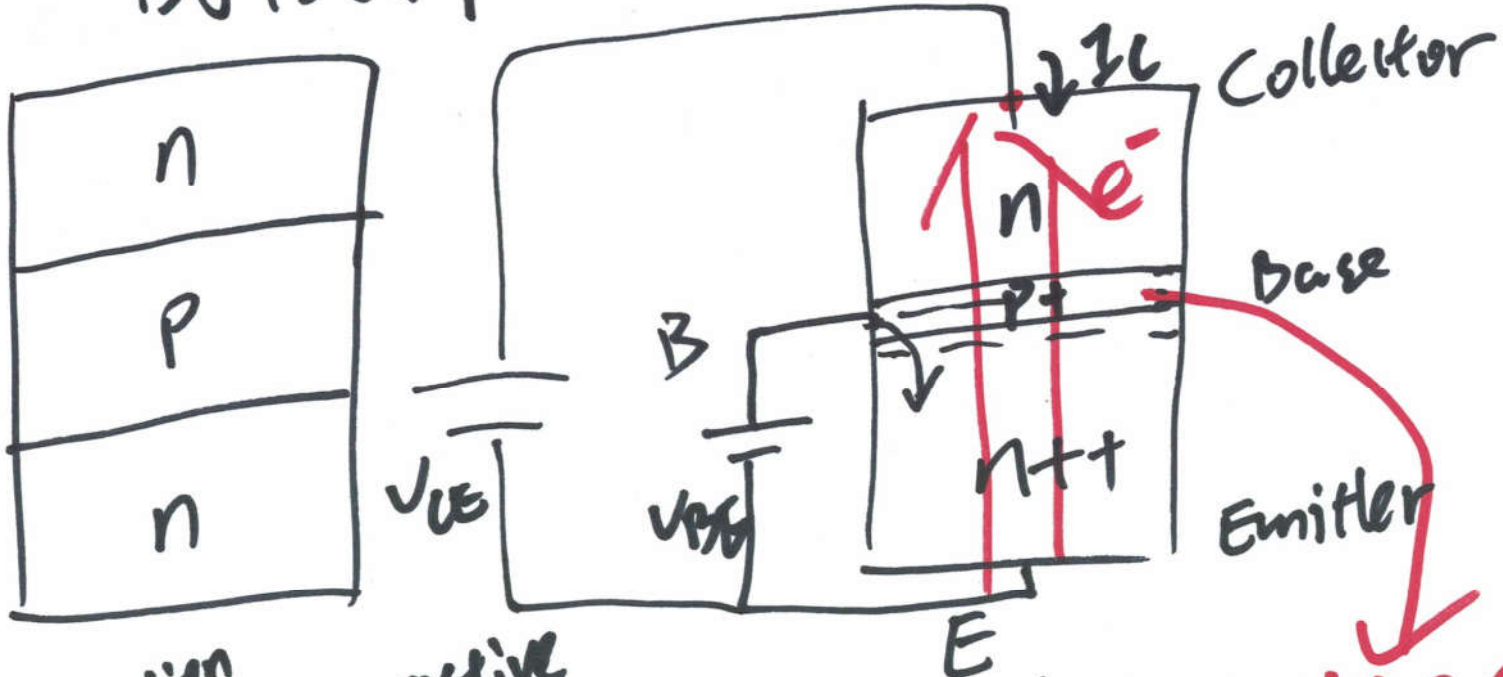
$$= V_i - \frac{V_i}{2} - \frac{5}{2} = \frac{V_i}{2} - 2.5$$

$5 > V_i > -5$

$$V_o = V_i$$

# Sedra/Smith microelectronics

## BJTs (Bipolar Junction Transistors)



acts as an insulation layer

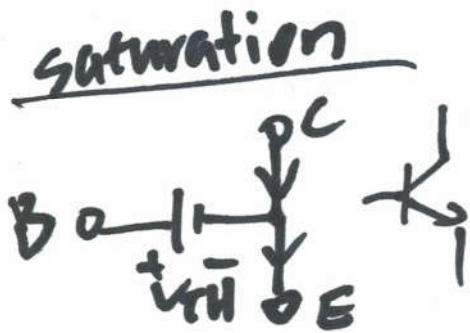
in CMOS: channel length Modulation (CLM)



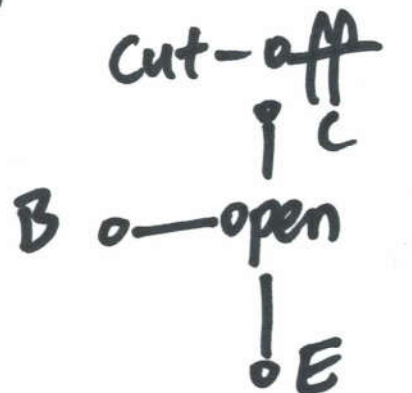
QUIZ Next week

REVIEW: PN junctions, depletion region  
body effect, CLM,  $I_s$ ,  $I_D$ ,  $V_b$

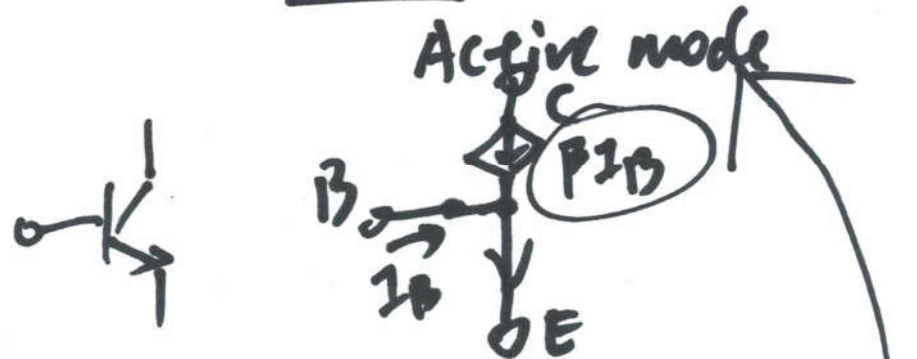
Three modes of operation for an npn BJT



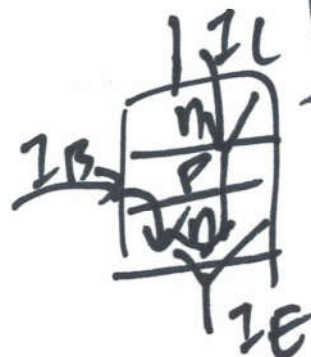
$$\begin{aligned} V_B > V_C \\ V_B > V_E \end{aligned}$$



$$\begin{aligned} V_B < V_C \\ V_B < V_E \end{aligned}$$



$$V_C > V_B > V_E$$



$$\begin{aligned} I_E &= I_B + I_C \\ I_C &= \beta I_B \end{aligned}$$