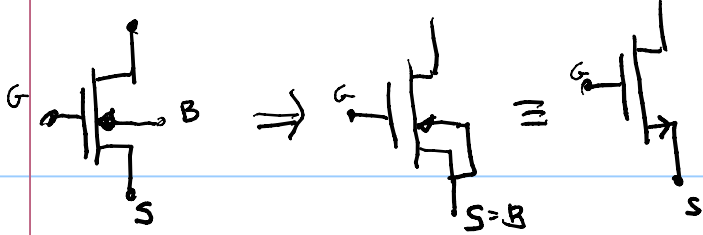
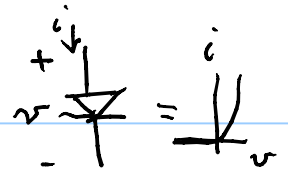


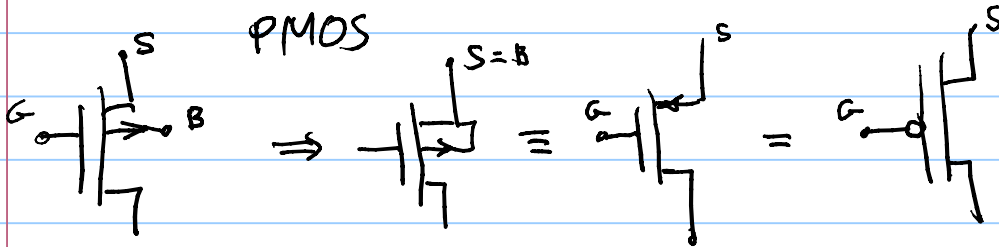
NMOS



EE 303  
01/31/08

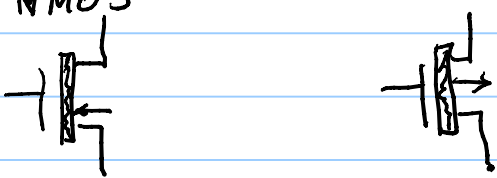


PMOS



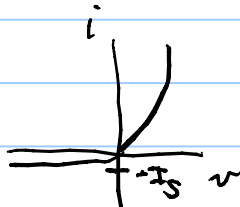
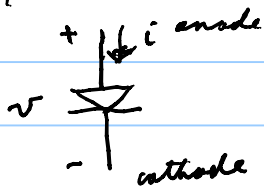
enhancement mode MOS

NMOS



depletion mode

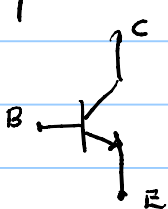
Main model equations



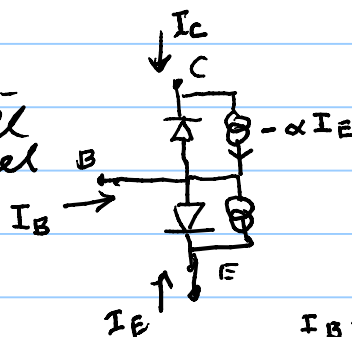
$$i = I_S (e^{+v/V_T} - 1)$$

$$V_T = \text{thermal voltage} = \frac{kT}{|q|}$$

BJT

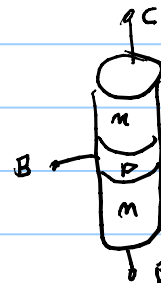


Ebers-Moll model



$$\alpha \approx 1, \alpha < 1$$

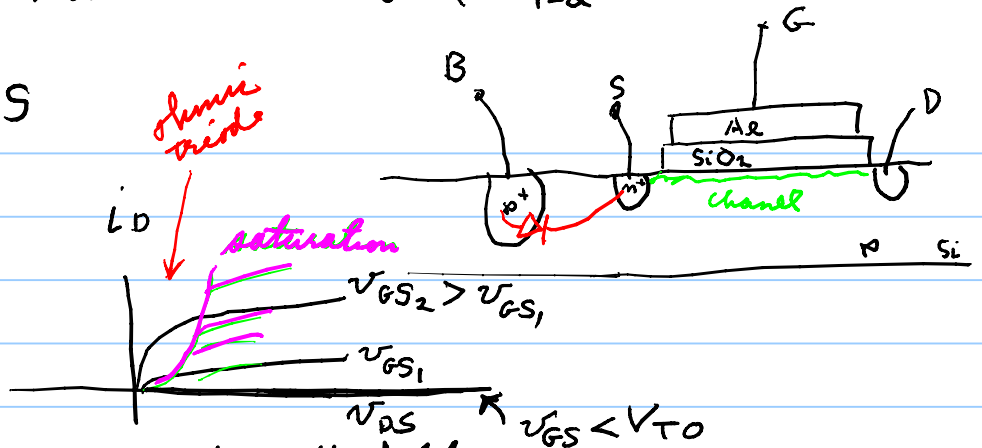
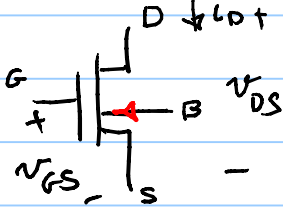
$$I_B + I_E + I_C = 0$$



if reverse bias the B-C diode  $I_C = -\alpha I_E$ ;  $I_B = -I_E - I_C = \frac{1}{\alpha} I_C - I_C$

$$I_C = \frac{1}{1-\alpha} \cdot I_B = \frac{\alpha}{1-\alpha} I_B = \beta I_B ; \quad \beta = \frac{\alpha}{1-\alpha}$$

MOS ~ NMOS



(for  $V_{DS} \geq 0$ )

$$i_D = \frac{K_P}{2} \frac{W}{L} \times \begin{cases} 0 & V_{GS} < V_{T0} = \text{threshold voltage} \\ [2(V_{GS} - V_{T0})V_{DS} - V_{DS}^2] (1 + \lambda V_{DS}) & V_{DS} \leq V_{GS} - V_{T0} \\ (V_{GS} - V_{T0})^2 (1 + \lambda V_{DS}) & \text{saturation region} \end{cases}$$

$$V_{GS} - V_{T0} \leq V_{DS}$$

