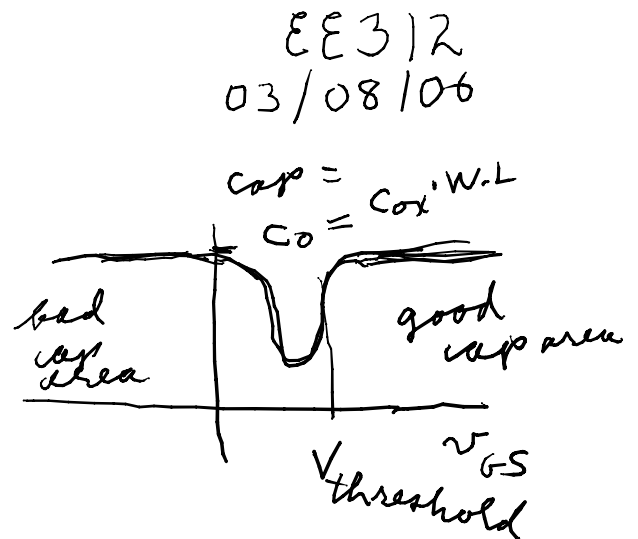
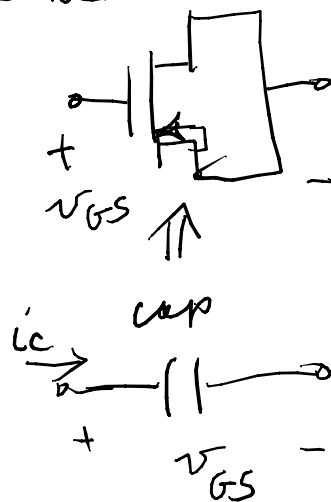


MOS fet C's



$$i = \frac{dq}{dt} = \frac{dC \cdot v}{dt} = C \frac{dv}{dt} + \frac{dC}{dt} \cdot v$$

in ohmic = triode

$$C_{gs} = C_{ds} = \frac{1}{2} W \cdot L \cdot C_{ox}$$

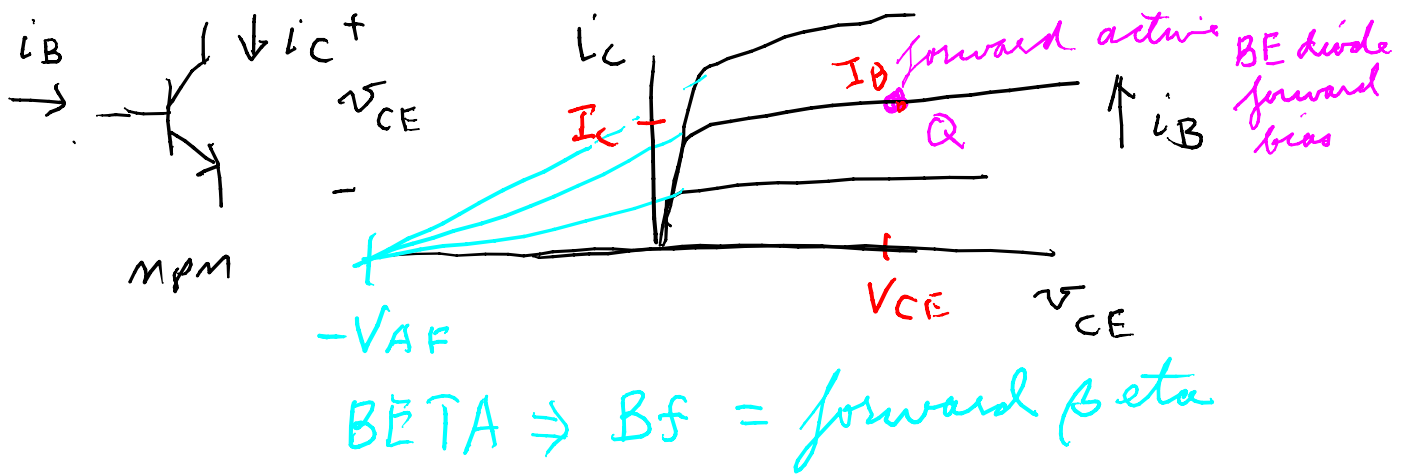
in saturation

$$C_{gs} = \frac{1}{2} W \cdot L \cdot C_{ox} ; C_{gd} = W \cdot C_{DGO}$$

(overlap capacitance)

off

$$C_{gs} = W \cdot C_{SGO} , C_{gd} = W \cdot C_{DGO}$$



Σ 2N3904 npn (417 lab)

$$V_{AF} = 74, \quad \beta_f = 416$$

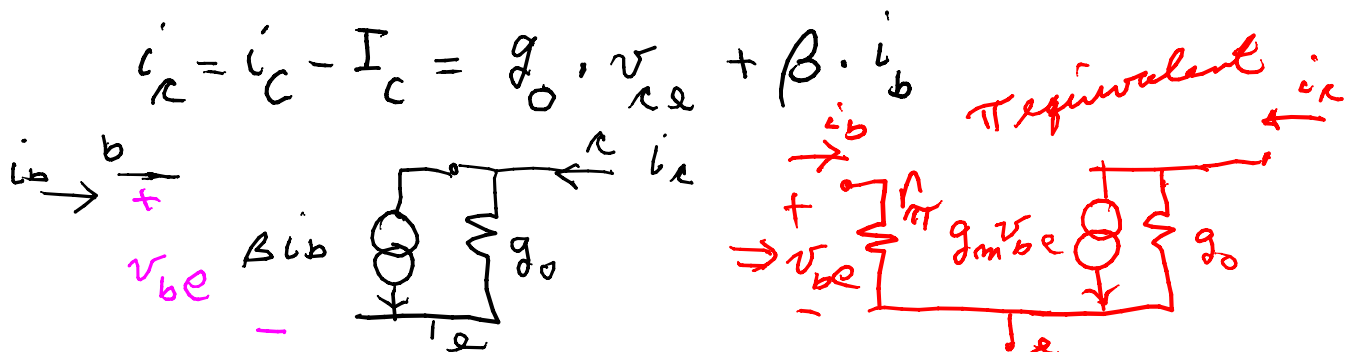
$$\beta_r = 0.737 = \text{reverse beta} \\ (C \rightarrow E) \\ E \rightarrow C$$

2N3906 pnp

$$V_{AF} = 18.7, \quad \beta_f = 180$$

$$\beta_r = 4.977$$

$$\text{here } i_C = f(v_{CE}, i_B) = I_C + \left. \frac{\partial i_C}{\partial v_{CE}} \right|_Q (v_{CE} - V_{CE}) + \left. \frac{\partial i_C}{\partial i_B} \right|_Q (i_B - I_B) + \dots$$



$$-i_E = I_S (e^{v_{BE}/V_T} - 1)$$

small
in forward
active region

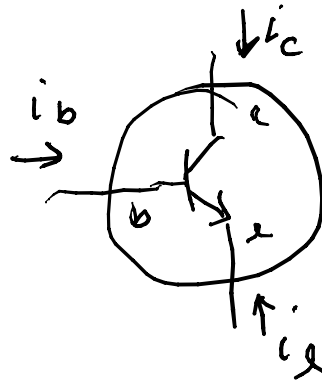
$$i_c = \left. \frac{\partial i_E}{\partial v_{BE}} \right|_{v_{ce}=0} = \frac{1}{V_T} \cdot I_S e^{v_{BE}/V_T} = \frac{I_E}{V_T} \cdot v_{be}$$

change to i_b

$$\text{use KCL: } i_b + i_c + i_e = 0$$

$$(\text{also } i_B + i_C + i_E = 0)$$

$$i_b + \beta i_b + i_e = 0 \Rightarrow$$



$$i_b = \frac{-i_e}{\beta + 1} = -\left(\frac{I_E}{V_T}\right) \frac{1}{\beta + 1} v_{be}$$

$$i_c = \beta i_b = g_m \cdot v_{be}$$

$$\begin{aligned} &\equiv g_m v_{be} \\ &= \frac{I_C}{\beta V_T} v_{be} \end{aligned}$$

$$g_m = g_{21} = \left. \frac{i_2}{v_1} \right|_{v_2=0}$$

$$= \left. \frac{i_c}{v_{be}} \right|_{v_{ce}=0} = \frac{-\beta \left(\frac{I_E}{\beta + 1} \right)}{V_T}$$

$$= \frac{I_C}{V_T}$$

$$i_c = \beta i_b = \left(\frac{-i_e}{\beta + 1} \right) \beta$$

$$= -\frac{\beta}{\beta + 1} i_e$$

$$= -\alpha i_e$$

$$i_b = \frac{\beta + 1}{\beta} (-i_c)$$

$$g_o = \left. \frac{\partial i_c}{\partial v_{ce}} \right|_{v_{be}=0} = \frac{I_C}{(V_{AF} + V_{CE})} \approx \frac{I_C}{V_T} \cdot \frac{V_T}{V_{AF}}$$

$$\begin{aligned} &\equiv i_b = 0 \\ &\equiv i_B \approx I_B \end{aligned}$$