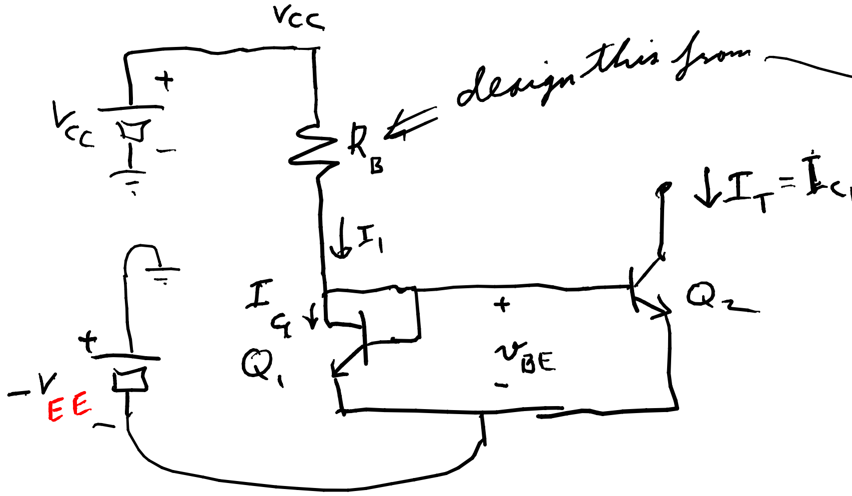
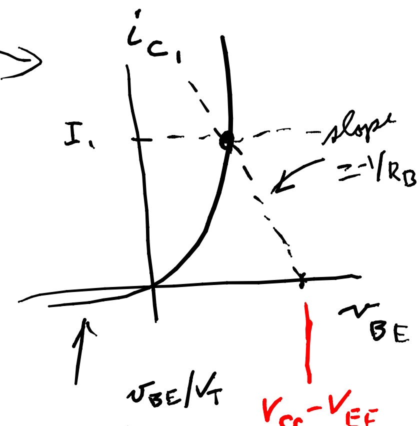
Exams are open book

old exams are on the web under RWN courses

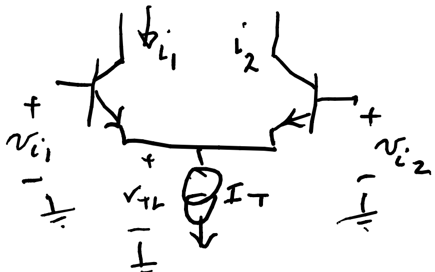
EE303
03/02/07





$i_{C_1} = \alpha I_E e^{v_{BE}/V_T}$

$\leftarrow i_2 - i_1$



$$i_1 = \alpha I_{ES} e^{(v_{i_1} - V_{TL})/V_T}$$

$$i_2 = \alpha I_{ES} e^{(v_{i_2} - V_{TL})/V_T}$$

V_{TL} = voltage on common connection of emitters w.r.t ground

$$i_o = i_2 - i_1 = \alpha I_{ES}\left(e^{(v_{i_2} - V_{TL})/V_T} - e^{(v_{i_1} - V_{TL})/V_T}\right)$$

$$= \alpha I_{ES} e^{(v_{i_2} - V_{TL})/V_T}\left(1 - e^{(v_{i_1} - v_{i_2})/V_T}\right)$$

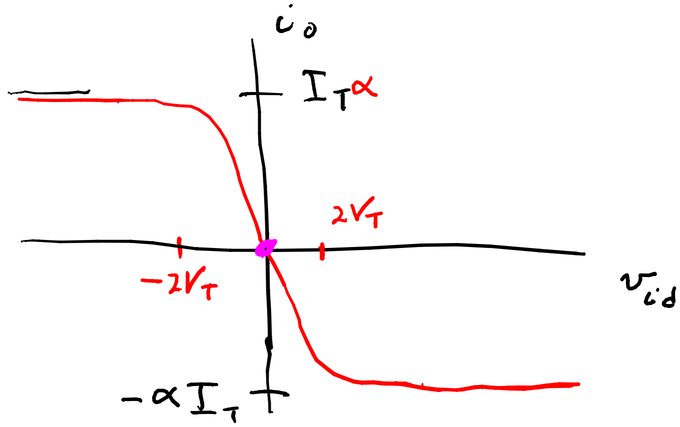
$v_{id} = v_{i_1} - v_{i_2}$

KCL: $-[i_{E_1} + i_{E_2}] = -I_T = -I_{ES} e^{(v_{i_1} - V_{TL})/V_T} - I_{ES} e^{(v_{i_2} - V_{TL})/V_T}$

$$I_T = I_{ES} e^{(v_{i_2} - V_{TL})/V_T}\left(1 + e^{v_{id}/V_T}\right)$$

$$\frac{i_o}{I_T} = \frac{\alpha\left(1 - e^{v_{id}/V_T}\right)}{1 + e^{v_{id}/V_T}} = \alpha \frac{e^{v_{id}/(2V_T)}}{e^{v_{id}/(2V_T)}}\left(\frac{e^{-\frac{v_{id}}{2V_T}} - e^{+v_{id}/2V_T}}{e^{-\frac{v_{id}}{2V_T}} + e^{v_{id}/2V_T}}\right)$$

$$= -\alpha \tanh\left(\frac{v_{id}}{2V_T}\right)$$



small signal gain near the origin – linearized to

$i_o = G_m \cdot v_{id}$; $\tanh x = \dfrac{e^x - e^{-x}}{e^x + e^{-x}}$

G_m = slope at origin $= \dfrac{(1 + x + \cdots) - (1 - x + \cdots)}{(1 + x + \cdots) + (1 - x + \cdots)}$

$i_o = -\alpha I_T \left((v_{id}/(2V_T)) \right) \longrightarrow \approx \dfrac{2x}{2}$

$= \dfrac{-\alpha I_T}{2V_T} \cdot v_{id}$; $|G_m| = \dfrac{\alpha I_T}{2V_T} \leftarrow$ Tail current

∴ can set small gain by setting I_T

see pages 707+