12/11/14

lec 43

$\frac{I_C}{I_B} = \beta_{dc}$ —— DC current gain

$\beta_{dc} \sim 50 - 200$

$$y = \begin{bmatrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{bmatrix}$$

$I_C = I_S \exp\left(\frac{V_{BE}}{V_t}\right)$

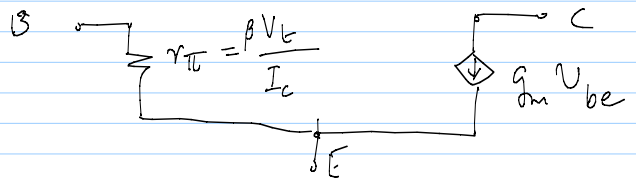
$I_B = I_C / \beta_{dc}$

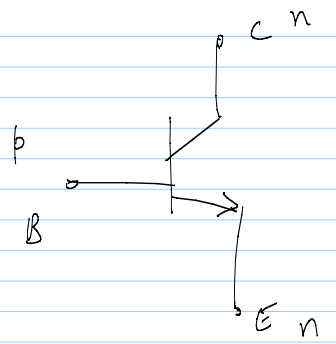
$$y_{11} = \frac{\partial I_B}{\partial V_{BE}} = \frac{\partial}{\partial V_{BE}}\left[\frac{I_S}{\beta_{dc}} \exp\left(\frac{V_{BE}}{V_t}\right)\right] = \frac{I_C}{\beta V_t}$$

$$y_{12} = \frac{\partial I_B}{\partial V_{CE}} = 0$$

$$y_{21} = \frac{\partial I_C}{\partial V_{BE}} = \frac{I_C}{V_t} = "g_m"$$

$$y_{22} = \frac{\partial I_C}{\partial V_{CE}} = 0$$





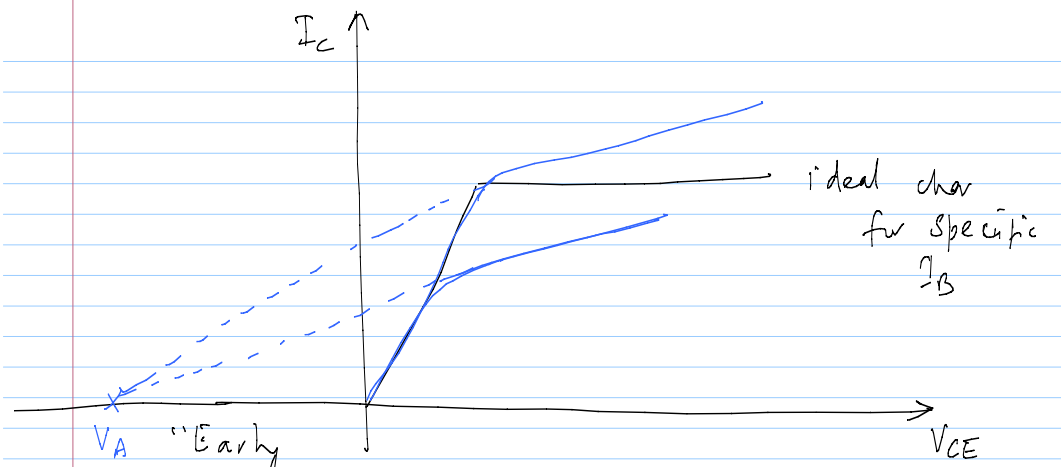
for proper operation

BE jn. – forward biased

CB jn. – reverse biased

$V_{BE_{on}} = 0.65\,V$, CB jn. gets fwd. biased when $V_{CE} = V_{BE_{on}}$

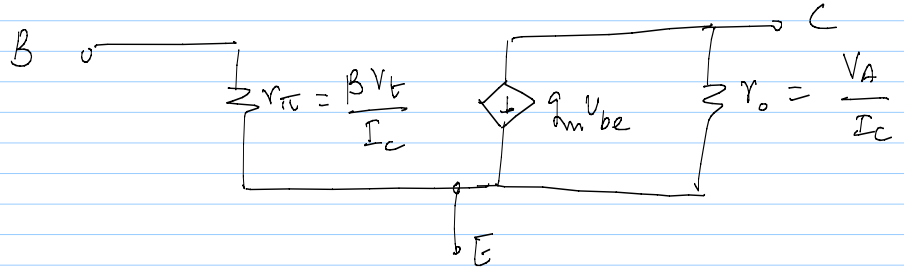
$V_{CE_{sat.}} \approx 0.2V$



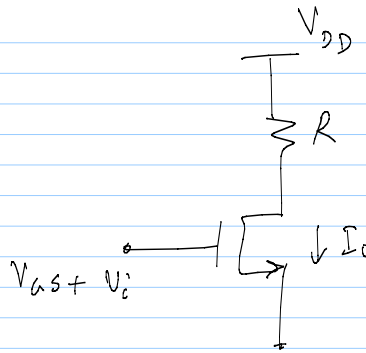
$$I_C = I_S \exp\left(\frac{V_{BE}}{V_t}\right)\left\{1 + \frac{V_{CE}}{V_A}\right\}$$

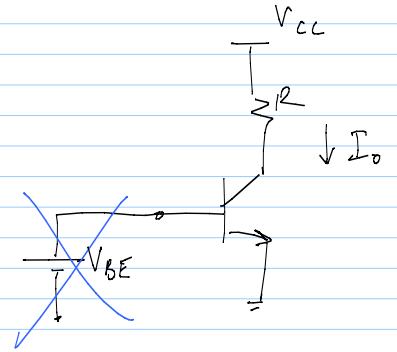
$$g_{22} = \frac{\partial I_C}{\partial V_{CE}} = \frac{I_C}{V_A}$$

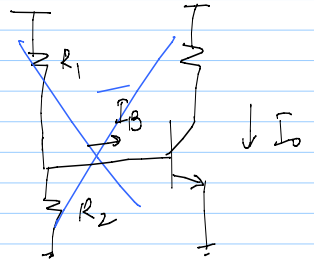
Incremental eq. ckt. of BJT



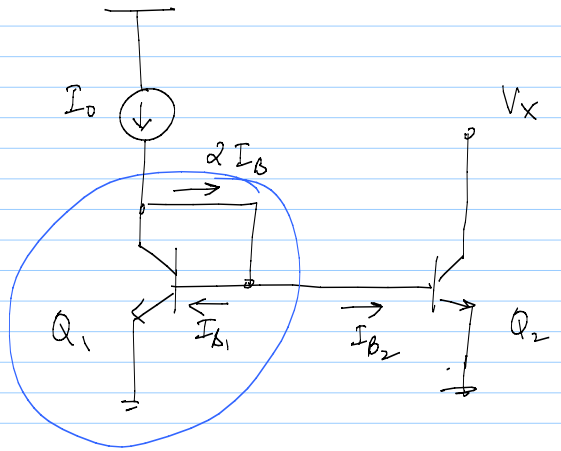
"hybrid-π" model of BJT







← resistive divider is loaded by I_B



Diode

$$V_{BE_1} = V_t \ln\left(\frac{I_{C_1}}{I_S}\right)$$

$$I_{C_1} = I_O - 2I_B$$

$$I_{C_2} = I_{C_1}$$

$$= I_O - 2I_B$$

$$= I_O - 2\frac{I_{C_2}}{\beta}$$

$$I_{C_2} = I_O \cdot \frac{\beta}{\beta+2}$$