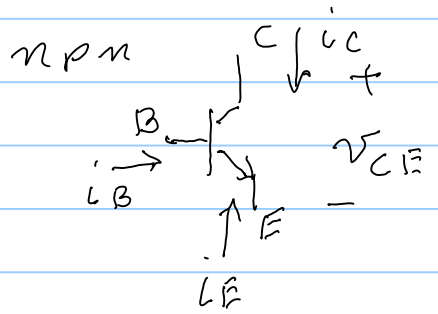
EE 303H
09/10/15

Note Title 9/10/2015

npn



$i_B + i_C + i_E = 0$ KCL

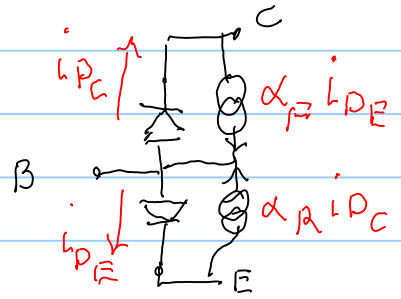
$i_B = -i_C - i_E = -i_C + \frac{1}{\alpha} i_C$

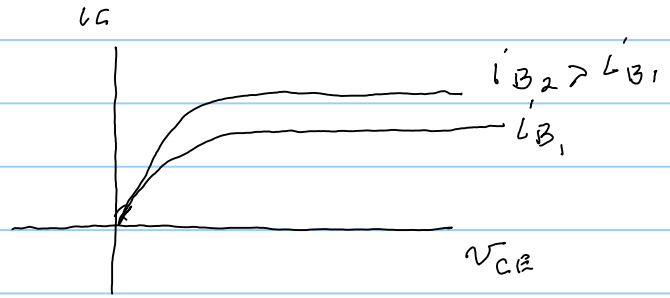
$= \frac{1-\alpha}{\alpha} i_C \Rightarrow i_C = \frac{\alpha}{1-\alpha} i_B$

law of npn $i_C = -\alpha i_E$

$i_E = -\frac{1}{\alpha} i_C$

$\beta = \frac{\alpha}{1-\alpha} \approx 50 - 500$





if $\beta = 100$, $i_B = 10^{-6}$, $i_C = 10^{-4}$

$= 0.1$ mA

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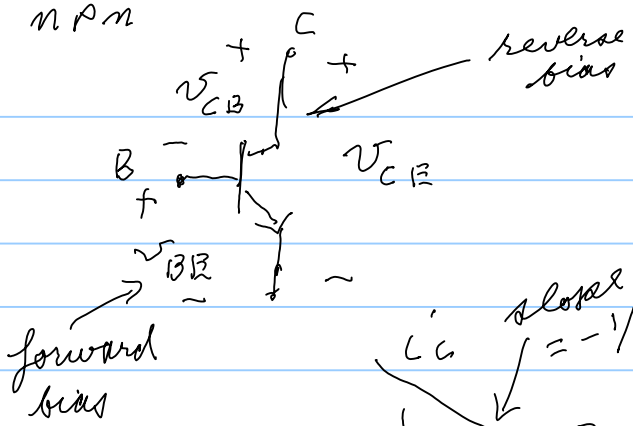
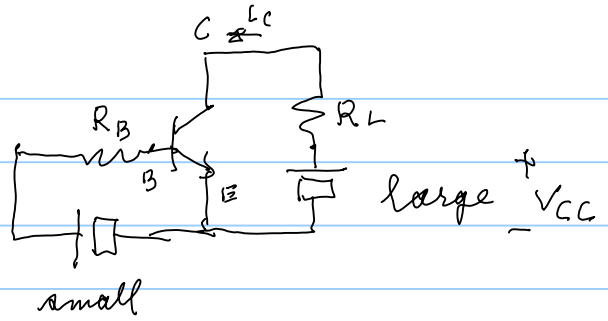
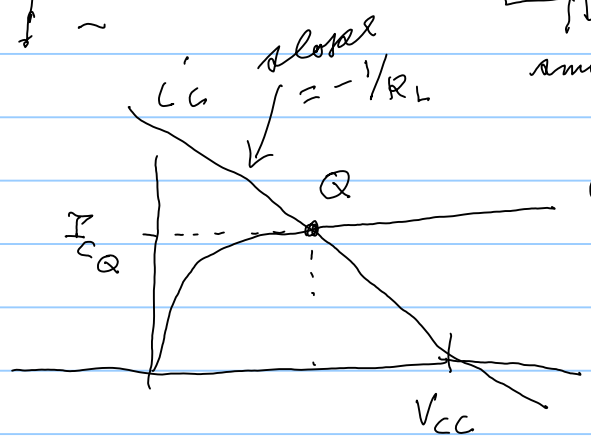
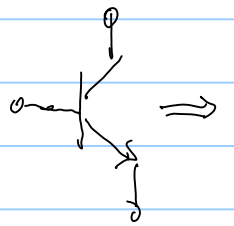
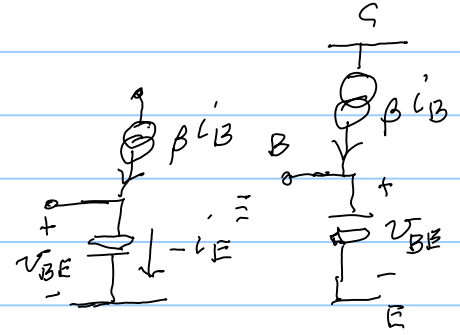


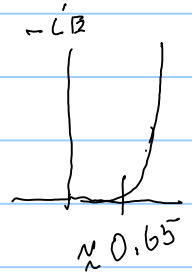


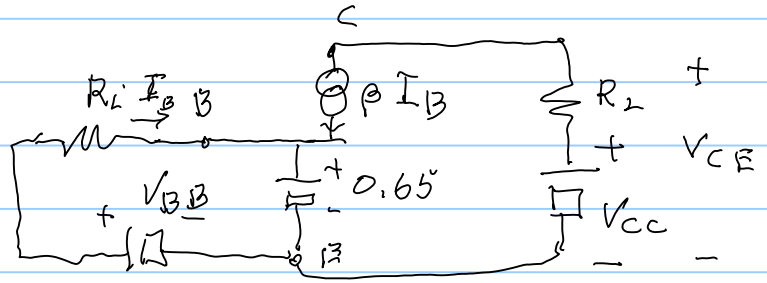






for bias
$i_B \rightarrow I_B$
$v_{BE} \rightarrow V_{BE}$



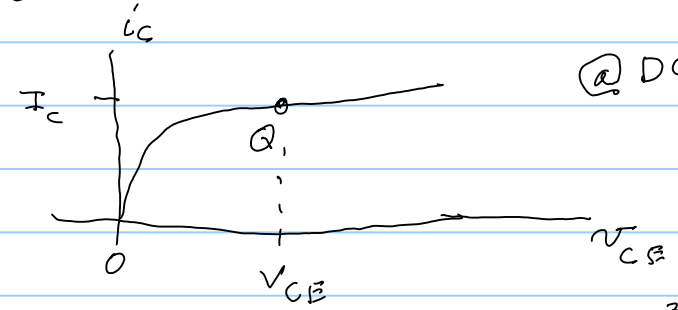


KVL B–E $\quad V_{BB} = R_i I_B + 0.65 \Rightarrow I_B = \dfrac{V_{BB} - 0.65}{R_i}$ } biases the base

Ex: $V_{BB} = 1.65 \Rightarrow I_B = 1/R_i$ if $I_B \approx 1 \times 10^{-6}$, $R_i = 1\,\text{Meg}\,\Omega$ }

Bias at the collector; β given; βI_B is known; $\beta I_B = I_C$

KVL $\quad V_{CE} = -R_L I_C + V_{CC}$



@ DC :

know V_{CC} as a battery, say

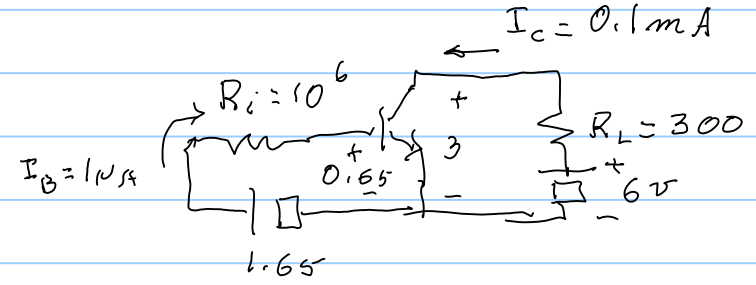
$V_{CC} = 6v$, $\quad -R_L \beta I_B$

know $V_{CE} \Rightarrow \dfrac{V_{CC} - V_{CE}}{\beta I_B} = R_L = \dfrac{6-3}{\beta \times 10^{-6}} = \dfrac{3}{10^{-4}} = 0.3 \times 10^{3} \Rightarrow 300\,\Omega_m$

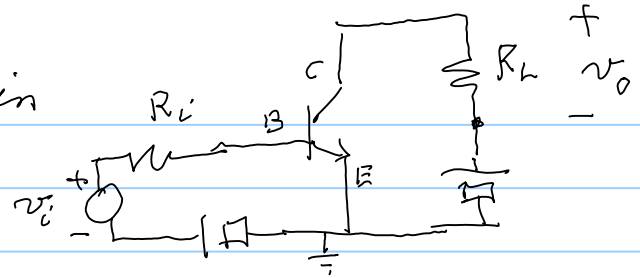
say 3v.

$\beta = 100$

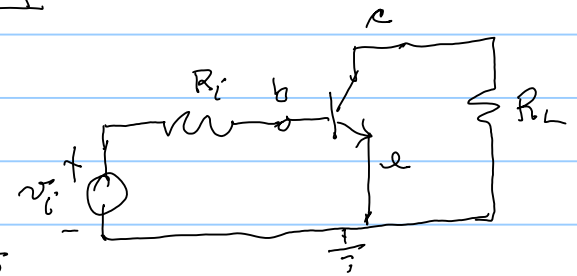
$\beta I_B = I_C$

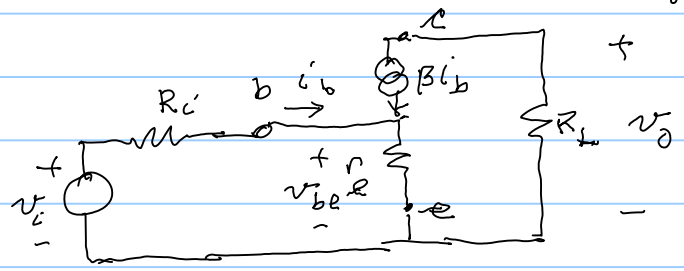


Signal gain



small signal ⇒ equivalent circuit





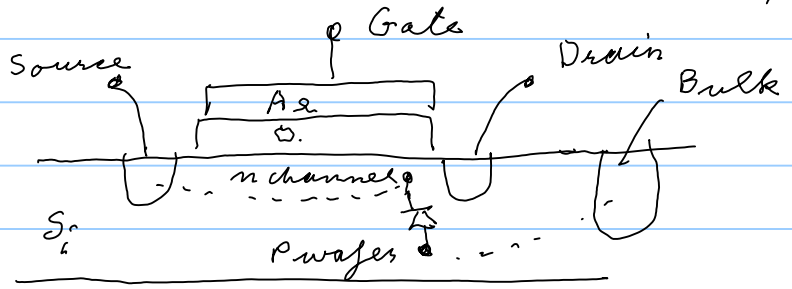
$$r_e = \frac{1}{g_e} \; ; \quad g_e = \frac{|I_E|}{V_T}$$

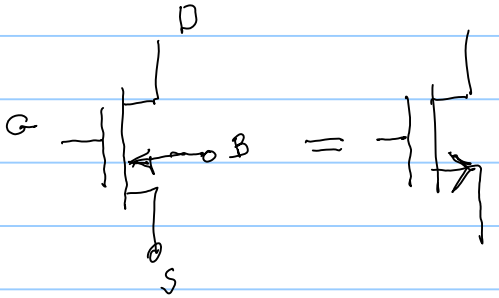
$$v_o = -\beta i_b \cdot R_L \; ; \qquad v_{be} = r_e \cdot (i_b + \beta i_b) = r_e (-i_e)$$

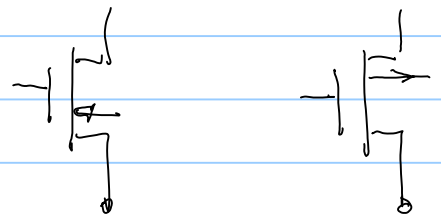
$$v_i = R_i i_b + v_{be} = \left[R_i + r_e (1+\beta)\right] i_b \Rightarrow i_b = \frac{v_i}{R_i + (1+\beta) r_e}$$

$$v_o = -\frac{\beta R_L}{R_i' + (1+\beta) r_i} v_i \quad \Longrightarrow \quad \frac{v_o}{v_i} = -\frac{\beta}{R_i + (1+\beta) r_e} \cdot R_L \approx -\beta \frac{R_L}{R_i}$$

MOS transistors = metal oxide silicon







NMOS PMOS

i_D NMOS