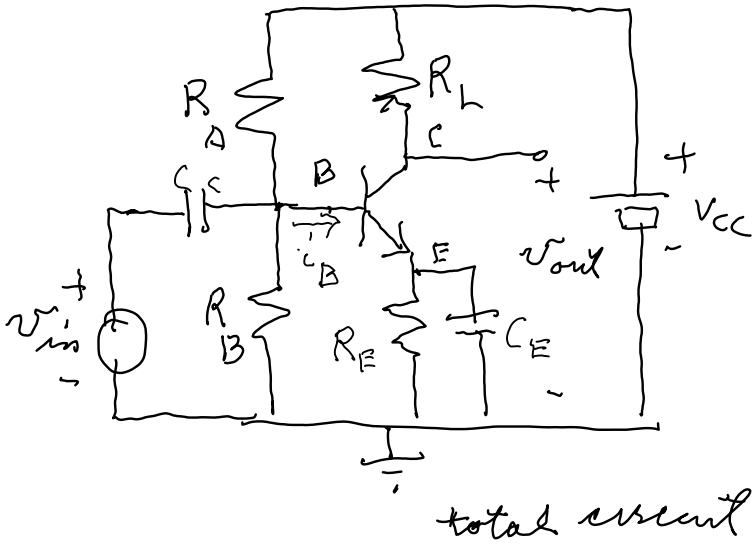
ENEE303
02/21/19

Note Title 2/21/2019

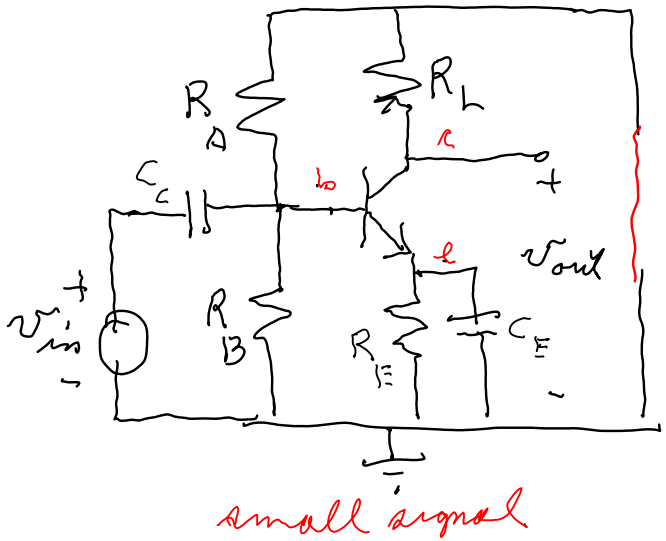
$$R_A = \frac{\beta}{I_C}\left[V_{CC} - (1+k_{AB})\left(\underbrace{V_{BE}}_{0.7V} + R_E\frac{I_C}{\alpha}\right)\right]$$ ⇐ bias resistor choices for BJT

$$k_{AB} = \frac{R_B}{R_A}$$



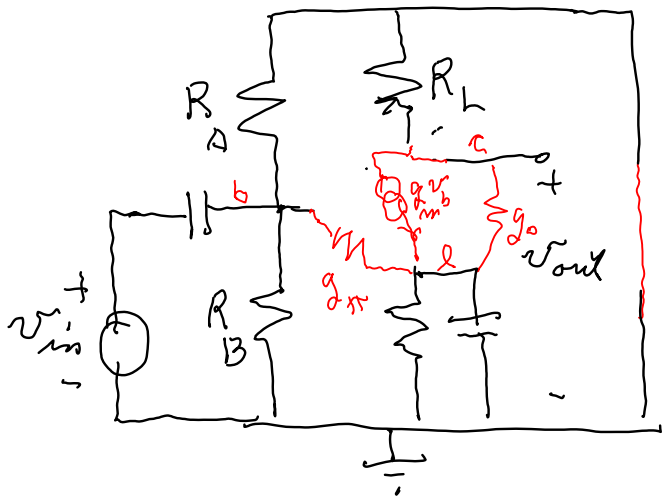
total circuit

⇒



small signal

common emitter



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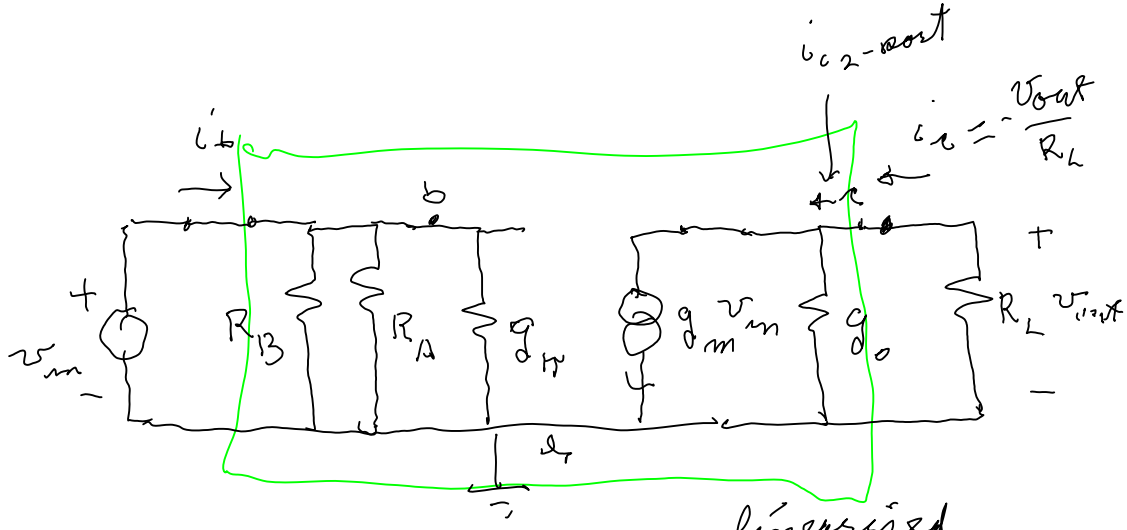


linearized

mid frequency band

$i = Y v$

$$\begin{bmatrix} i_b \\ i_c \end{bmatrix} = \begin{bmatrix} g_\pi + (G_A + G_B) & 0 \\ g_m & g_o \end{bmatrix} \begin{bmatrix} v_{in} \\ v_{out} \end{bmatrix}$$

$$i_x = g_m v_{in} + g_o v_{out} = -v_{out}/R_L \qquad \text{by KCL}$$

$$A_v = \frac{v_{out}}{v_{in}} \Rightarrow \qquad g_m v_{in} = -(g_o + G_L) v_{out}$$

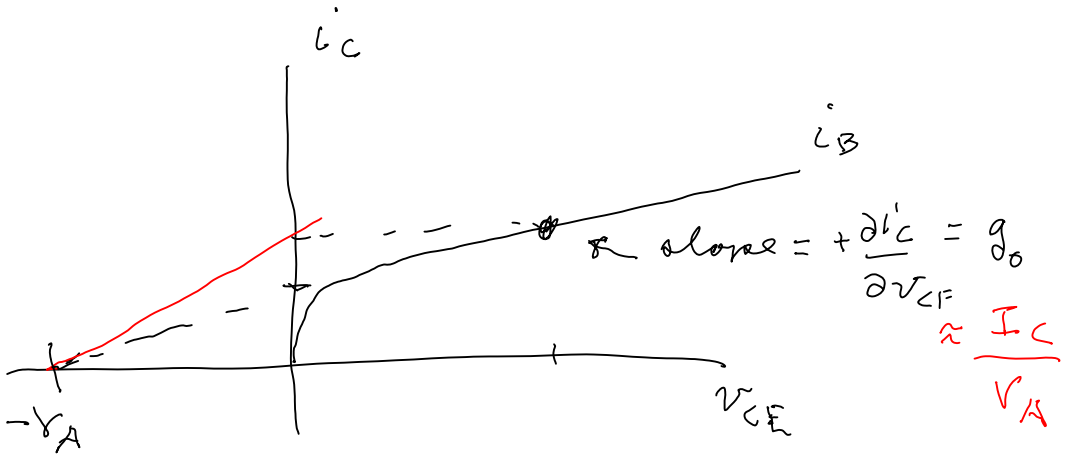
$$\frac{v_{out}}{v_{in}} = \frac{-g_m}{g_o + G_L} \approx -g_m/G_L = -g_m R_L$$

$$\approx 0$$

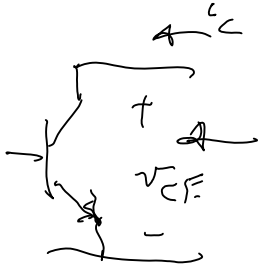
$$= -\frac{I_C}{V_T} R_L$$

If $I_C = 2.6\,mA$, $V_T = 26\,mV$ $\Rightarrow$ $g_m = \frac{2.6}{26} = 0.1$ if we choose $R_L = 10\,k\Omega$

then $A_v = -0.1 \times 10 \times 10^3 = 10^3$

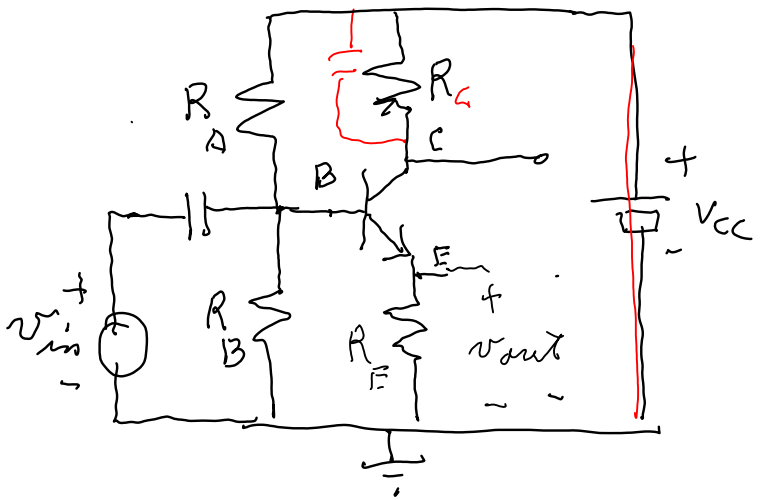


$$\text{slope} = +\frac{\partial i_C}{\partial v_{CE}} = g_o \approx \frac{I_C}{V_A}$$

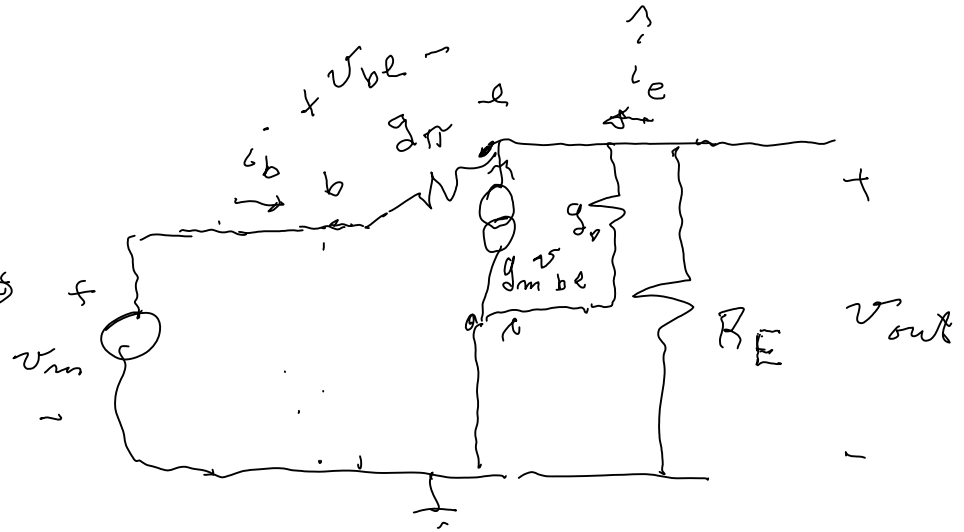


output ree g_o as small signal conductance

grounded collector



$\Rightarrow$



$i_b = g_\pi v_{be}$; $v_{out} = -R_E i_e$; KCL: $0 = i_b + g_m v_{be} - g_o v_{out}$

KCL : ; $\Rightarrow$ $0 = g_\pi v_{be} + g_m v_{be} - g_o v_{out}$

KVL $\Rightarrow \quad 0 = -v_{in} + v_{be} + v_{out} \Longrightarrow v_{be} = v_{in} - v_{out}$

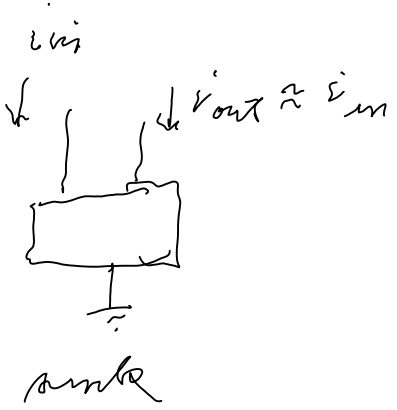
$$0 = (g_\pi + g_m)\left[v_{in} - v_{out}\right] - g_o v_{out} \Longrightarrow \left(g_o + g_\pi + g_m\right) v_{out} = (g_\pi + g_m) v_{in}$$

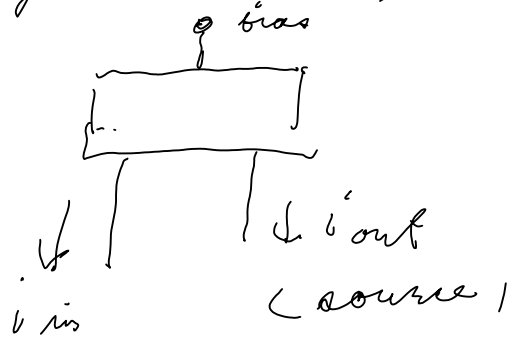
$$A_v = \frac{v_{out}}{v_{in}} = \frac{(g_\pi + g_m)}{(g_o + g_\pi + g_m)} \approx \frac{g_m}{g_m} \approx 1$$

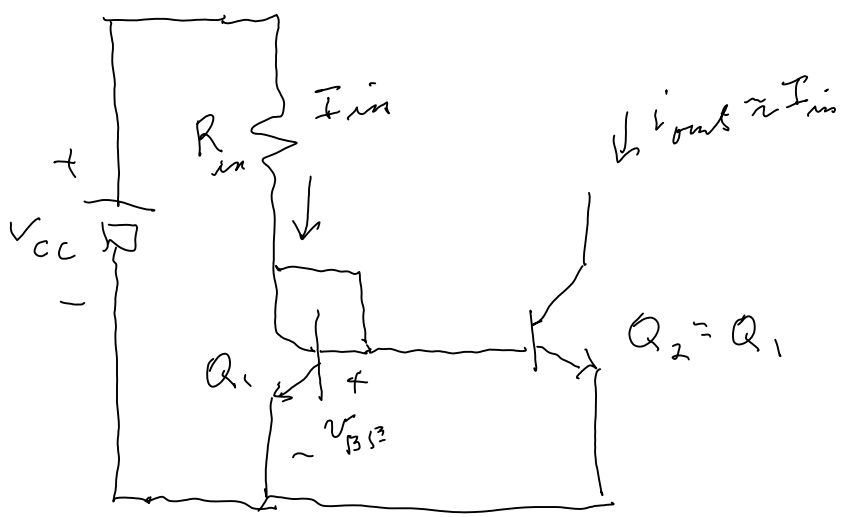
$\Leftarrow$ gain of ground collector = emitter follower

$\Rightarrow$ used to isolate loads from sources.

current mirrors

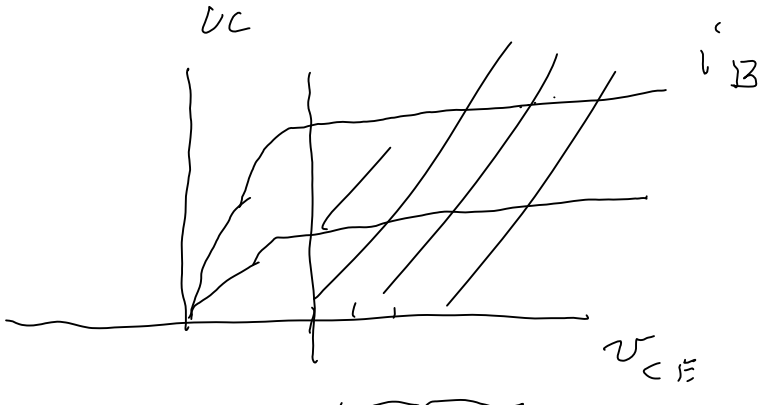




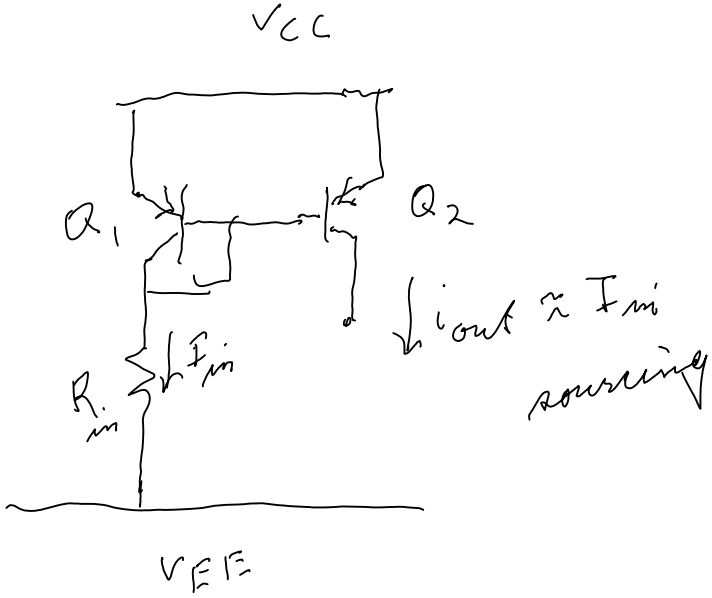


$$R_{in} I_{in} = V_{CC} - V_{BE}$$

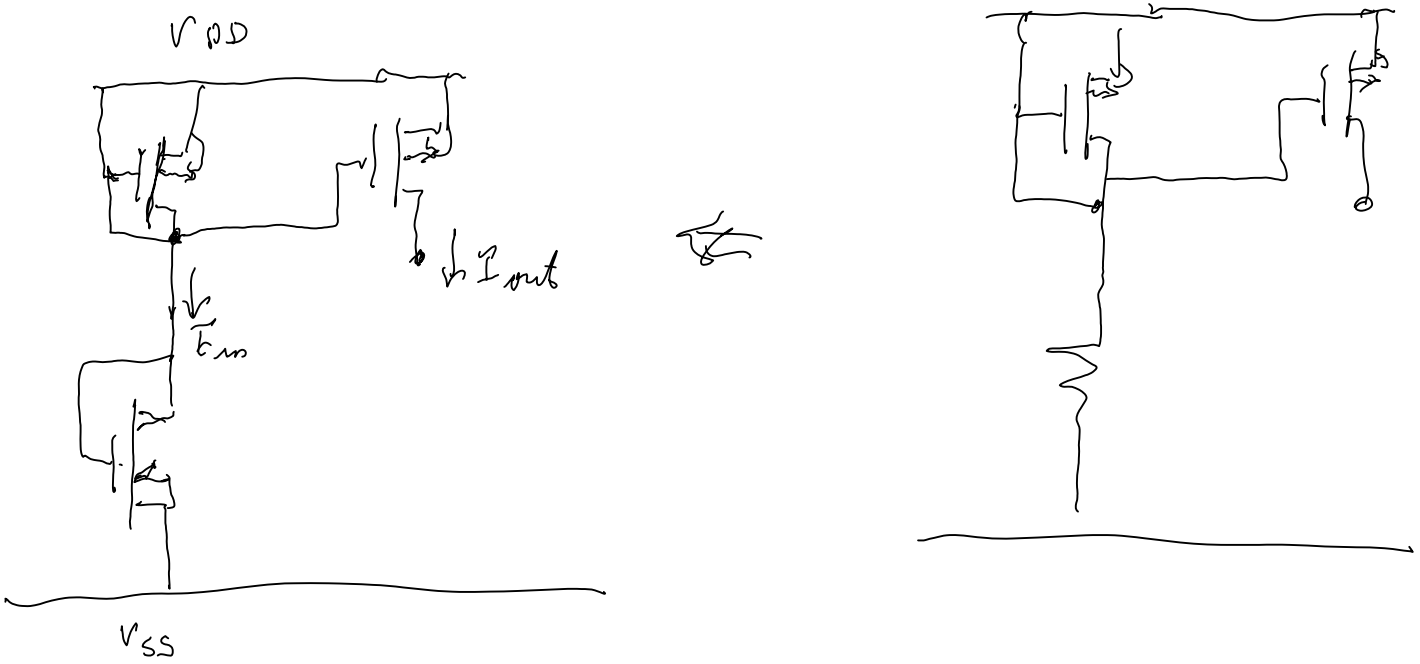
$$\Rightarrow R_{in} = \frac{V_{CC} - V_{BE}}{I_{in}}$$

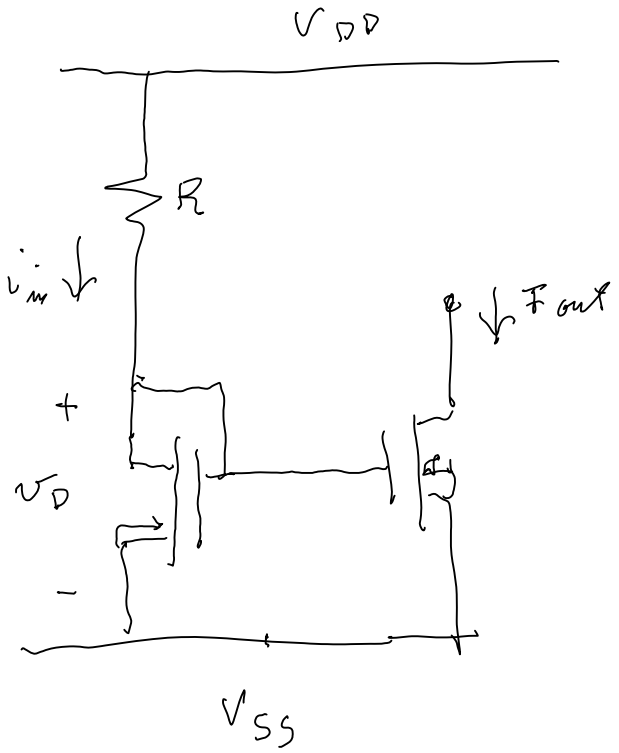


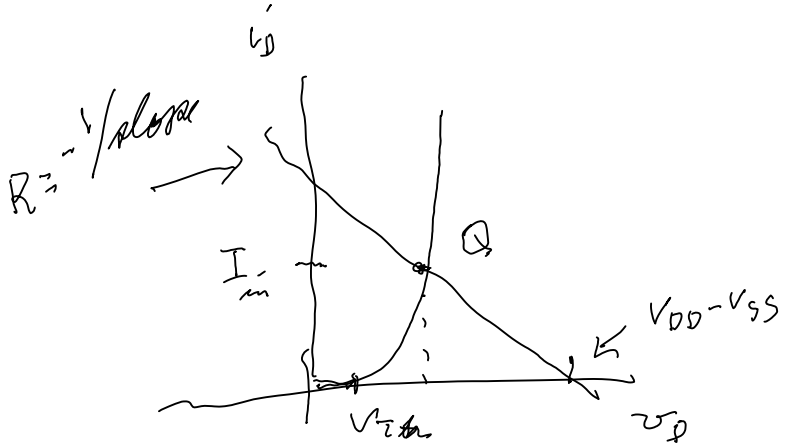
need to be in forward active region



$$R_{in} = \frac{(V_{CC} - V_{EE}) - (V_{EB})}{I_{in}}$$


VDD
Iout
Iin
Vss





$$i_D = k_n \frac{W}{L} \left(v_D - V_{th} \right)^2$$