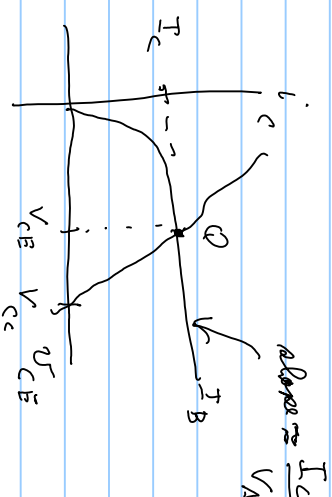
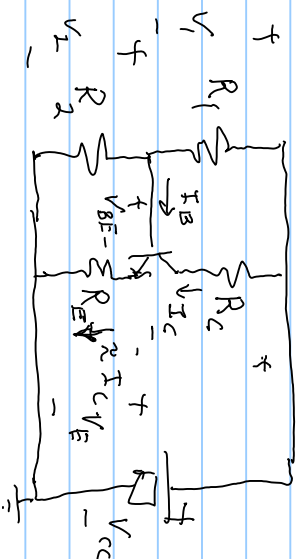


Biasing an nPN



(fixed. active)

assume @ Q, $I_C = 2 \text{ mA} \Rightarrow g_m = I_C / V_T$

$$\beta = 200 ; I_B = \frac{I_C}{\beta} = \frac{2 \times 10^{-3}}{200} = 10 \times 10^{-6} = 10 \mu\text{A}$$

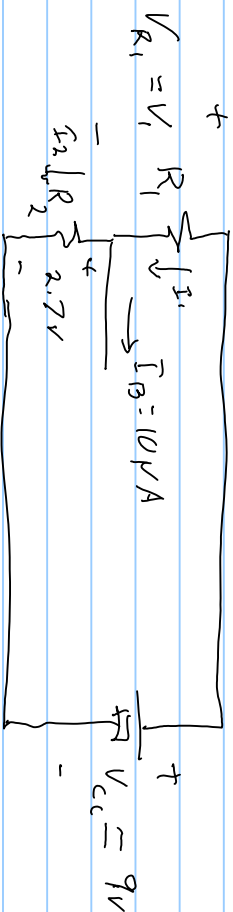
$$\alpha = \frac{\beta}{1 + \beta} = \frac{200}{201} \approx 1$$

$$\text{assume } R_E = 1 \text{ k}\Omega = 10^3$$

$$V_E \text{ on } R_E \Rightarrow V_E = R_E \left(\frac{I_C}{\alpha} \right) \approx 10 \times 2 \times 10^{-3} = 2 \text{ V on } R_E$$

$V_{BE} = 0.7 \text{ V}$ on fixed bias the V_{BE}

$$\Rightarrow V_{R_2} = V_{BE} + V_E = 0.7 + 2 = 2.7 \text{ V.}$$



$$V_1 = V_{CC} - 2.7 = 6.3 \text{ V} ; I_1 \sim I_2 = I_B = 10 \mu\text{A}$$

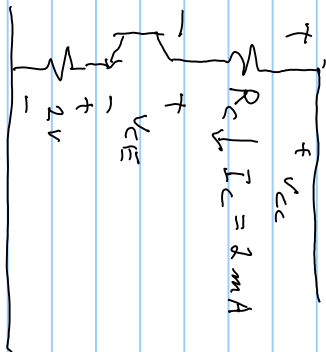
Choose R_1 but if $R_1 = 1 \text{ M}\Omega$, then $R_1 I_B = 10 \text{ V} \Rightarrow$ too big as only have

$$\text{try } R_1 = 100 \text{ k}\Omega \Rightarrow V_{R_1}/R_1 = I_1 = \frac{6.3}{100 \text{ k}} = 6.3 \times 10^{-5} = 63 \mu\text{A} > I_B = 10 \mu\text{A}$$

$$I_2 = I_1 - I_B \Rightarrow 63 \mu - 10 \mu = 53 \times 10^{-6} \Rightarrow R_2 = \frac{2.7 \text{ V}}{53 \times 10^{-6} \text{ A}} = \frac{2.7}{5.3} \times 10^5 \approx \frac{1}{2} \times 10^5$$

$$R_2 = 10^4 \times \frac{10}{2} = 50 \times 10^3 \Rightarrow R_2 = 50 \text{ k}\Omega$$

$$V_{RC} = V_{CC} - V_{CE} - 2$$



Q Q need V_{CE} assume it is $\underline{5V} = V_{CE}$

$$\Rightarrow V_{RC} = 9 - 5 - 2 = 2V_{on} R_C$$

$$R_C = \frac{2V}{2mA} = \frac{1}{10^{-3}} = 1k\Omega$$

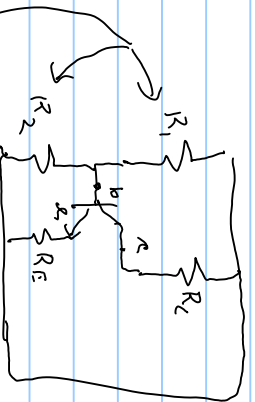
$$\text{But } \frac{V_{out}}{V_{in}} \text{ ideal} = -g_m R_L = -g_m R_C = -\frac{I_C}{V_T} \cdot R_C = -\frac{2 \times 10^{-3}}{26 \times 10^{-3}} \cdot 10^3 = -\frac{1}{13} \times 10^3 = -\frac{1}{1.3} \times 10^2$$

$$\approx -0.8 \times 10^2$$

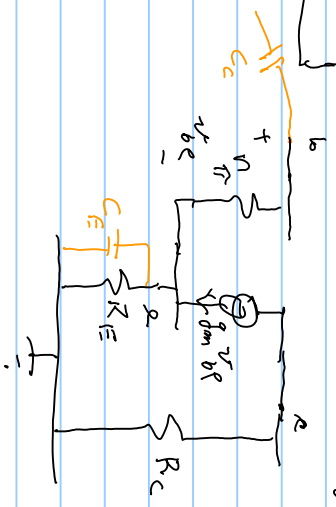
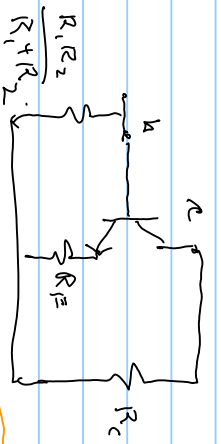
$$\approx -80$$



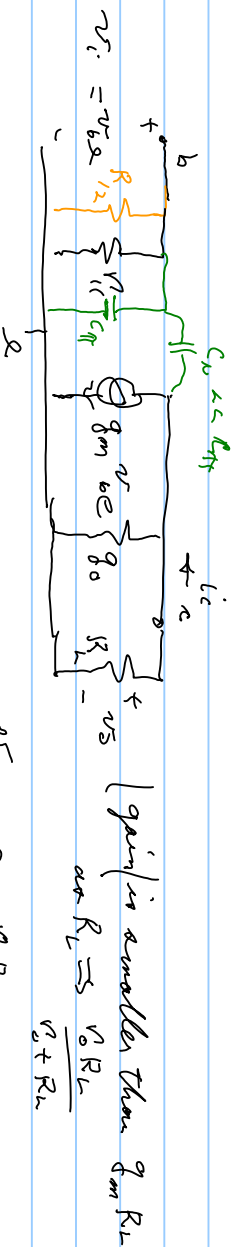
short for signal @ $\frac{dV_{ce}}{dt} \approx 0$



in parallel for small signal
device maps so can ignore for signal



to minimize the distortion of voltage gain we bypass R_E by a capacitor, large



$$g_m = \frac{I_c}{V_T}, \quad g_o = \frac{I_c}{V_A}$$

$$\frac{v_o}{v_i} = -g_m \cdot \frac{R_o R_L}{R_o + R_L}$$

gain is smaller than $g_m R_L$ as $R_L \rightarrow \frac{R_o R_L}{R_o + R_L}$

for frequency behavior, effects of C_E & C_{be} : look at i_c in order to circuit

$$i_c \approx g_m v_{be}; \text{ but } v_{be} = g_{\pi} v_{be} = (g_{\pi} + \alpha C_{\pi}) \cdot v_{be} \Rightarrow v_{be} = i_b / g_{\pi}$$

$$i_{out} = \frac{g_m}{g_{\pi} + \alpha C_{\pi}}, i_b$$