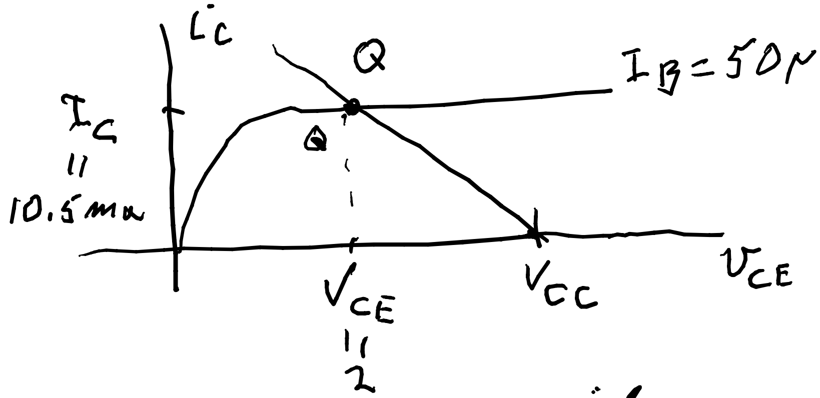
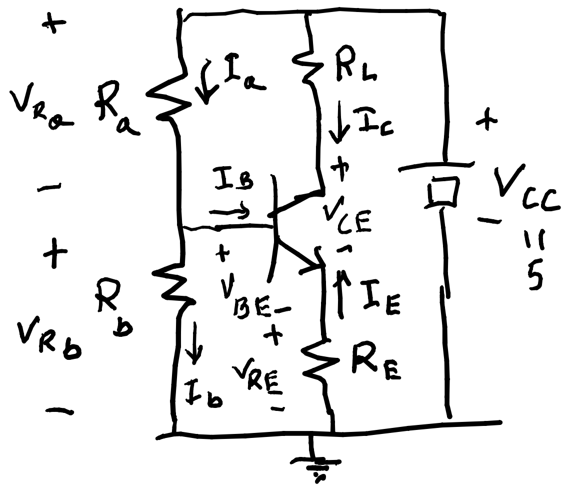
EE303H
09/19/13

Biasing the 2N2222





$-I_E = I_c/\alpha$

β = given

$\alpha = \frac{\beta}{1+\beta} = \frac{256}{257} = 0.996$

$\beta = \beta_f = 256$

$-I_E = \frac{10.5\times10^{-3}}{0.996} = 10.54\,mA$

assume $V_{BE} = 0.7$, $R_E = 50\Omega \Rightarrow V_{RE} = R_E(-I_E) = 50\times10.54\,mV$

$= \frac{100}{2}\times 10.54\times10^{-3} = 0.527V$

$V_{R_b} = V_{BE} + V_{R_E} = 1.227V$

$\Rightarrow V_{R_a} = V_{CC} - V_{R_b} = 5 - 1.227 = 3.773$

$I_B = 50\mu A \Rightarrow I_a = I_B + I_b \Rightarrow R_a I_a = R_a(I_B + I_b) = 3.773$

$R_b I_b = 1.227$

$R_a I_B + \frac{1.227}{R_b} * R_a = 3.773 \Rightarrow$ solve for R_a

$R_a\left(I_B + \frac{1.227}{R_b}\right) = 3.773 \Rightarrow R_a = \frac{3.773}{50\times10^{-6} + \frac{1.227}{R_b}}$

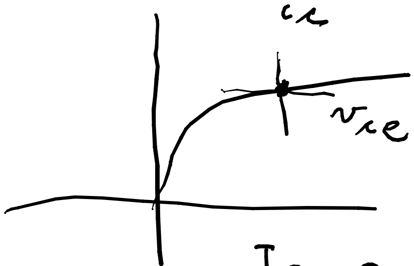
choose R_b in MEG ohm range, $R_b = 1\,MEG = 10^6\Omega$

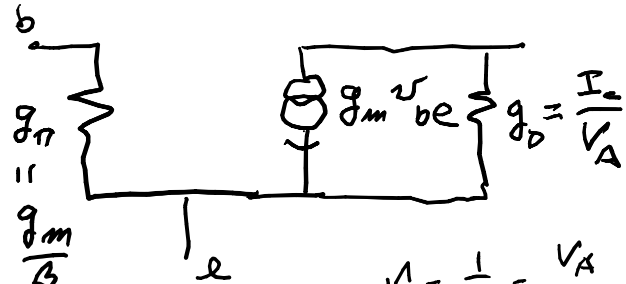
$\Rightarrow R_a = \frac{3.773}{51.227}\times10^6 = 0.659\times10^6 = 659K\Omega$

also know R_L: $V_{RL} = R_L I_C = V_{CC} - V_{RE} - V_{CE} = 5 - 0.527 - 2$

$= 2.473$ volt

$R_L = \frac{2.473}{10.5\times10^{-3}} = 0.236\times10^{+3} = 236\Omega$





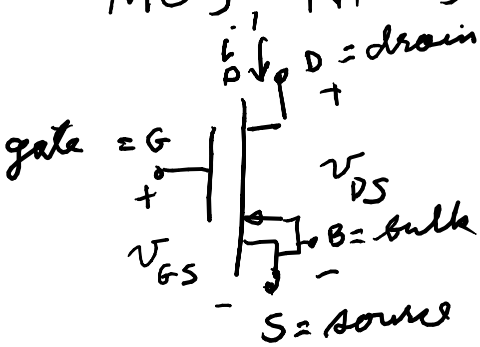
$g_\pi = \frac{g_m}{\beta} = \frac{0.404}{256}$

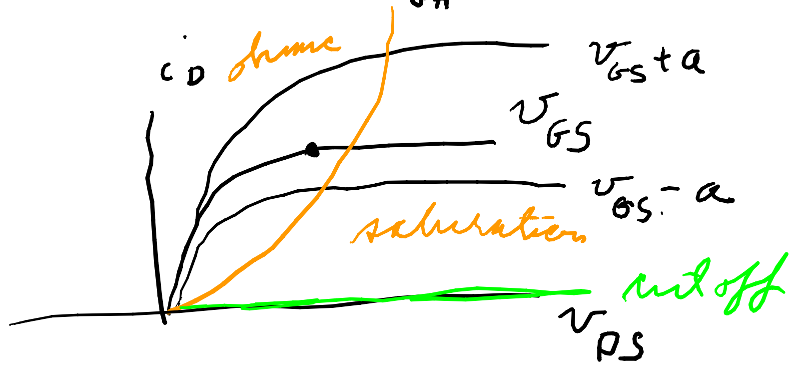
$$\frac{I_C}{V_T} = g_m = \frac{10.5\,ma}{26\,mV} = 0.404\,\mho$$

$$r_\pi = \frac{1}{g_\pi} = 633\,\Omega$$

$$r_o = \frac{1}{g_o} = \frac{V_A}{I_c} = \frac{74.03}{10.5\times 10^{-3}} = 7.05\,K\Omega$$

MOS, NMOS

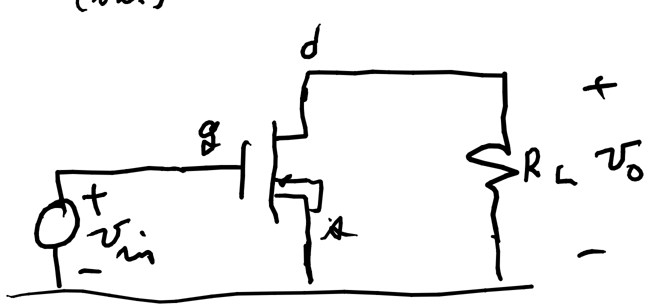


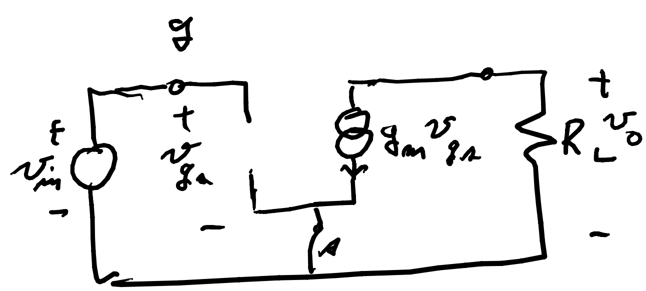


$$i_D = \begin{cases} 0 & v_{GS} \le V_{TO} \text{ cut off} \\ \frac{KP}{2} * \frac{W}{L}(v_{GS}-V_{TO})^2(1+\lambda v_{DS}) & v_{GS}-V_{TO} \le v_{DS} \text{ saturation} \\ \frac{KP}{2} * \frac{W}{L}\left[(v_{GS}-V_{TO})v_{DS} - \frac{1}{2}v_{DS}^2\right](1+\lambda v_{DS}) & v_{DS} \le v_{GS}-V_{TO} \text{ ohmic, triode} \end{cases}$$

$$g_m = \left.\frac{\partial i_D}{\partial v_{GS}}\right|_{Q\,(sat)} = 2 * \frac{KP}{2}\frac{W}{L}(v_{GS}-V_{TO})(1+\lambda v_{DS})\Big|_Q = \frac{2 I_D}{(V_{GS}-V_{TO})}$$

$(V_{GS}-V_{TO})$ = overdrive





$$\frac{v_o}{v_{in}} = -g_m R_L$$

$$v_o = (-g_m v_{in}) R_L$$