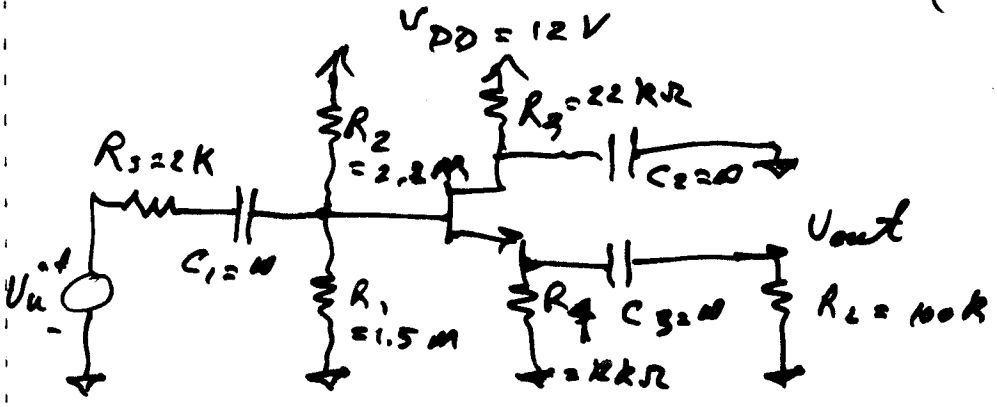
COMMON DRAIN AMPLIFIER (SOURCE FOLLOWER)



$K_n = 500 \mu A/V^2$

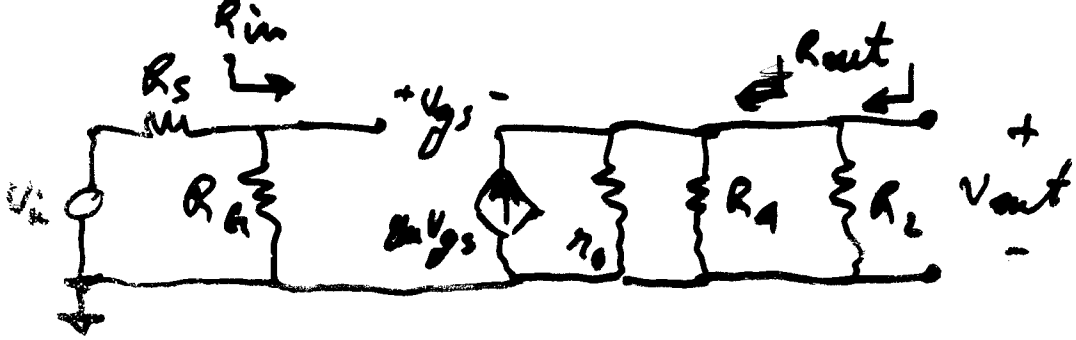
$V_{TN} = 1V$

$\lambda = 0.02 V^{-1}$

Q POINT : $I_{DS} = 241 \mu A$, $V_{DS} = 3.81 V$

SMALL SIGNAL MODEL

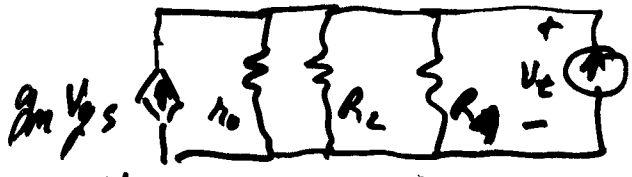
$R_G = R_1 // R_2$



$$g_m = \sqrt{2 K_n I_{DS} (1 + \lambda V_{DS})} = 509 \mu S$$

$$r_o = \frac{\frac{1}{\lambda} + V_{DS}}{I_{DS}} = 223 k\Omega$$

$R_{in} = R_G = 892 k\Omega$ $\quad R_{out} = ? = \left.\frac{v_t}{i_t}\right|_{V_{in}=0}$



$\Sigma i = 0$

$-g_m V_{gs} + g_o v_t + G_4 v_t + G_L v_t = 0$

$V_{gs} = V_g - V_s = -V_s$

$$\frac{v_t}{i_t} = \frac{1}{g_m + g_o + G_4 + G_L} \approx \frac{1}{g_m}$$

$R_{out} = \underline{1.96 k\Omega}$

Find $\frac{V_{out}}{V_{in}} = ?$

$$\frac{V_{out}}{V_{in}} = \left(\frac{V_{out}}{V_{gs}}\right)\left(\frac{V_{gs}}{V_{in}}\right) = \left\{g_m(r_o \| R_4 \| R_L)\right\} \times \{?\}$$

$$V_{gs} = V_g - V_s = \left(\frac{R_a}{R_s + R_a}\right) V_{in} - g_m V_{gs}(r_o \| R_4 \| R_a$$

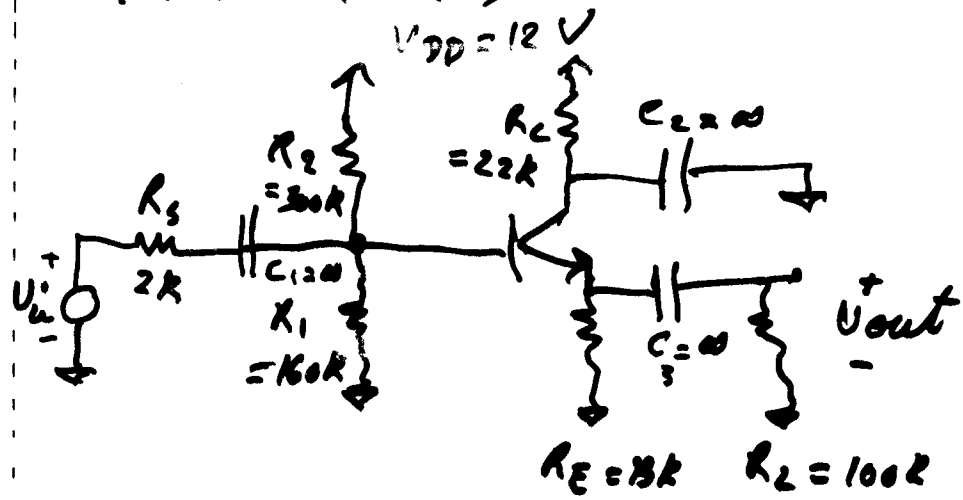
$$\frac{V_{gs}}{V_{in}} = \frac{\frac{R_a}{R_s + R_a}}{1 + g_m(r_o \| R_4 \| R_L)}$$

$$\frac{V_{out}}{V_{in}} = \left(\frac{R_a}{R_s + R_a}\right) \cdot \frac{g_m(r_o \| R_4 \| R_L)}{1 + g_m(r_o \| R_4 \| R_L)}$$

$$= \left(\frac{892}{894}\right) \cdot \left(\frac{30.5}{1 + 30.5}\right) = \underline{0.966\ V/V}$$

COMMON COLLECTOR (EMITTER FOLLOWER)

FIG 14.3(a)



$\beta_F = 100$

$V_A = 50$

$I_C = 245\,\mu A$

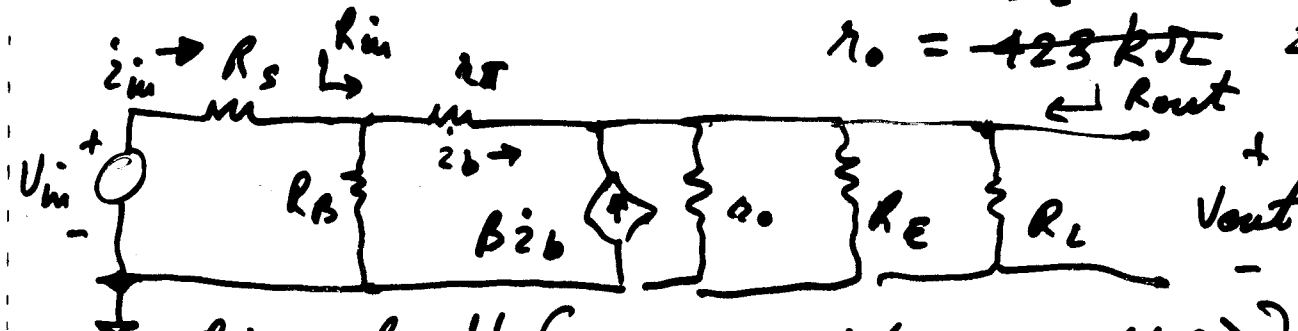
$V_{CE} = 3.64\ V$

SMALL SIGNAL MODEL: $R_B = R_1 \| R_2$

$R_B = R_1 \| R_2 = 104.35\ k\Omega$ $\quad g_m = \frac{I_C}{V_t} = 9.8\ mS$

$r_\pi = \frac{\beta_F}{g_m} = 10.2\ k\Omega$ $\quad r_o = \frac{V_A + V_{CE}}{I_C} = \frac{53.64}{245\,\mu A}$

$r_o = \cancel{423\ k\Omega}$ 219k.



$R_{in} = R_B \| \left[r_\pi + (1+\beta)(r_o \| R_E \| R_2) \right]$

$= 98.5\ k\Omega$

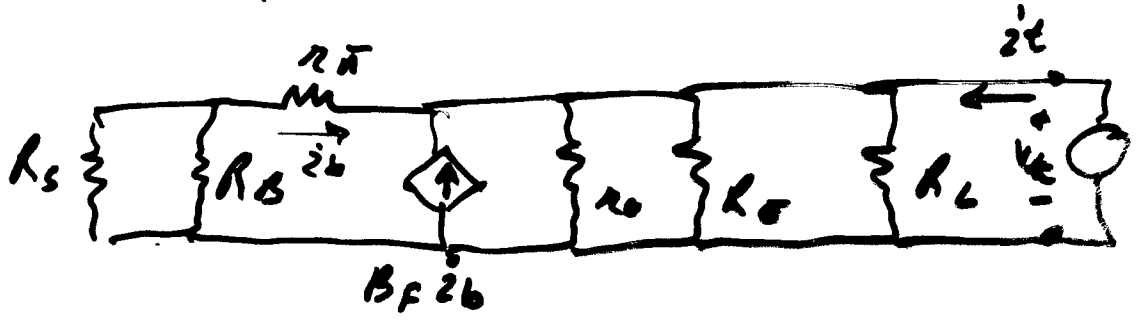
$$\frac{V_{out}}{V_{in}} = \left(\frac{V_{out}}{i_b}\right)\left(\frac{i_b}{i_{in}}\right)\left(\frac{i_{in}}{V_{in}}\right)$$

$$R' = r_o \,//\, R_E \,//\, R_L = 17.3k$$

$$= \left[(1+\beta_F)R'\right] \cdot \left[\frac{R_B}{R_B + r_\pi + (1+\beta)R'}\right] \cdot \left[\frac{1}{R_s + R_{in}}\right]$$

$$\frac{V_{out}}{V_{in}} = 0.963 \ \{V/V\}$$

$R_{out} = ?$ Set $V_{in} = 0$



$$\Sigma i = 0 \rightarrow \quad i_t = g_o V_t + G_E V_t + G_L V_t - i_b(1+\beta_F)$$

$$\because \quad i_b = -\frac{V_t}{r_\pi + R_s \,//\, R_B}$$

$$i_t = \left\{ g_o + G_E + G_L + \frac{1+\beta_F}{r_\pi + R_s \,//\, R_B} \right\} \cdot V_t$$

$$R_{out} = \frac{V_t}{i_t} = \frac{1}{\frac{1}{r_o} + \frac{1}{R_E} + \frac{1}{R_L} + \frac{1+\beta}{r_\pi + R_s \,//\, R_B}} = 119.6\ \Omega$$