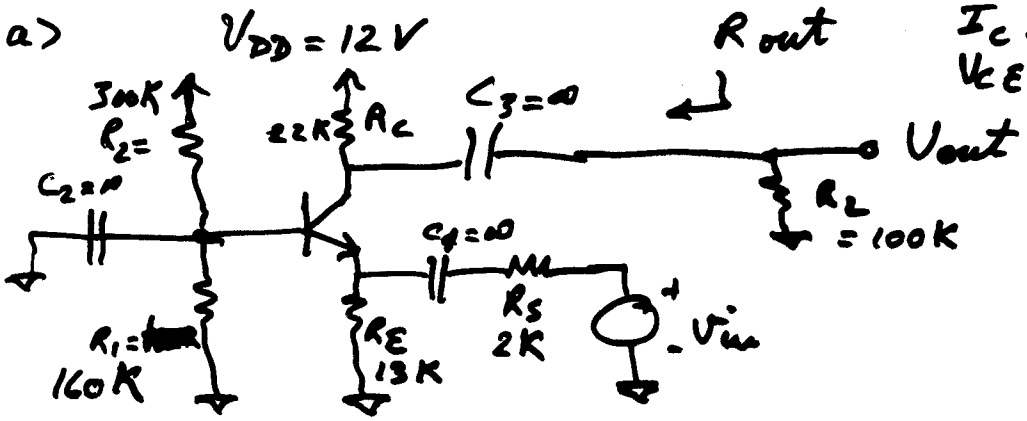
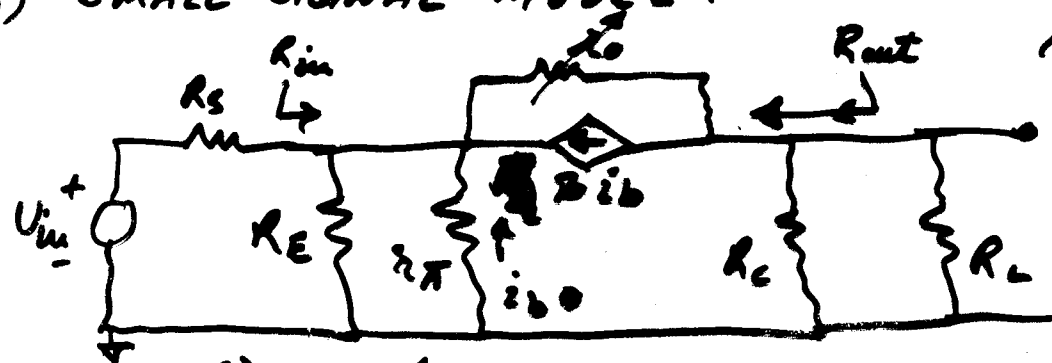
1) COMMON BASE AMPLIFIER

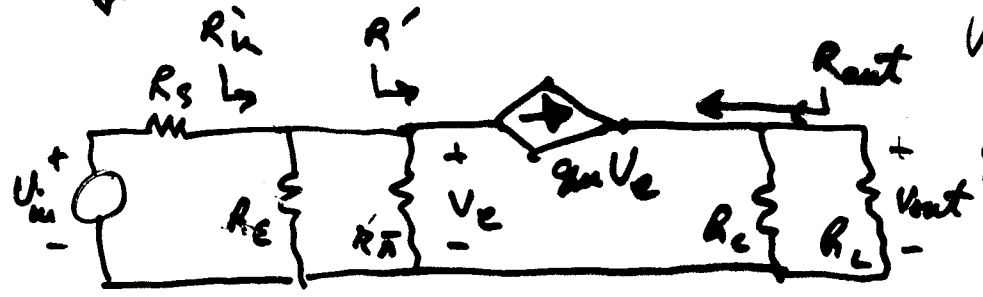
$\beta_F = 100$
$V_A = 50V$
$I_C = 245\,mA$
$V_{CE} = 3.4\,V$

a)



b) SMALL SIGNAL MODEL:





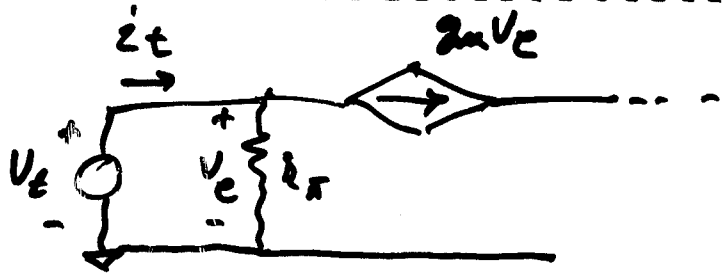
$V_{BE} = 0 - V_e = V$

$g_m = \frac{I_C}{V_t} = \frac{245m}{25m}$

$= 9.80\,m\,S$

$r_o = \frac{V_A}{I} = 204K$

$R_{in} = R_E \,||\, R'$ $\quad R' = \frac{V_e}{i_t}$



$$i_t = \frac{V_t}{r_\pi} + g_m V_t = V_t\left(\frac{1}{r_\pi} + g_m\right)$$

$$\therefore R' = \frac{1}{\frac{1}{r_\pi} + g_m} = \frac{r_\pi}{1 + g_m r_\pi} \approx \frac{1}{g_m} = 102\,\Omega$$

$$R_{in} = 13K \,//\, 102\,\Omega = 101\,\Omega$$

$$\frac{V_{out}}{V_{in}} = \left(\frac{V_{out}}{V_\pi}\right)\left(\frac{V_\pi}{V_{in}}\right) = \left(g_m R_C // R_L\right)\cdot\left(\frac{R_{in}}{R_{in} + R_S}\right)$$

$$\frac{V_{out}}{V_{in}} = 8.48 \left\{V/V\right\}$$

d) OUTPUT RESISTANCE

$$V_t = (i_t - g_m V_{be})\, r_o - V_{be} = r_o i_t - V_{be}(1 + g_m r_o)$$

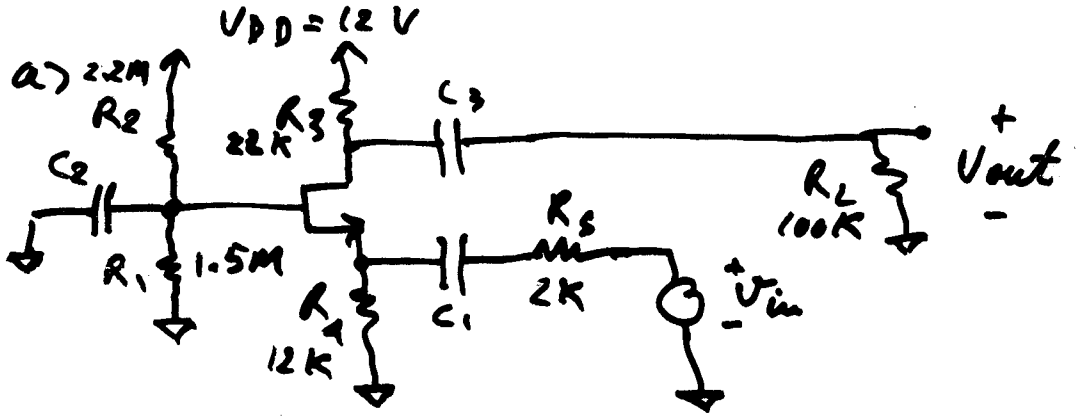
$$-V_{be} = i_t\,(r_\pi // R_E // R_S)$$

$$\therefore V_t = \left\{r_o + (r_\pi // R_E // R_S)(1 + g_m r_o)\right\} i_t$$

$$R_{out} = \frac{V_t}{i_t} = r_o + (r_\pi // R_E // R_S)(1 + g_m r_o) \approx g_m r_o (r_\pi // R_E // R_S) + r_o$$

$$R_{out} = 3.166\,M\Omega$$

2) COMMON GATE AMPLIFIER $C_{1,2,3} = \infty$



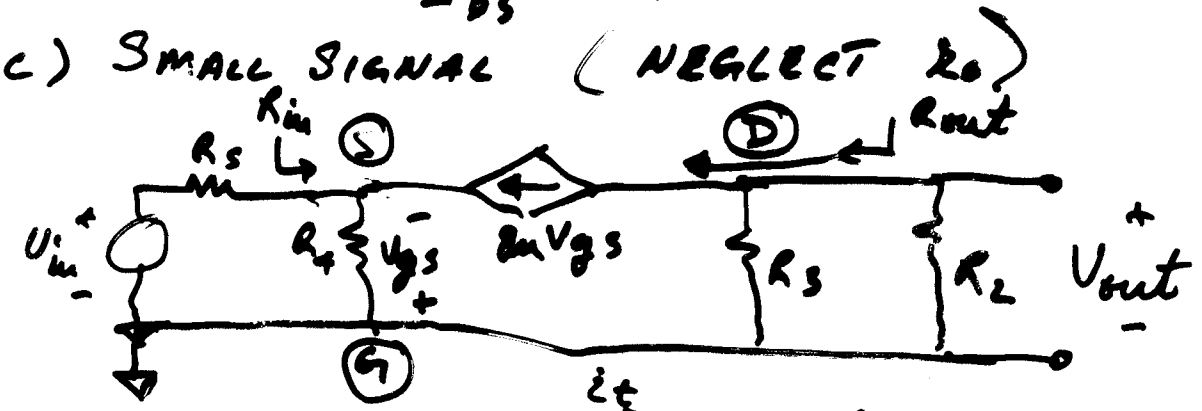
$K_n = 500\ \mu A/V^2$, $V_{TN} = 1\ V$, $\lambda = 0.02\ V^{-1}$

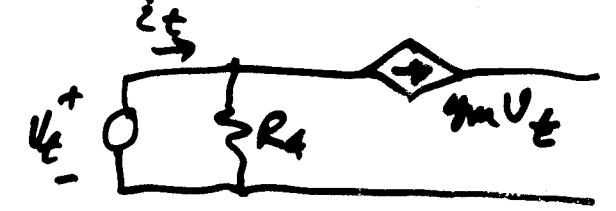
$I_{DS} = 241\ \mu A$, $V_{DS} = 3.8\ V$

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

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

c) SMALL SIGNAL (NEGLECT r_o)





$$R_{in} = \frac{V_t}{i_t}$$

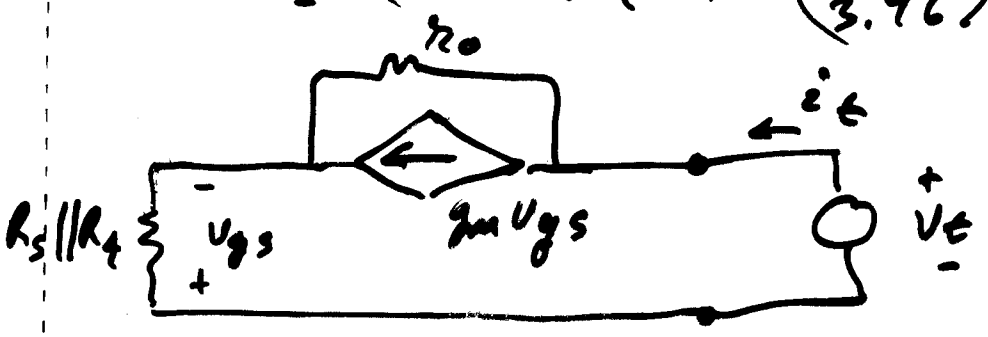
$$i_t = \frac{V_t}{R_4} + g_m V_t \rightarrow R_{in} = \frac{1}{\frac{1}{R_4} + g_m} \approx \frac{1}{g_m}$$

$$R_{in} = \frac{1}{509\mu S} = \underline{1.96 K\Omega}$$

~~$R_{out} = R_3 = 22 K\Omega$~~

$$\frac{V_{out}}{V_{in}} = \left(\frac{V_{out}}{V_{gs}}\right)\left(\frac{V_{gs}}{V_{in}}\right) = -(g_m R_3 // R_2)\left(-\frac{R_{in}}{R_{in}+R_s}\right)$$

$$= (0.509)(18)\left(\frac{1.96}{3.96}\right) = 4.54 \left\{V/V\right\}$$



$$v_t = (i_t - g_m v_{gs}) r_o - v_{gs}$$

$$v_t = i_t r_o - v_{gs}(1 + g_m r_o)$$

$$v_t = i_t \left\{ r_o + R_s // R_4 (1 + g_m r_o) \right\}$$

$$R_{out} = r_o + R_s // R_4 (1 + g_m r_o)$$

$$= 416 K\Omega$$