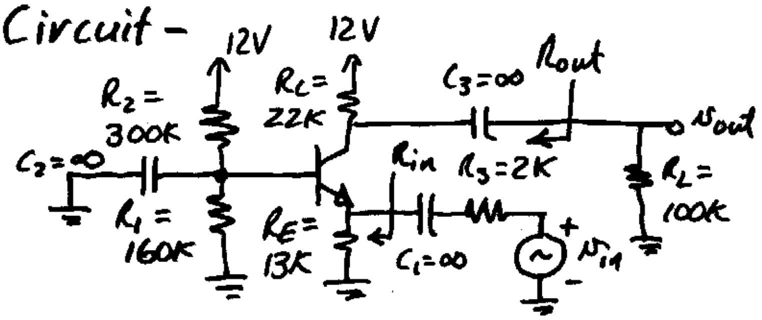
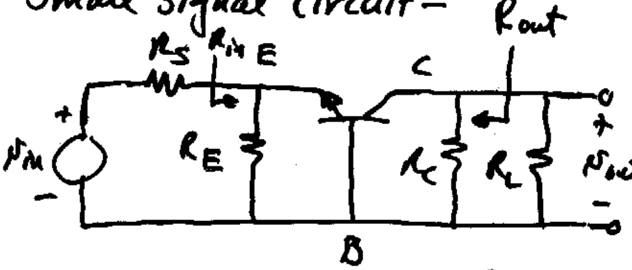
Common Base Amplifier

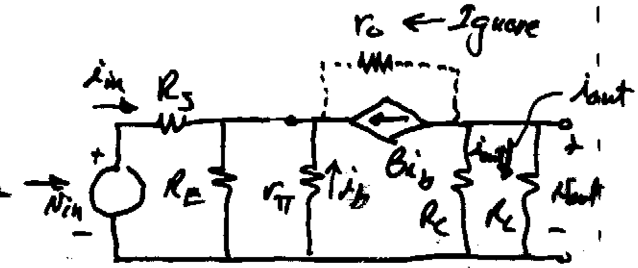
Circuit -



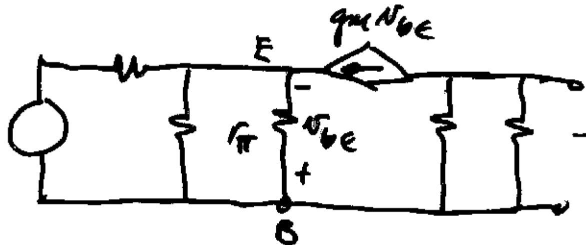
If $B_F = 100$ and $V_A = 50V$ find R_{in}, R_{out}, and $\frac{v_{out}}{v_{in}}$ if $I_C = 245\mu A$ and $V_{CE} = 3.4V$

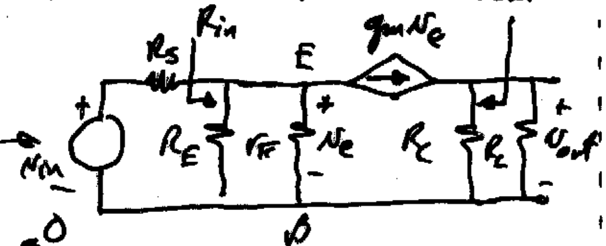
Small signal circuit -





For the heck of it, lets control the source by v_{be}.





$$v_{be} = v_b - v_e$$

$$g_m = \frac{I_C}{V_T} = \frac{245\mu A}{25mV} = 9.8mS \;,\; r_\pi = \beta\frac{1}{g_m} = 10.2k\Omega \;\; (r_o = 204k)$$

$$R_{in} = R_E \| \frac{r_\pi}{1+B} = R_E \| \frac{1}{g_m} = 13K \| 102\Omega = \underline{\underline{101\Omega}}$$

$R_{out} = ?$

$R_{out} = \frac{v_x}{i_x}$

If $r_o = \infty$, then $R_{out} = R_C = 22k$

If $r_o \neq \infty$,

$$R_{out} = \left[r_o + (r_\pi \| R_E \| R_S)(1 + g_m r_o)\right] \| R_C = 3.66M\Omega \| 22k\Omega$$

CB Amplifier - Cont'd

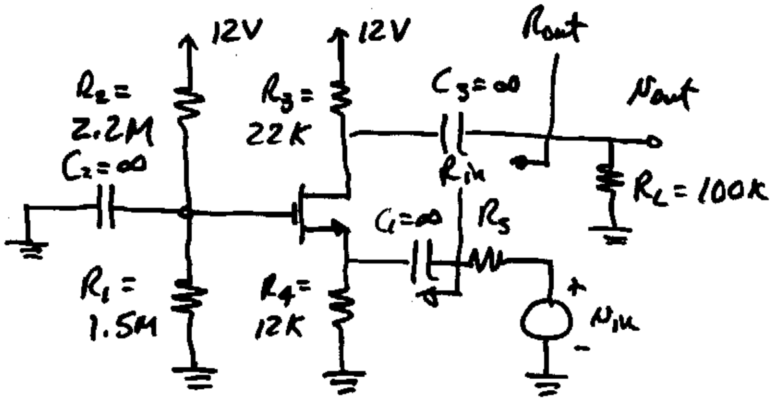
$$\frac{v_{out}}{v_{in}} = \left(\frac{v_{out}}{v_e}\right)\left(\frac{v_e}{v_{in}}\right) = \left[+g_m(R_C \| R_L)\right]\left[\frac{R_{in}}{R_S+R_{in}}\right] = (9.8\times 18)\left(\frac{0.101}{2.101}\right)$$

$$\frac{v_{out}}{v_{in}} = \underline{\underline{8.48\ V/V}}$$

$$\frac{i_{out}}{i_{in}} = \frac{(v_{out}/R_L)}{\frac{v_{in}}{R_S+R_{in}}} = \frac{v_{out}}{v_{in}} \times \frac{R_S+R_{in}}{R_L}$$

$$\frac{i_{out}}{i_{in}} = 8.48\left(\frac{2.01}{100}\right) = ?$$

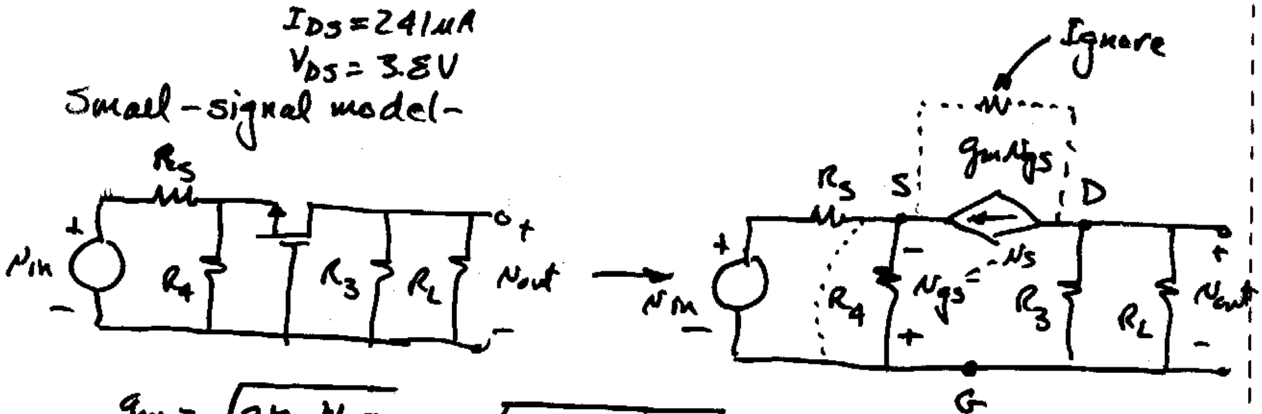
Common Gate Amplifier



If $K_n = 500\,\mu A/V^2$
$V_{TN} = 1V$
$\lambda = 0.02\,V^{-1}$
Find R_{in}, R_{out} and $\frac{v_{out}}{v_{in}}$

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

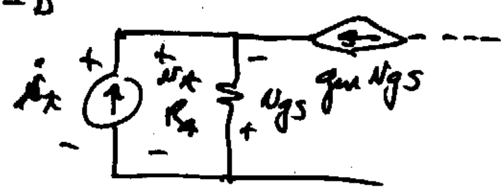
Small-signal model-



$$g_m = \sqrt{2K_n \frac{W}{L} I_D} = \sqrt{2\cdot 500\cdot 1\cdot 241}\ \mu S = 509\,\mu S$$

$$r_{ds} = \frac{\frac{1}{\lambda} + V_{DS}}{I_D} \cong 223\,k\Omega$$

$$R_{in} = \frac{v_x}{i_x}$$



$\Sigma i = 0$

$$i_x = \frac{v_x}{R_4} + g_m v_x$$

$$i_x = -\frac{v_{gs}}{R_4} - g_m v_{gs}$$

$$v_x = -v_{gs}$$

CG Amplifier – Cont'd

$$R_{in} = \frac{v_t}{i_t} = \frac{1}{\frac{1}{R_4} + g_m} = \frac{1}{g_m} \| R_4 \simeq \frac{1}{g_m} \cong \underline{\underline{1.96 k\Omega}}$$

$$R_{out}(r_{ds} = \infty) = R_3 = 22K\Omega$$

$$\frac{v_{out}}{v_{in}} = \left(\frac{v_{out}}{v_{gs}}\right)\left(\frac{v_{gs}}{v_{in}}\right) = \left(-g_m \times R_3 \| R_L\right)\left(-\frac{R_{in}}{R_s + R_{in}}\right)$$

$$= (-.509 \times 18)\left(\frac{-1.96K}{2K + 1.96K}\right) = +4.54\ V/V$$

$$R_{out}(r_{ds} \neq \infty) = \Big[\underbrace{r_o + (R_s \| R_t)(1 + g_m r_{ds})}_{416k\Omega}\Big] \| \underset{22k}{R_c}$$