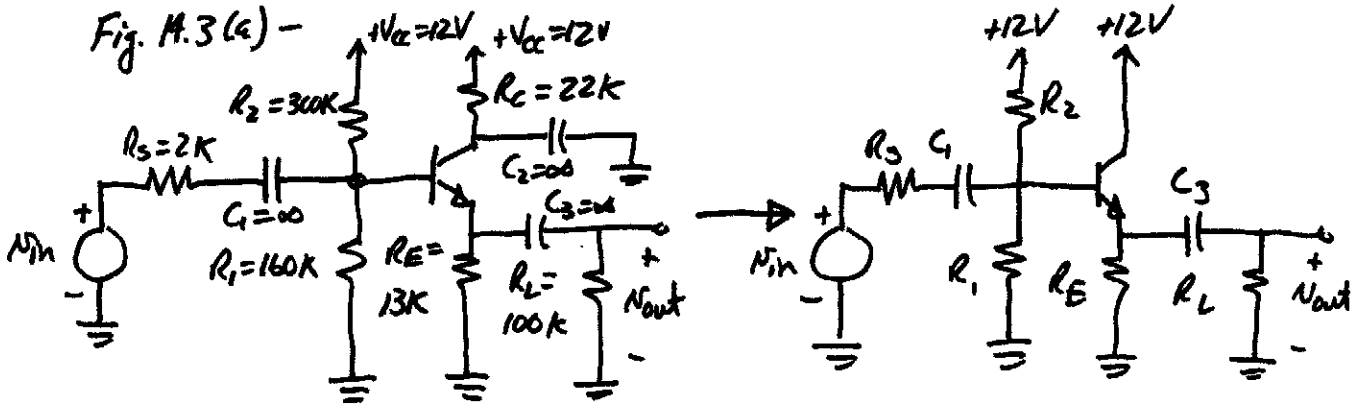
# Lecture 17 - Amplifier Examples

## 1.) Common Collector (Emitter follower)

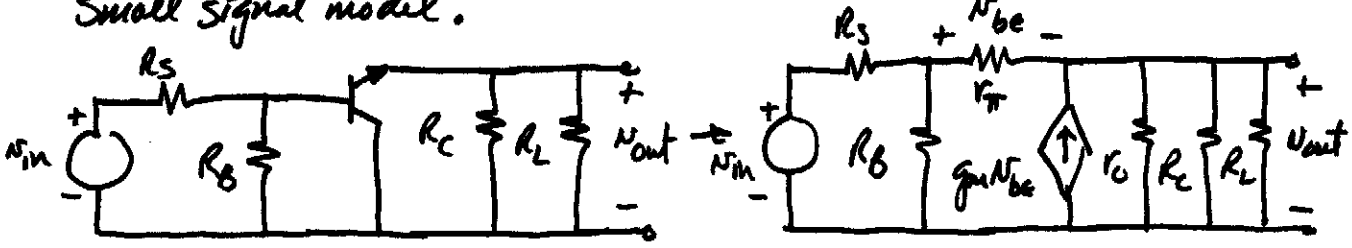
Fig. M.3(a) -




Assume $\beta_F = 100$ and $V_A = 50$

Q point: $I_C = 245\mu A$ and $V_{CE} = 3.64V$

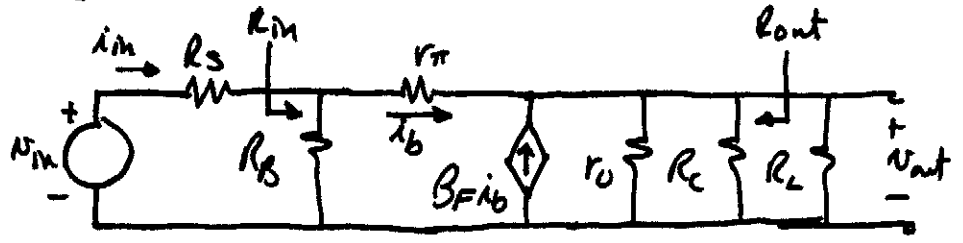
Small signal model:




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

$r_\pi = \frac{\beta_F}{g_m} = 10.2k\Omega$ $\quad r_o = \frac{V_A + V_{CE}}{I_C} = \frac{103.64}{245\mu A} = 423k\Omega$

It will be easier to use the current controlled model which is,




$R_{in} = R_B \| [r_\pi + (1+\beta_F)(r_o \| R_C \| R_L)] = 104.35K \| [10.2K + 101(17.3K)]$

$R_{in} = 104.35K \| 1.76M\Omega = \underline{\underline{98.5k\Omega}}$

1.) Common Collector – Cont'd

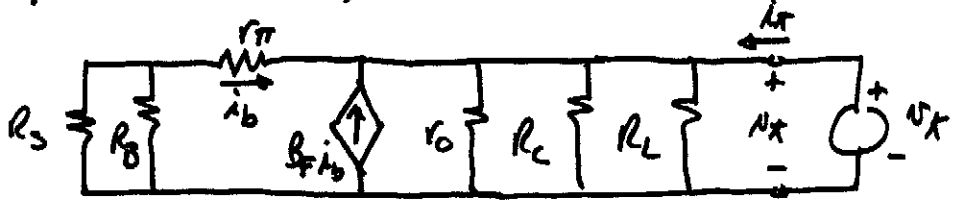
$$\frac{v_{out}}{v_{in}} = \left(\frac{v_{out}}{i_b}\right)\left(\frac{i_b}{i_{in}}\right)\left(\frac{i_{in}}{v_{in}}\right) \qquad \text{Let } R' = r_o \| R_C \| R_L = 17.3\text{K}$$

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

$$= (101)(17.3\text{K})\left(\frac{109.35\text{K}}{109.35\text{K} + 1760\text{K}}\right)\left(\frac{1}{2\text{K} + 98.5\text{K}}\right)$$

$$= (1747.3\text{K})(0.05597)\left(\frac{1}{101.5\text{K}}\right) = \underline{\underline{0.963\ \text{V/V}}}$$

$R_{out} = ?$ Set $v_{in} = 0$,




$$\Sigma i = 0 \rightarrow \quad i_x = g_o v_x + G_C v_x + G_L v_x - i_b(1+\beta_F)$$

But $\quad i_b = -\dfrac{v_x}{r_\pi + R_S \| R_B}$

$$\therefore \qquad i_x = \left[g_o + G_C + G_L + \frac{1+\beta_F}{r_\pi + R_S \| R_B}\right] v_x$$

$$R_{out} = \frac{v_x}{i_x} = \frac{1}{\frac{1}{r_o} + \frac{1}{R_C} + \frac{1}{R_L} + \frac{101}{r_\pi + R_S \| R_B}} = \frac{1}{\frac{1}{423\text{K}} + \frac{1}{22\text{K}} + \frac{1}{100\text{K}} + \frac{101}{12.16\text{K}}}$$

$R_{out} =$ ~~[illegible]~~ $\underline{\underline{119.6\ \Omega}}$