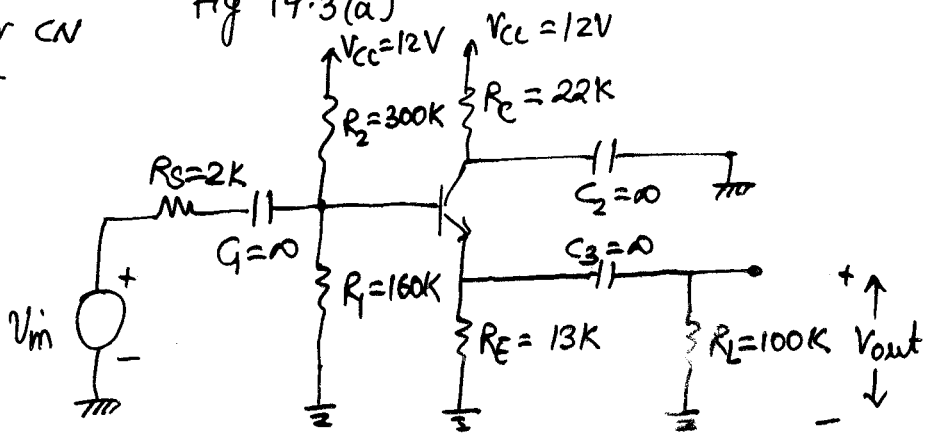
Quiz 5
1. CC/CD or CN
2. BJT/FET

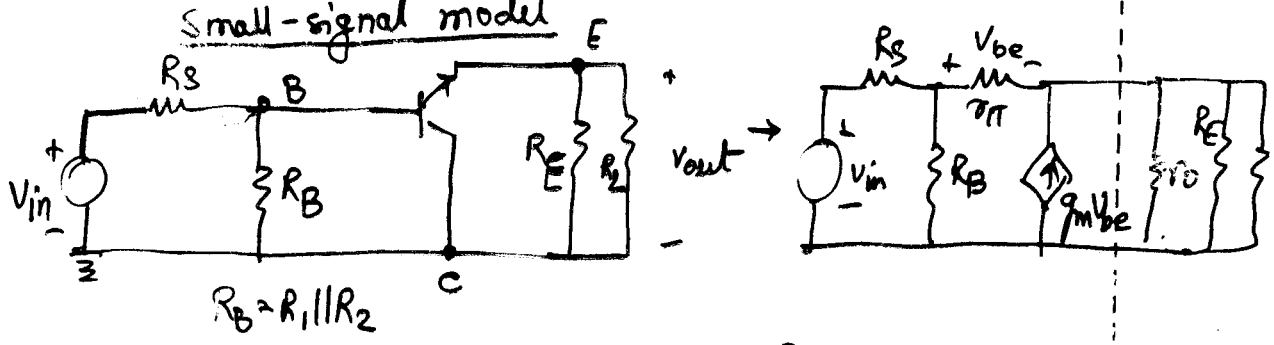
Common Collector (Emitter follower)

fig 14.3(a)



Assume: $\beta_F = 100$, $V_A = 50V$, Q point: $\{I_C = 245\mu A,\ V_{CE} = 3.64V\}$

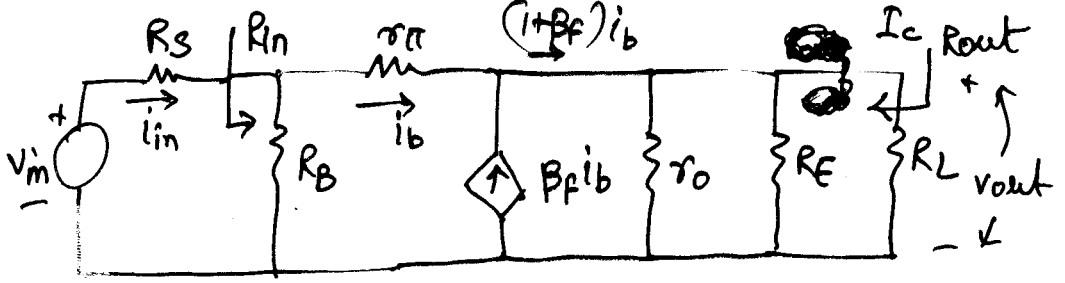
Small-signal model



$R_B = R_1 \| R_2$

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

$r_\pi = \frac{\beta_f}{g_m} = 10.2K\Omega$, $r_o = \frac{V_A + V_{CE}}{I_C} = 219K\Omega$



1. $R_{in} = ??$

$$R_{in} = R_B \,||\, \{r_\pi + (1+\beta_F)(r_o \,||\, R_E \,||\, R_L)\}$$

$$= 104.35K \,||\, \{10.2\,K\Omega + 101\,(17.3K)\} = 98.5\,K\Omega$$

2. $\left(\frac{v_{out}}{v_{in}}\right) = ??$

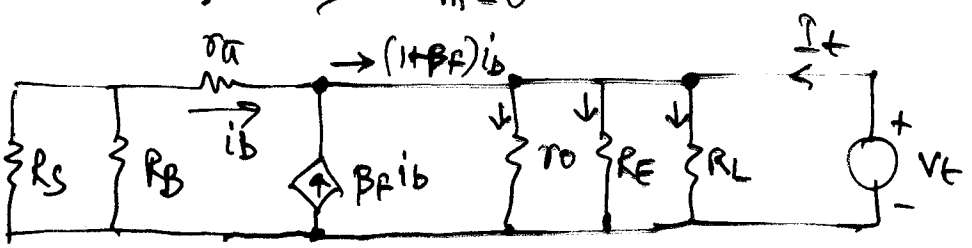
$$\left(\frac{v_{out}}{v_{in}}\right) = \left(\frac{v_{out}}{i_b}\right)\left(\frac{i_b}{i_{in}}\right)\left(\frac{i_{in}}{v_{in}}\right)$$

$$= \{(1+\beta_F)(r_o \,||\, R_E \,||\, R_L)\}\left\{\frac{R_B}{R_B + r_\pi + (1+\beta_F)(r_o \,||\, R_E \,||\, R_L)}\right\}\left\{\frac{1}{R_S + R_{in}}\right\}$$

$$= \{(101)\,(17.3K)\}\left\{\frac{104.35K}{104.35K + 1760K}\right\}\left\{\frac{1}{2K + 98.5K}\right\}$$

$$= 0.963\ V/V$$

3. $R_{out} = ??$ $\Rightarrow$ $v_{in} = 0$



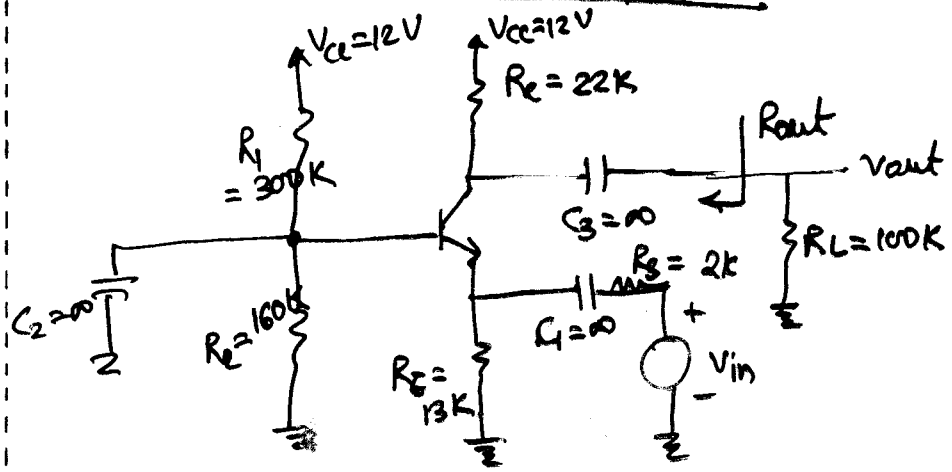
$$R_{out} = \frac{V_t}{I_t}$$

$$\Sigma i = 0 \Rightarrow \quad V_t\left(\frac{1}{R_E} + \frac{1}{R_L} + \frac{1}{r_o}\right) - (1+\beta_F) i_b = i_t$$

$$i_b = \frac{-V_t}{\{r_\pi + (R_S \,||\, R_B)\}}$$

$$R_{out} = \frac{V_t}{I_t} = \frac{1}{\left[\left(\frac{1}{r_o}+\frac{1}{R_E}+\frac{1}{R_C}\right)+\frac{(1+\beta_F)}{\{r_\pi+(R_S \| R_B)\}}\right]} = 119.6\,\Omega$$

Common Base amplifier



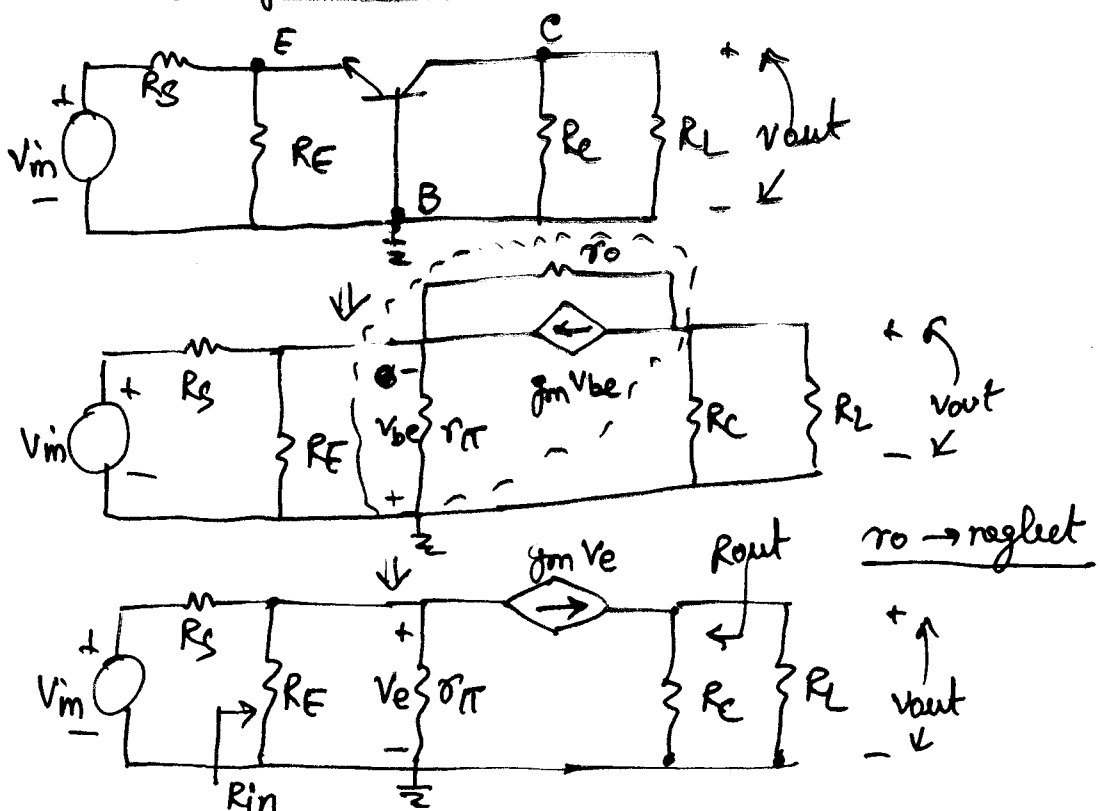
$\beta_F = 100$

$V_A = 50V$

$I_c = 2.54mA$

$V_{CE} = 3.4V$

Small-signal model

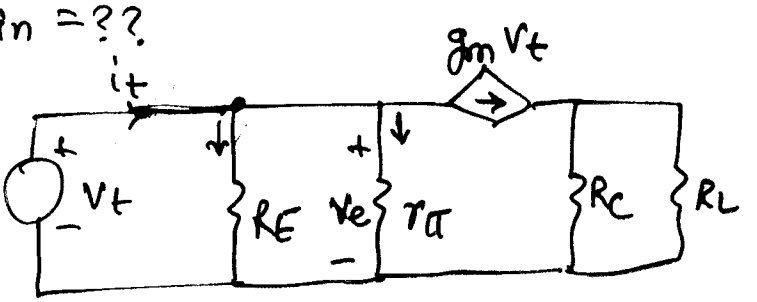


$r_o \rightarrow$ neglect

$$g_m = \frac{I_c}{V_t} = \frac{245\mu A}{25mV} = 9.8mS$$

$$r_o = \frac{V_A}{I_c} = 204\,K\Omega, \quad r_\pi = \frac{\beta_F}{g_m} = 10.2K\Omega.$$

① $R_{in} = ??$



$V_e = V_t$

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

$$i_t = \frac{V_t}{R_E} + \frac{V_t}{r_\pi} + g_m V_t$$

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

$$= V_t\left(\frac{1}{R_E} + \frac{g_m}{\beta_F} + g_m\right)$$

$$i_t \cong V_t\left(\frac{1}{R_E} + g_m\right)$$

$$R_{in} \cong \frac{V_t}{i_t} \cong \left(g_m + \frac{1}{R_E}\right)^{-1} \cong 101\,\Omega$$

2. $\left(\frac{v_{out}}{v_{in}}\right) = ??$

$$\left(\frac{v_{out}}{v_{in}}\right) = \left(\frac{v_{out}}{v_e}\right)\left(\frac{v_e}{v_{in}}\right)$$

$$= \left\{g_m (R_c \| R_L)\right\}\left\{\frac{R_{in}}{R_{in}+R_s}\right\} = 8.48\ V/V$$

3. $R_{out} = ??$