

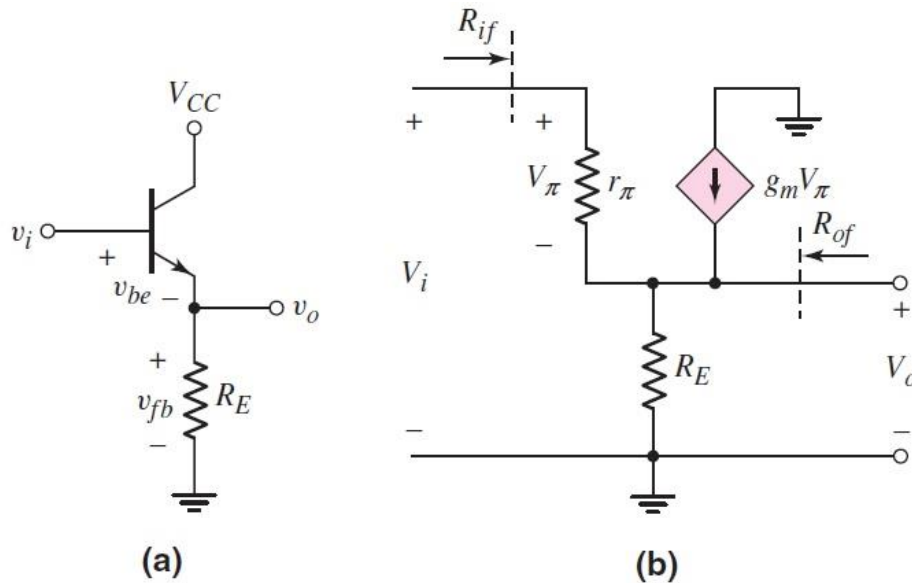
Mark:

EE3110 Electronic Circuits
Emitter follower as feedback amplifier

Name: _____ Student Number: _____ Date : _____

Assume the transistor in the emitter-follower circuit in figure below is biased such that $I_{CQ} = 1.2 \text{ mA}$. Let $R_E = 1.5 \text{ k}\Omega$.

Given: $g_m = \frac{I_C}{V_T}$ and $\beta_f = g_m r_\pi$ where $V_T = 25 \text{ mV}$



(a) If the transistor current gain is $\beta_f = 120$, determine A_{vf} , R_{if} , and R_{of} .

(b) Determine the percent change in A_{vf} , R_{if} , and R_{of} if the transistor current gain increases to $\beta_f = 180$. Assume the quiescent collector current remains unchanged.

(a) open-loop gain,

$$A_v = \frac{V_o}{V_{\pi}} = \left(\frac{V_{\pi}}{r_{\pi}} + g_m V_{\pi} \right) R_E / V_{\pi}$$

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

$$\beta_v = 1$$

$$A_{vf} = \frac{A_v}{1 + \beta_v A_v} = \frac{\frac{I_C}{V_T} \left(1 + \frac{1}{\beta_f} \right) R_E}{1 + \frac{I_C}{V_T} \left(1 + \frac{1}{\beta_f} \right) R_E} = 0.9864$$

Since input is series, $R_{if} = (1 + \beta_v A_v) R_i$; $R_i = r_{\pi}$;

$$R_{if} = \left[1 + \frac{I_c}{V_T} \left(1 + \frac{1}{\beta_f} \right) R_E \right] \frac{\beta_f V_T}{I_c}$$

$$= \frac{\beta_f V_T}{I_c} + (\beta_f + 1) R_E$$

$$= 184 \text{ k}\Omega$$

$R_i = \frac{V_i}{I_i} \Big|_{V_o=0} = r_{\pi}$

Since output is shunt, $R_{of} = \frac{R_o}{(1 + \beta_v A_v)}$;

$$R_o = R_E$$

$$\therefore R_{of} = \frac{R_E}{\left(1 + \frac{I_c}{V_T} \left(1 + \frac{1}{\beta_f} \right) R_E \right)}$$

$$= 20.38 \text{ }\Omega$$

$$R_o = \frac{V_o}{I_o} \Big|_{V_i \text{ open}} = R_E$$

OR R_{of} can be expressed as follow

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