

EE 140

Inspection Analysis

CTN 1

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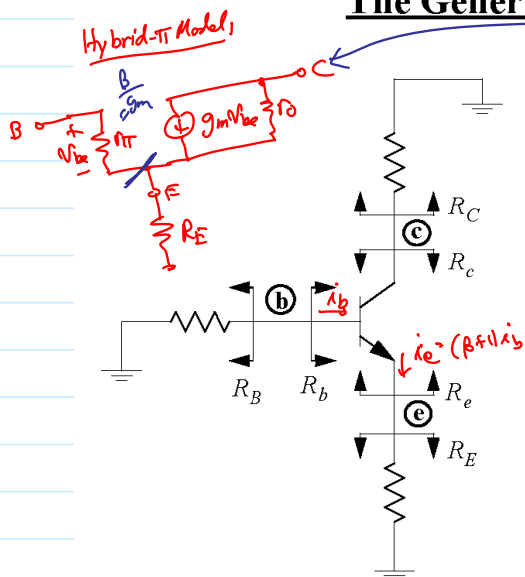
ANALOG INTEGRATED CIRCUITS

SPRING 2012

C. Nguyen

Useful Inspection Formulas

The General Case (Midband)



$$\alpha = \frac{\beta}{\beta + 1}$$

$$R_b = (r_e + R_E)(\beta + 1) = r_\pi + (\beta + 1)R_E$$

$$R_e = \frac{r_\pi + R_B}{\beta + 1} \approx \frac{1}{g_m} + \frac{R_B}{\beta + 1}$$

$$R_c = r_o \left[1 + \frac{g_m R_E}{1 + (R_B/r_\pi)} \right]$$

Base-to-Collector Gain:

$$\frac{v_c}{v_b} = -G_m R_c = -\frac{g_m R_c}{1 + g_m R_E}$$

Emitter-to-Collector Gain:

$$\frac{v_c}{v_e} = -G_m R_c = -\left(\frac{r_\pi}{r_\pi + R_B} \right) g_m R_c$$

Base-to-Emitter Gain:

$$\frac{v_e}{v_b} = \frac{R_E \parallel r_o}{R_E \parallel r_o + r_e}$$

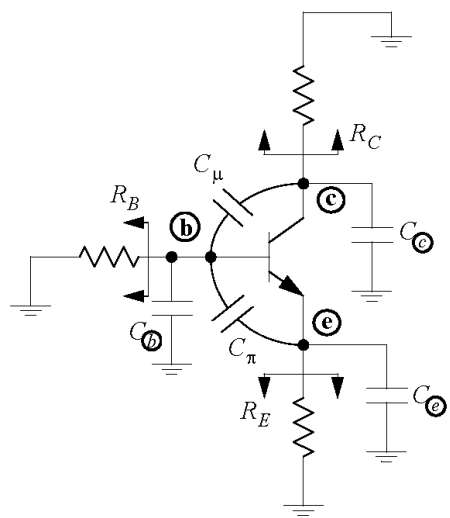
Node Resistances:

$$R_{\text{C}} = R_C \parallel R_c$$

$$R_{\text{E}} = R_E \parallel R_e$$

$$R_{\text{B}} = R_B \parallel R_b$$

High Frequency Analysis



$$\omega_H = \frac{1}{\tau_b + \tau_c + \tau_e + \tau_{\mu o} + \tau_{\pi o}}$$

$$\tau_b = C_{\text{C}} R_{\text{B}}$$

$$\tau_c = C_{\text{C}} R_{\text{C}}$$

$$\tau_e = C_{\text{E}} R_{\text{E}}$$

$$\tau_{\pi o} = C_{\pi} R_{\pi o}$$

$$\tau_{\mu o} = C_{\mu} R_{\mu o}$$

$$R_{\pi o} = r_\pi \parallel \frac{R_B + R_E}{1 + g_m R_E}$$

$$R_{\mu o} = R_{\text{C}} + R_{\text{C}} + G_m R_{\text{C}} R_{\text{B}}$$

EE 140

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CTN

2

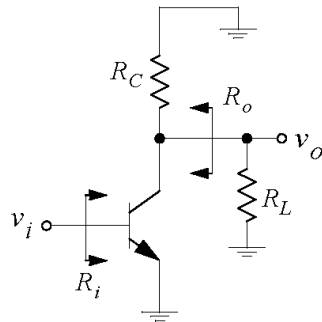
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Frequent Cases (Midband)

Common Emitter

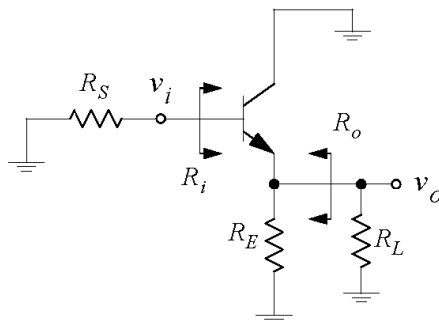


$$R_i = r_\pi$$

$$R_o = r_o \parallel R_C \approx R_C$$

$$\frac{v_o}{v_i} = -g_m(r_o \parallel R_C \parallel R_L) \approx -g_m(R_C \parallel R_L)$$

Common Collector (Emitter Follower)

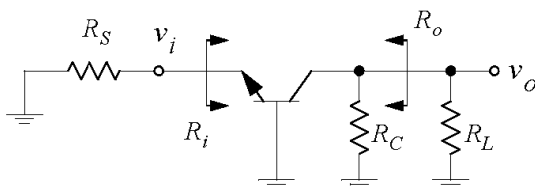


$$R_i = r_\pi + (\beta + 1)(r_o \parallel R_E \parallel R_L) \approx r_\pi + (\beta + 1)(R_E \parallel R_L)$$

$$R_o \cong \left(\frac{1}{g_m} + \frac{R_S}{\beta + 1} \right) \parallel R_E$$

$$\frac{v_o}{v_i} = \frac{(r_o \parallel R_E \parallel R_L)}{(r_o \parallel R_E \parallel R_L) + r_e} = \frac{(\beta + 1)(r_o \parallel R_E \parallel R_L)}{(\beta + 1)(r_o \parallel R_E \parallel R_L) + r_\pi} \approx \frac{(\beta + 1)(R_E \parallel R_L)}{(\beta + 1)(R_E \parallel R_L) + r_\pi}$$

Common Base



$$R_i = r_e \cong \frac{1}{g_m}$$

$$R_o = r_o(1 + g_m R_S) \parallel R_C \approx R_C$$

$$\frac{v_o}{v_i} \cong g_m(R_C \parallel R_L)$$