

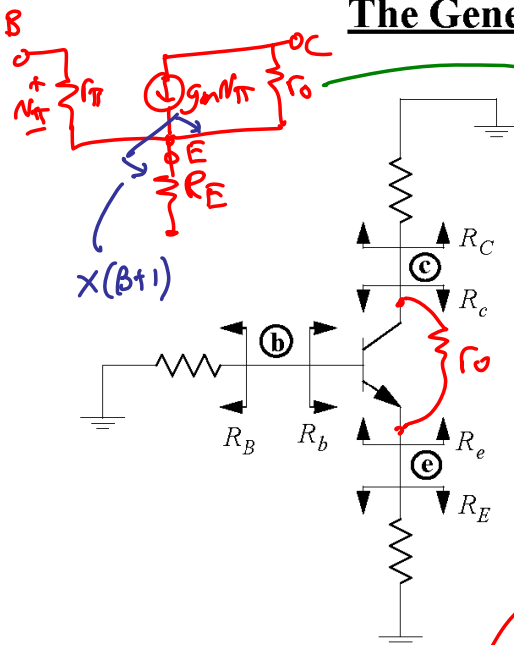
EE 140/240A

Inspection Analysis

CTN 1

Useful Inspection Formulas

The General Case (Midband)



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

$$R_e = \frac{r_\pi + R_B}{\beta + 1} \approx \frac{1}{g_m} + \frac{R_B}{\beta + 1} \quad (r_o \gg R_E)$$

$$R_c = r_o \left[1 + \frac{g_m R_E}{1 + (R_B/r_\pi)} \right] \quad (g_m R_E \ll \beta_0)$$

Handwritten notes: $x(\beta+1)$, $x(\beta+1)$, $\frac{1}{g_m}$, \uparrow as $R_E = \text{small}$

Base-to-Collector Gain:

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

Emitter-to-Collector Gain:

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

Base-to-Emitter Gain:

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

Node Resistances:

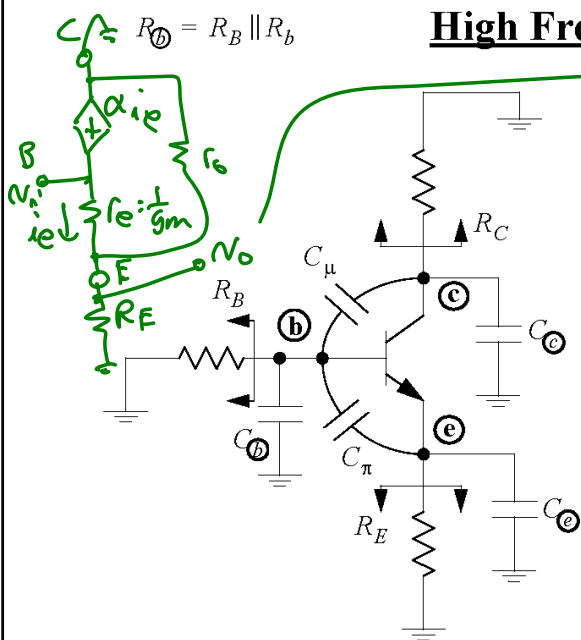
$$R_a = R_C \parallel R_c$$

$$R_b = R_E \parallel R_e$$

$$R_d = R_B \parallel R_b$$

Handwritten note: All resistance in shunt w/ node @, i.e., goes to ground from node @

High Frequency Analysis



$$\omega_H = \frac{1}{\tau_d + \tau_a + \tau_b + \tau_{\mu o} + \tau_{\pi o}}$$

$$\tau_b = C_b R_b \quad \tau_{\pi o} = C_\pi R_{\pi o}$$

$$\tau_c = C_c R_c \quad \tau_{\mu o} = C_\mu R_{\mu o}$$

$$\tau_e = C_e R_e$$

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

$$R_{\mu o} = R_d + R_a + G_m R_c R_b$$

Handwritten notes: $R_a = R_C \parallel R_c$
 $\frac{N_0}{N_i} = \frac{R_E \parallel r_o}{R_E \parallel r_o + r_e}$

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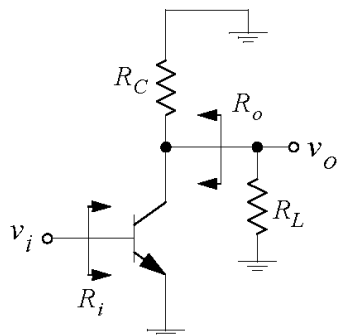
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Frequent Cases (Midband)

Common Emitter

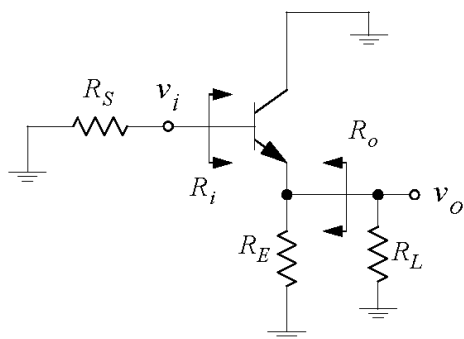


$$R_i = r_\pi$$

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

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

Common Collector (Emitter Follower)

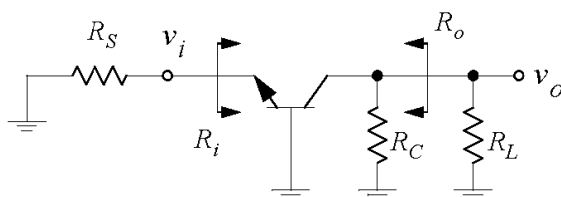


$$R_i = r_\pi + (\beta + 1)(r_o \parallel R_E \parallel R_L) \approx r_\pi + (\beta + 1)(R_E \parallel R_L)$$

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

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

Common Base



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

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

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