

MOSFET

BIPOLAR

Key Small-Signal Parameters

$$g_m = \mu_n C_{ox} (W/L) (V_{GS} - V_{TH})$$

$$= \sqrt{2\mu_n C_{ox} (W/L) I_D}$$

$$g_{mb} \ll g_m$$

$$r_o = \frac{1}{\lambda I_D}$$

Key Small-Signal Parameters

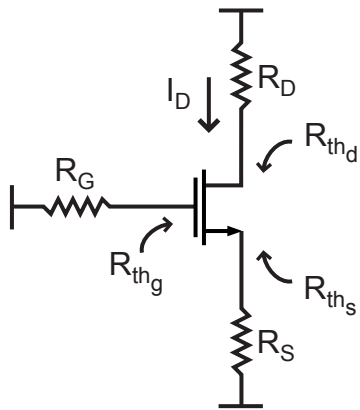
$$g_m = \frac{I_c}{V_t}, V_t = \frac{kT}{q}$$

$$V_t \approx 26 \text{ mV at room temp}$$

$$r_\pi = \frac{\beta_o}{g_m}, \beta_o \approx 100 \text{ to } 200$$

$$r_o = \frac{V_A}{I_c}, V_A \approx 100 \text{ to } 200 \text{ V}$$

Thevenin Resistances



Approximation

$$R_{thd} = r_o (1 + g_m R_S)$$

$$R_{thg} = \text{infinite}$$

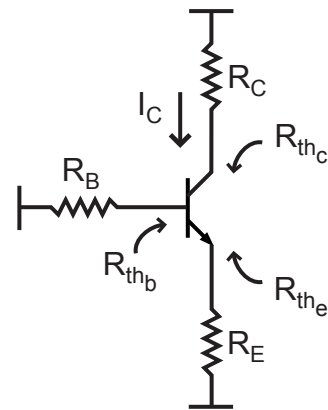
$$R_{ths} = \frac{1 + R_D / r_o}{g_m}$$

Assumption

$$g_{mb} \ll g_m$$

$$g_{mb} \ll g_m, g_m r_o \gg 1$$

Thevenin Resistances



Approximation

$$R_{thc} = r_o (1 + g_m (r_\pi || R_E))$$

$$R_{thb} = r_\pi + \beta_o R_E$$

$$R_{thc} = 1/g_m + R_B/\beta_o$$

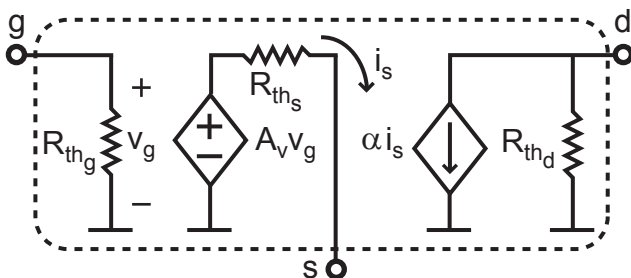
Assumption

$$R_B \ll r_\pi$$

$$R_C + R_E \ll r_o$$

$$R_C \ll \beta_o r_o$$

Proposed Thevenin Model



Approximation

$$A_v = 1$$

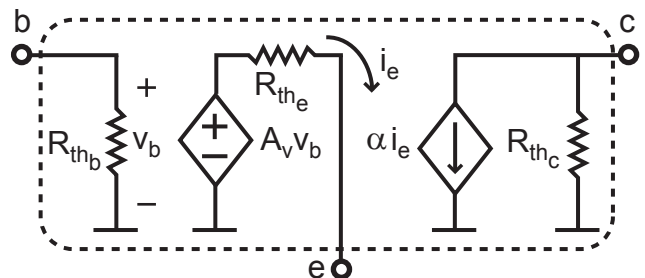
$$\alpha = 1$$

Assumption

$$g_{mb} \ll g_m, g_m r_o \gg 1$$

$$R_D \ll R_{thd}$$

Proposed Thevenin Model



Approximation

$$A_v = 1$$

$$\alpha = 1$$

Assumption

$$R_C + R_E \ll r_o, R_B \ll r_\pi$$

$$R_C + R_E \ll \beta_o r_o$$