

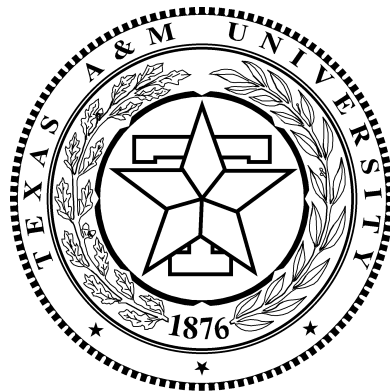
ECEN 326

Electronic Circuits

Active Loads

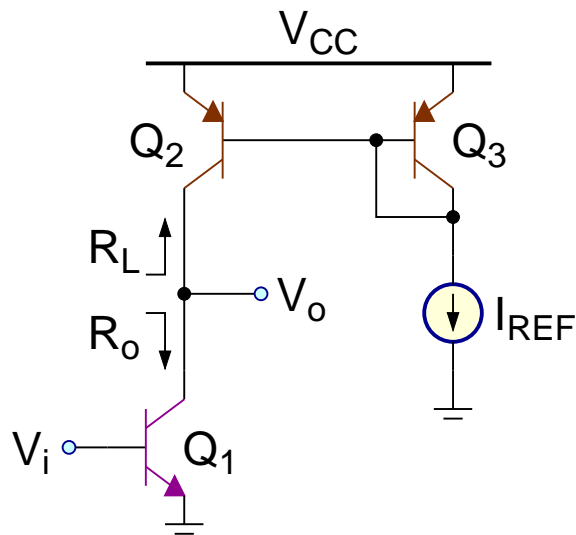
Dr. Aydın İlker Karşılayan

Texas A&M University
Department of Electrical and Computer Engineering



BJT Common Emitter

Simple current source



$$R_o = r_{o1}$$

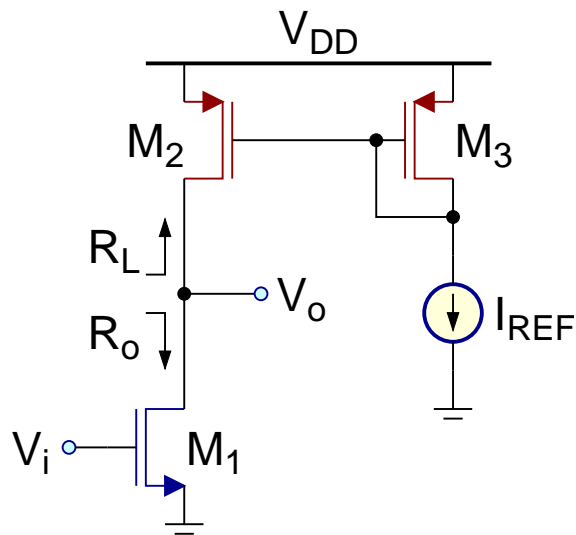
$$R_L = r_{o2}$$

$$G_m = -g_{m1}$$

$$\frac{V_o}{V_i} = G_m(R_o \parallel R_L)$$

MOS Common Source

Simple current source



$$R_o = r_{o1}$$

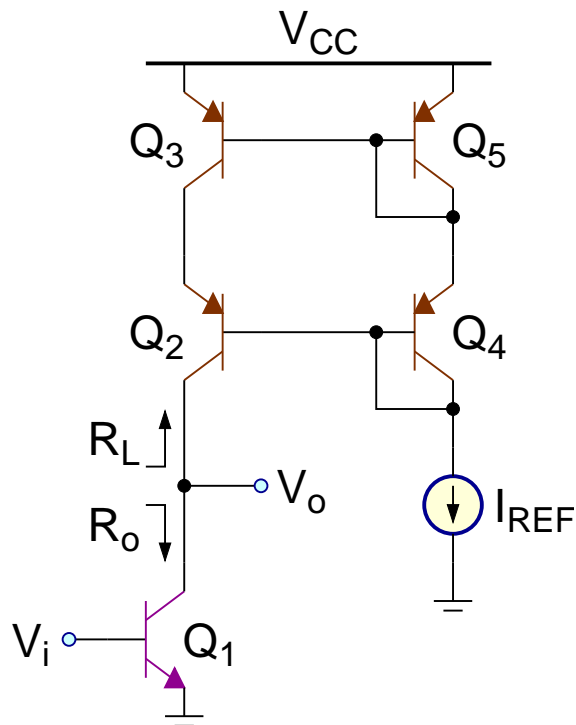
$$R_L = r_{o2}$$

$$G_m = -g_{m1}$$

$$\frac{V_o}{V_i} = G_m(R_o \parallel R_L)$$

BJT Common Emitter

Cascode current source



$$R_o = r_{o1}$$

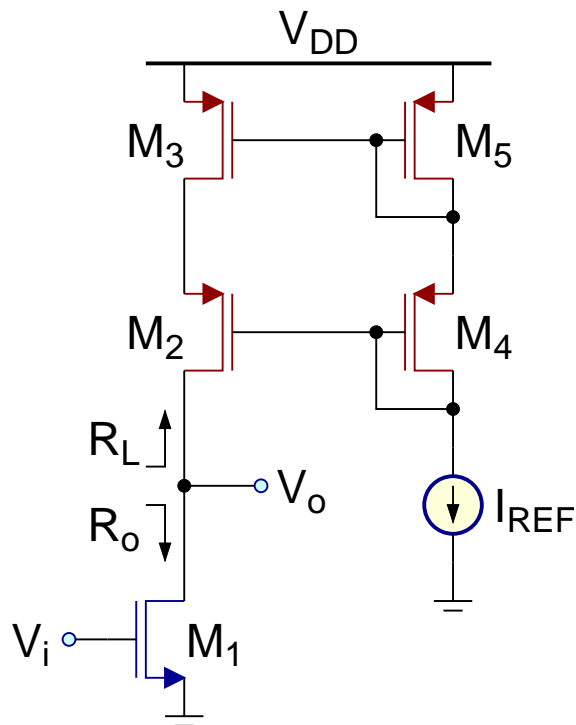
$$R_L \approx \frac{\beta r_{o2}}{2}$$

$$G_m = -g_{m1}$$

$$\frac{V_o}{V_i} = G_m (R_o \parallel R_L)$$

MOS Common Source

Cascode current source



$$R_o = r_{o1}$$

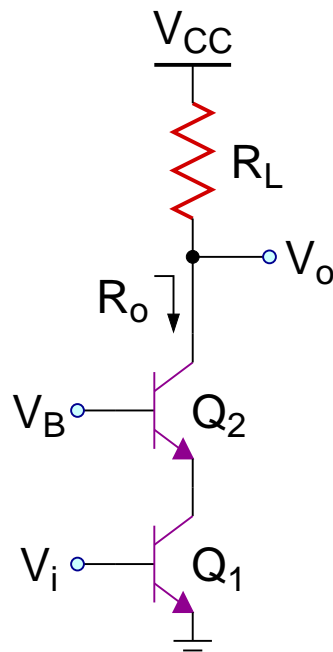
$$R_L = r_{o2} + r_{o3} + g_{m2}r_{o2}r_{o3}$$

$$G_m = -g_{m1}$$

$$\frac{v_o}{v_i} = G_m(R_o \parallel R_L)$$

BJT Cascode

Passive load

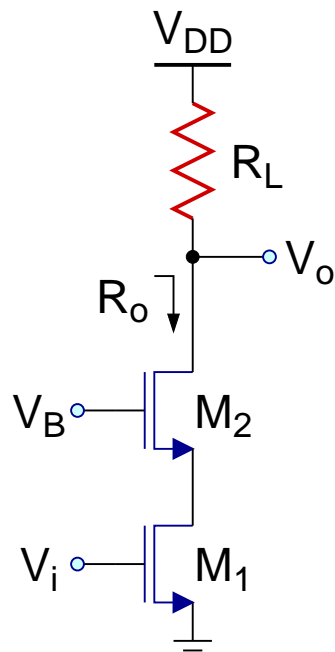


$$R_o = (r_{o1} \parallel r_{\pi 2}) + r_{o2} + g_{m2}(r_{o1} \parallel r_{\pi 2})r_{o2}$$

$$R_o \approx \beta r_{o2}$$

$$G_m \approx -g_{m1}$$

$$\frac{V_o}{V_i} = G_m(R_o \parallel R_L)$$



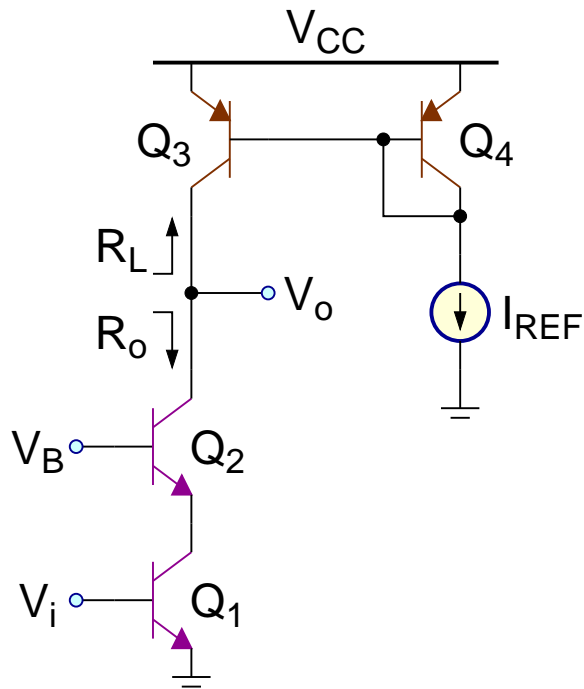
$$R_o = r_{o1} + r_{o2} + g_{m2}r_{o1}r_{o2}$$

$$G_m \approx -g_{m1}$$

$$\frac{V_o}{V_i} = G_m(R_o \parallel R_L)$$

BJT Cascode

Simple current source



$$R_o \approx \beta r_{o2}$$

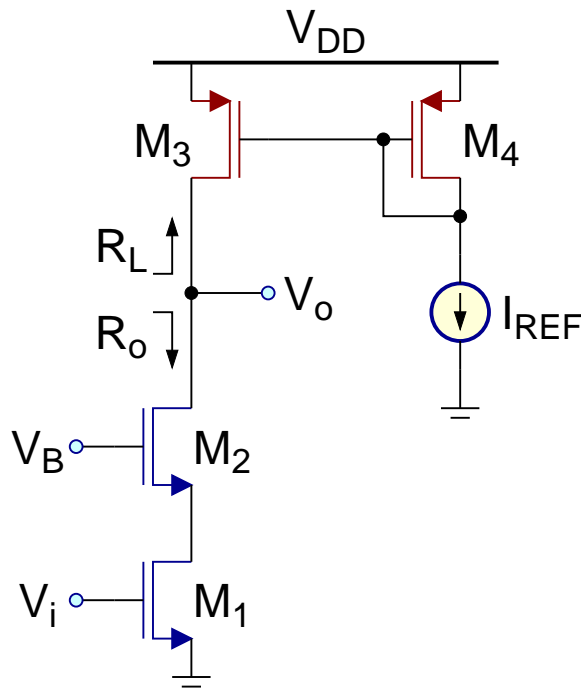
$$R_L = r_{o3}$$

$$G_m \approx -g_{m1}$$

$$\frac{V_o}{V_i} = G_m (R_o \parallel R_L)$$

MOS Cascode

Simple current source



$$R_o = r_{o1} + r_{o2} + g_{m2}r_{o1}r_{o2}$$

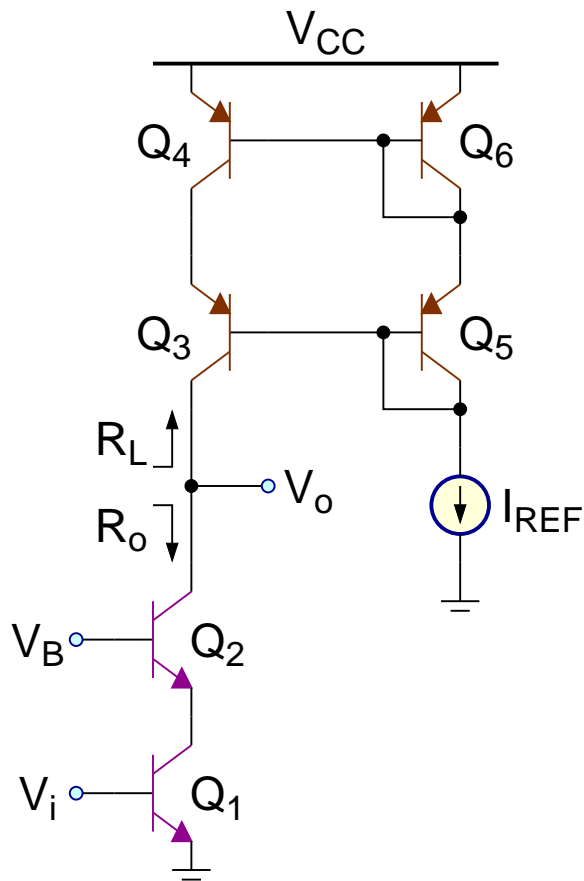
$$R_L = r_{o3}$$

$$G_m \approx -g_{m1}$$

$$\frac{V_o}{V_i} = G_m(R_o \parallel R_L)$$

BJT Cascode

Cascode current source



$$R_o \approx \beta r_{o2}$$

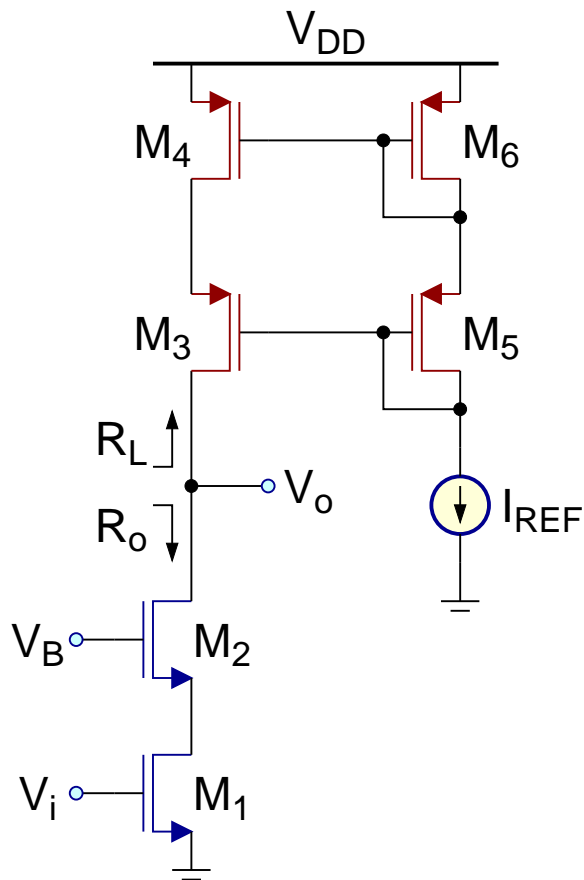
$$R_L \approx \frac{\beta r_{o3}}{2}$$

$$G_m \approx -g_{m1}$$

$$\frac{V_o}{V_i} = G_m (R_o \parallel R_L)$$

MOS Cascode

Cascode current source



$$R_o = r_{o1} + r_{o2} + g_{m2}r_{o1}r_{o2}$$

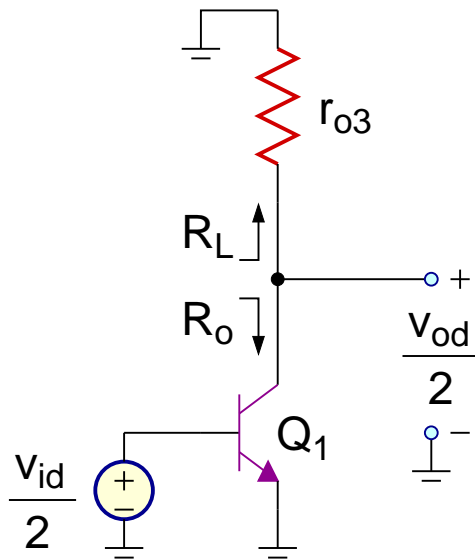
$$R_L = r_{o4} + r_{o3} + g_{m3}r_{o4}r_{o3}$$

$$G_m \approx -g_{m1}$$

$$\frac{v_o}{v_i} = G_m(R_o \parallel R_L)$$

BJT Differential Pair

Differential-mode half circuit



$$R_o = r_{o1}$$

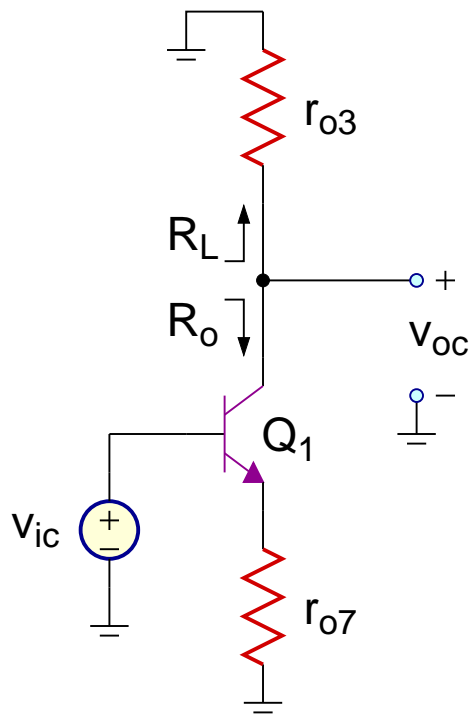
$$R_L = r_{o3}$$

$$G_m = -g_{m1}$$

$$\frac{V_{od}}{V_{id}} = G_m(R_o \parallel R_L)$$

BJT Differential Pair

Common-mode half circuit



$$R_o \approx \beta r_{o1}$$

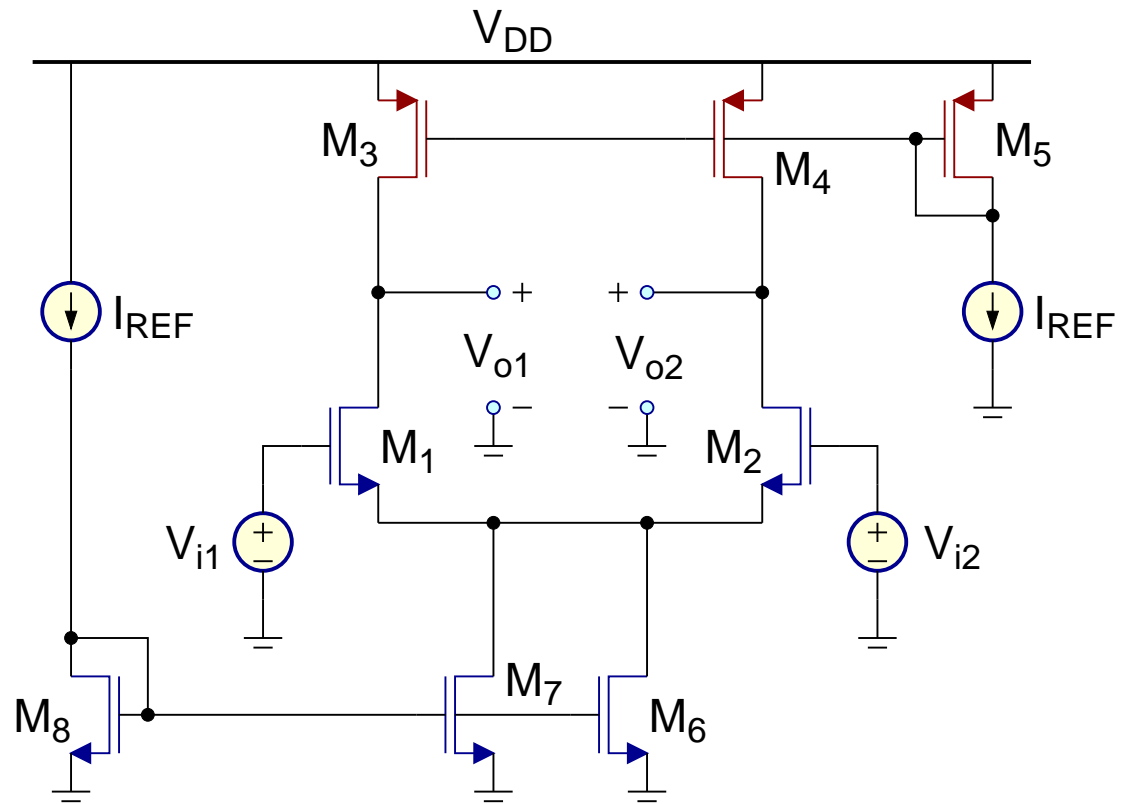
$$R_L = r_{o3}$$

$$G_m \approx \frac{g_{m1}}{1 + g_{m1}r_{o7} + \frac{r_{o7}}{r_{o1}}}$$

$$\frac{V_{oc}}{V_{ic}} = G_m(R_o \parallel R_L)$$

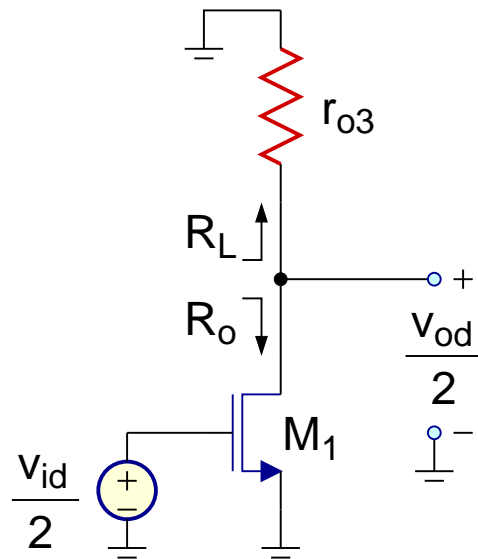
MOS Differential Pair

Simple current source



MOS Differential Pair

Differential-mode half circuit



$$R_o = r_{o1}$$

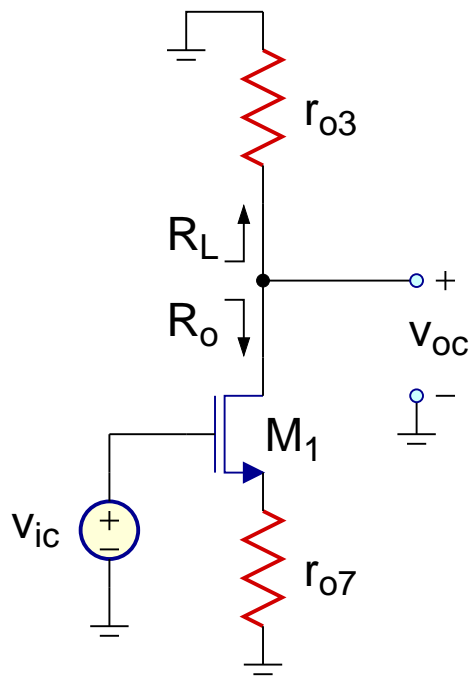
$$R_L = r_{o3}$$

$$G_m = -g_{m1}$$

$$\frac{V_{od}}{V_{id}} = G_m (R_o \parallel R_L)$$

MOS Differential Pair

Common-mode half circuit



$$R_o = r_{o7} + r_{o1} + g_{m1}r_{o7}r_{o1}$$

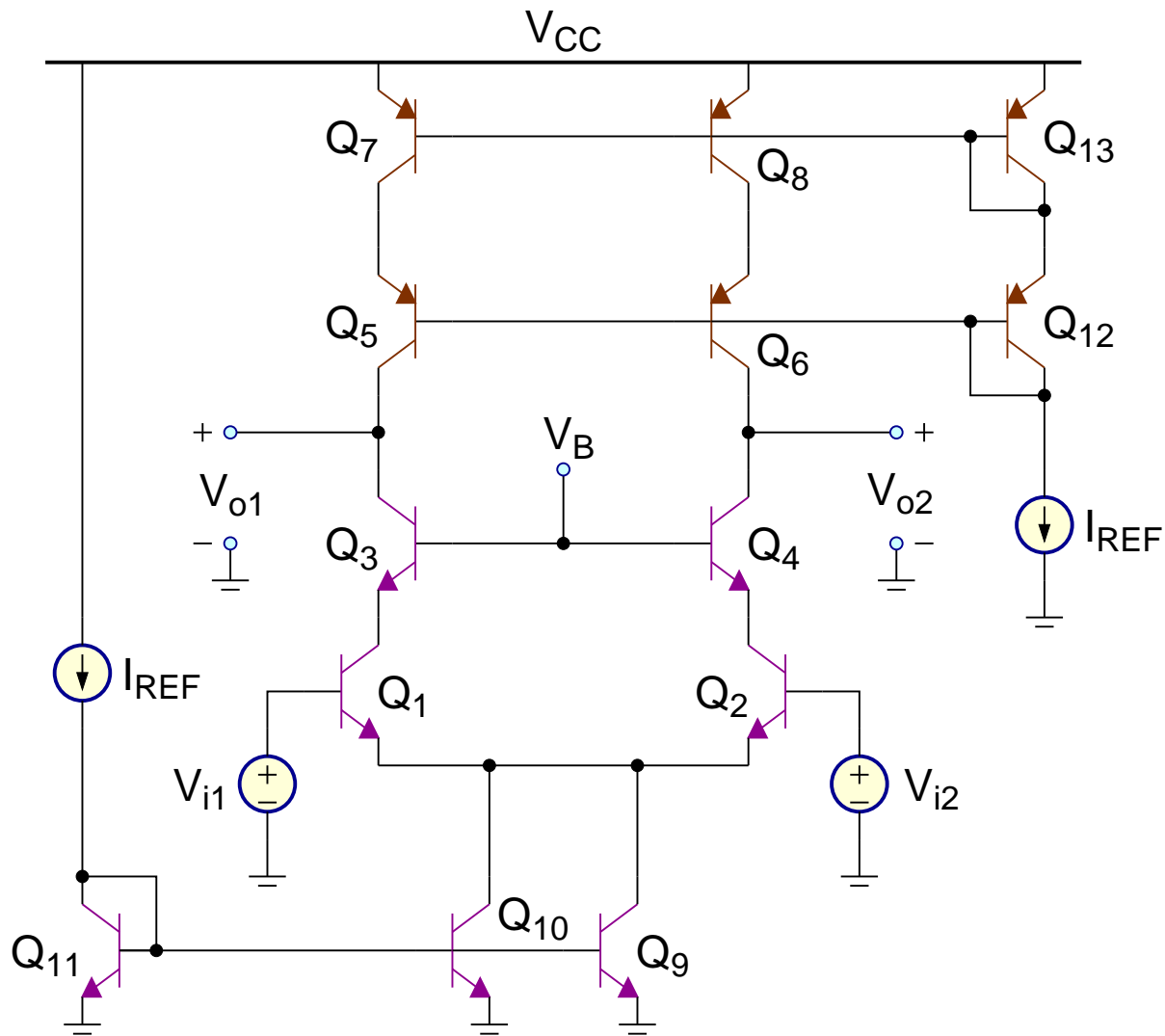
$$R_L = r_{o3}$$

$$G_m = -\frac{g_{m1}}{1 + g_{m1}r_{o7} + \frac{r_{o7}}{r_{o1}}}$$

$$\frac{V_{oc}}{V_{ic}} = G_m(R_o \parallel R_L)$$

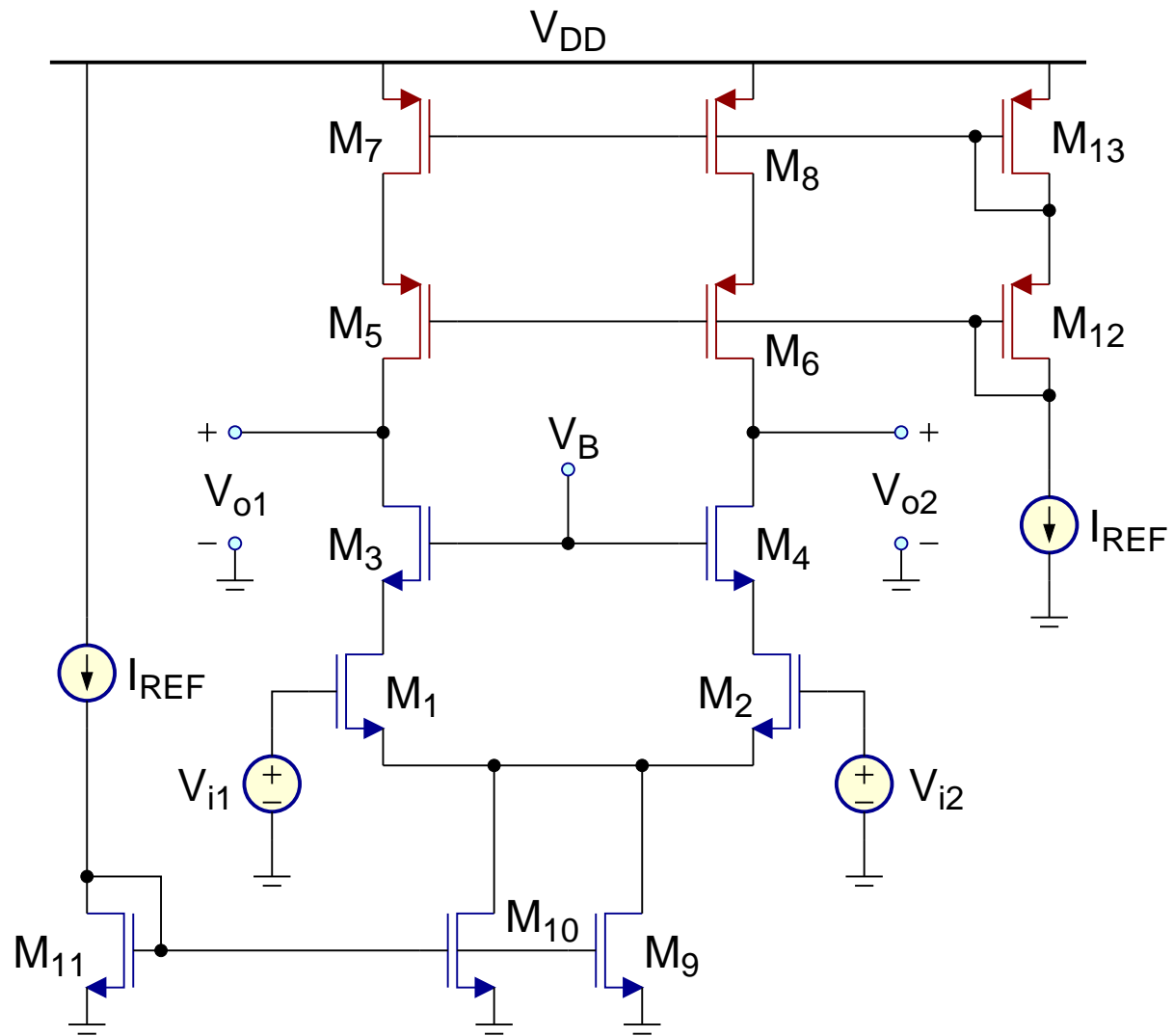
BJT Differential Cascode

Cascode current source



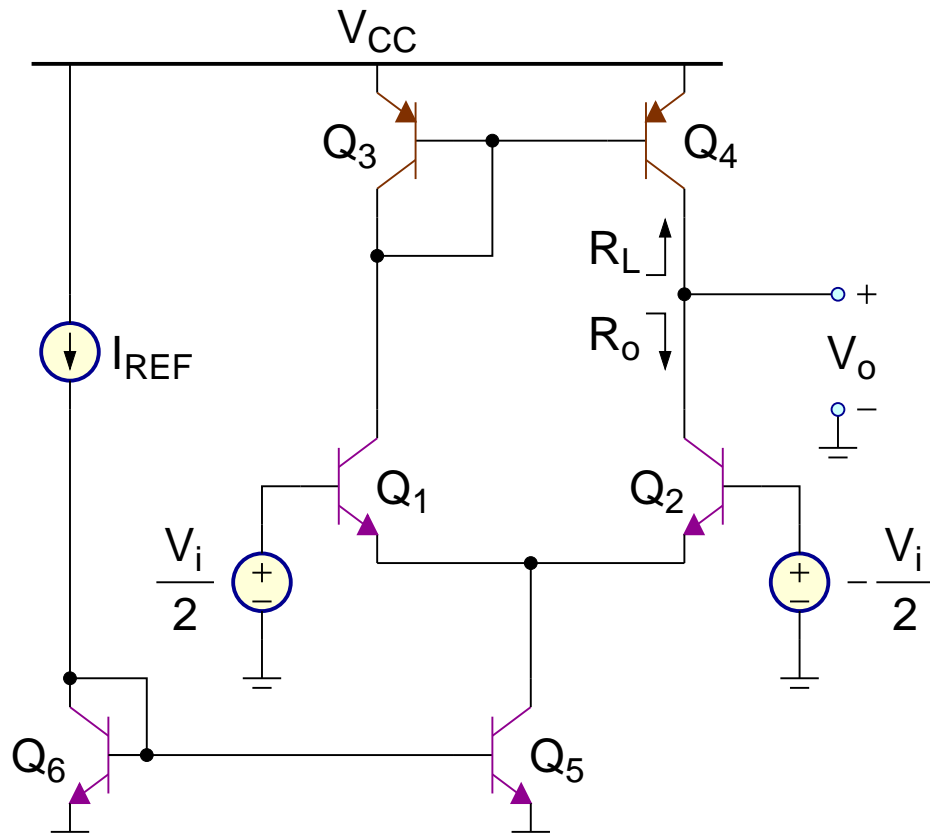
MOS Differential Cascode

Cascode current source



BJT Differential Pair

Simple current mirror



$$R_o = r_{o2}$$

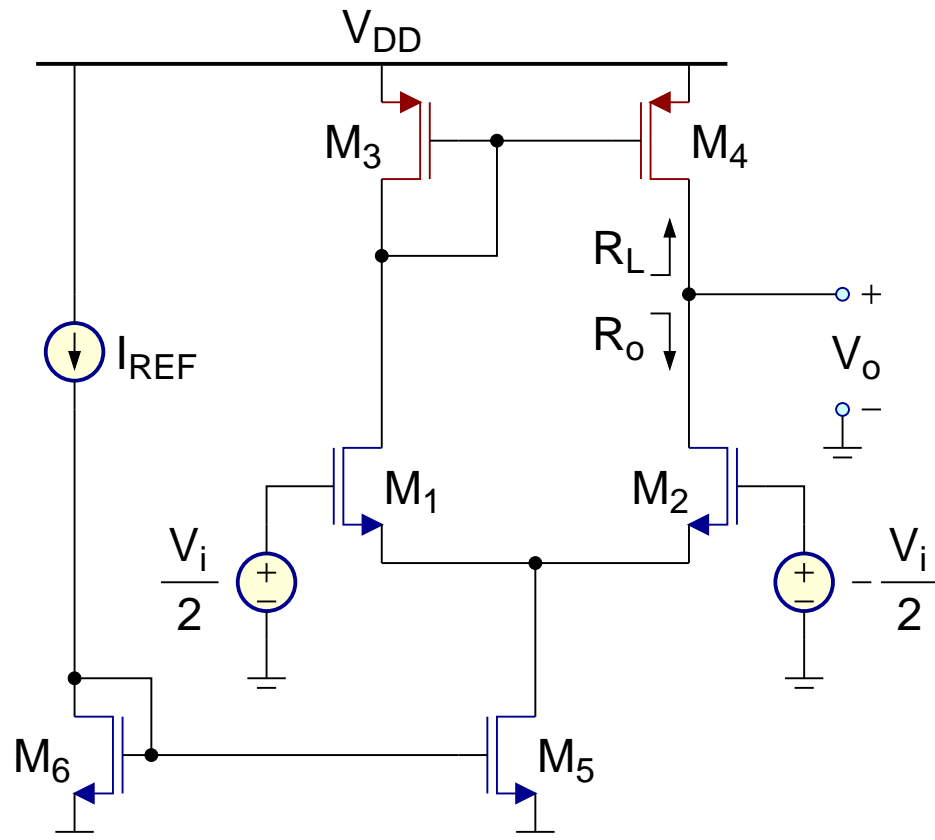
$$R_L = r_{o4}$$

$$G_m = -g_{m1}$$

$$\frac{V_o}{V_i} = G_m (R_o \parallel R_L)$$

MOS Differential Pair

Simple current mirror



$$R_o = r_{o2}$$

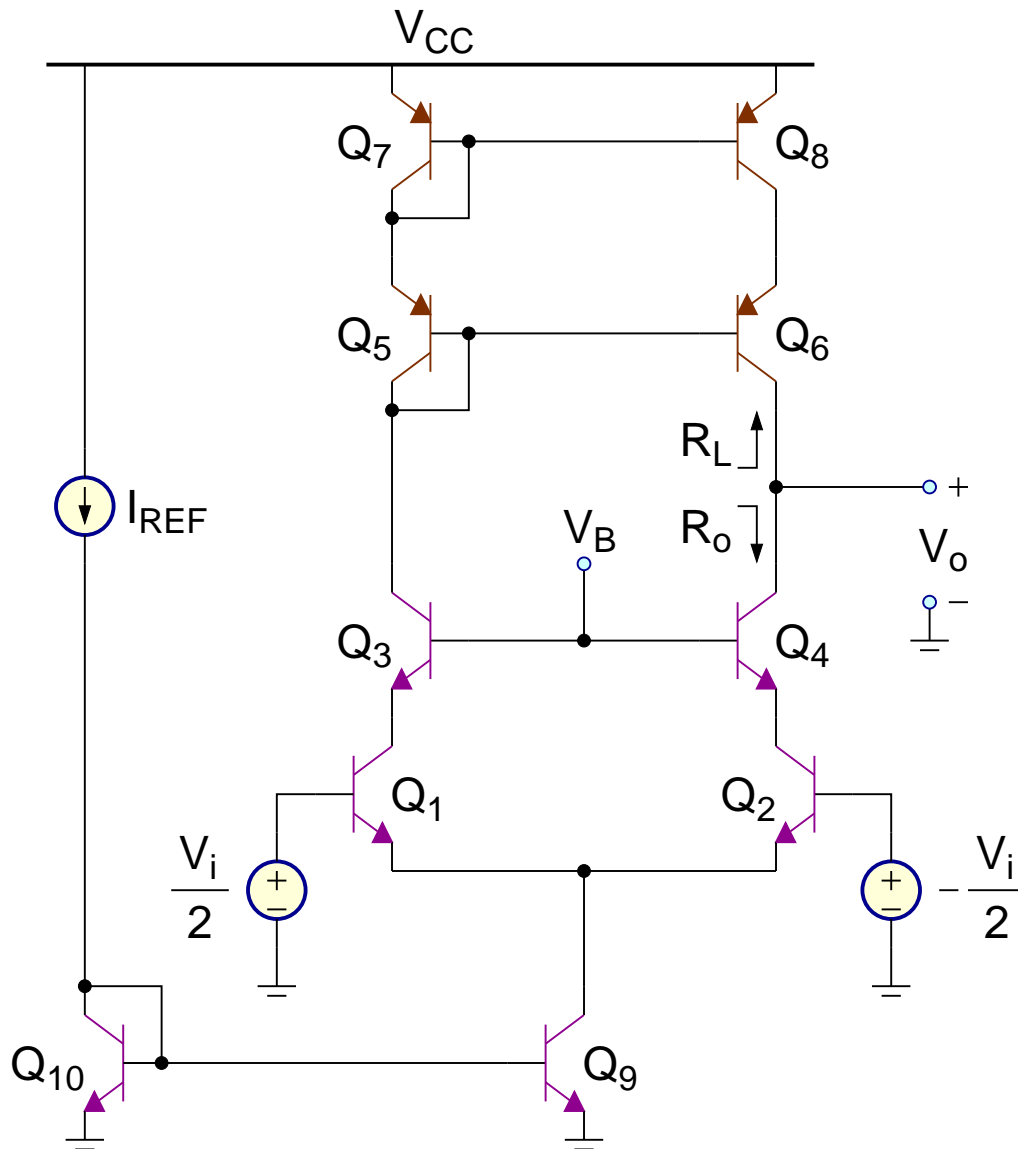
$$R_L = r_{o4}$$

$$G_m = -g_{m1}$$

$$\frac{v_o}{v_i} = G_m(R_o \parallel R_L)$$

BJT Differential Cascode

Cascode current mirror



$$R_o \approx \beta r_{o4}$$

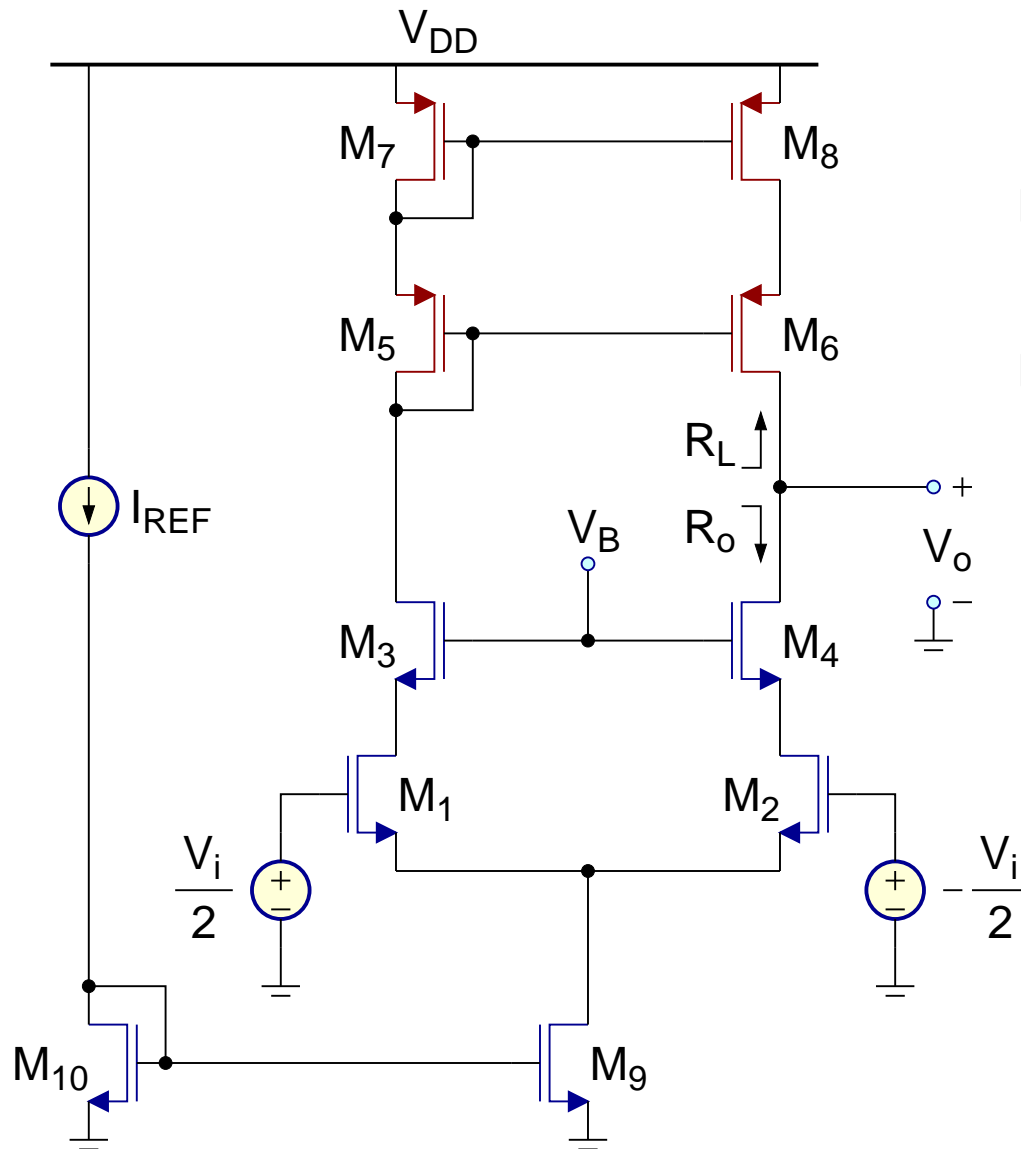
$$R_L \approx \frac{\beta r_{o6}}{2}$$

$$G_m \approx -g_{m1}$$

$$\frac{v_o}{v_i} = G_m (R_o \parallel R_L)$$

MOS Differential Cascode

Cascode current mirror



$$R_o = r_{o2} + r_{o4} + g_{m4}r_{o2}r_{o4}$$

$$R_L = r_{o8} + r_{o6} + g_{m6}r_{o8}r_{o6}$$

$$G_m \approx -g_{m1}$$

$$\frac{v_o}{v_i} = G_m(R_o \parallel R_L)$$