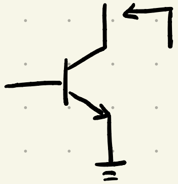
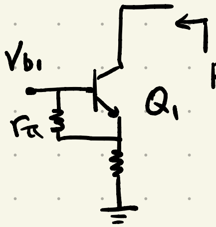
Lec 2. Mos and Bipolar Cascode Current source, Intro. to Cascode Amplifiers

Bipolar Cascode Current Sources



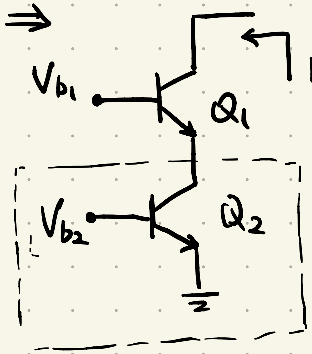
$R_{out} = r_o$

$\Rightarrow$

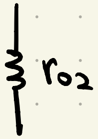


$R_{out} = (1+g_{m1}r_{o1})(R_E // r_\pi) + r_{o1}$

$\Rightarrow$

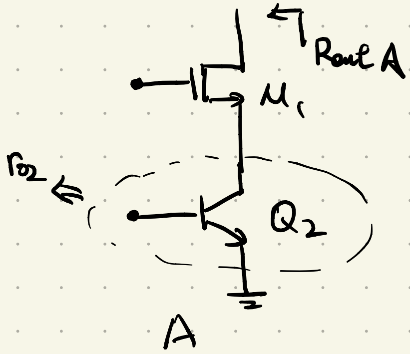


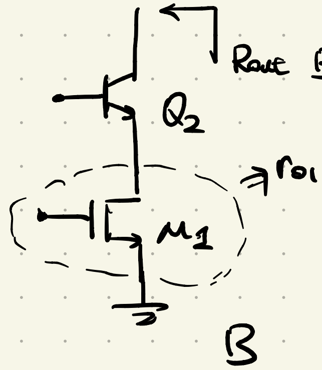
$R_{out} = (1+g_{m1}r_{o1})(r_{o2} // r_{\pi 1}) + r_{o1}$



we only need $V_{CE_2} = 0.6V$ to make the Q_2 in FAR (In contrast with the case of resistor that $V = I_D R_D$)

Example





Assume $r_{o1} = r_{o2}$

$R_{out}\,A = (1+g_{m1}r_{o1})r_{o2} + r_{o1}$

$\approx g_{m1} r_{o1} r_{o2}$

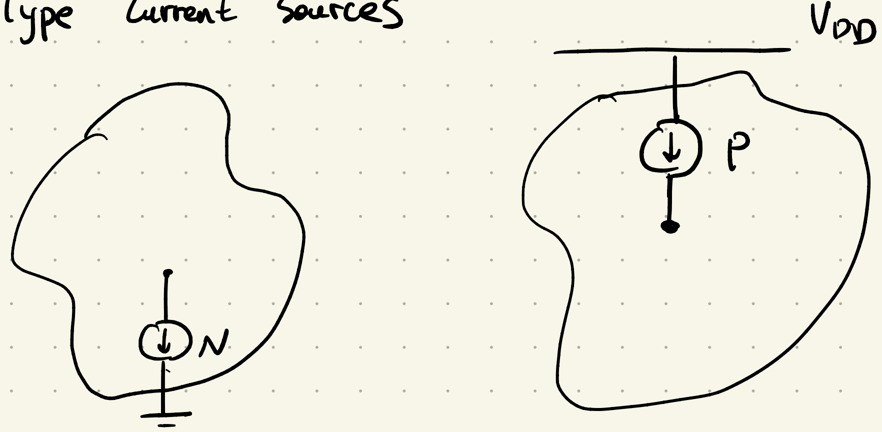
$R_{out}\,B = (1+g_{m2}r_{o2})(r_{o1} // r_{\pi 2}) + r_{o2}$

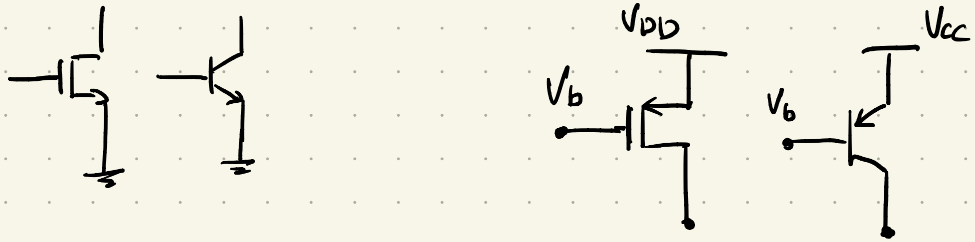
$\approx g_{m2} r_{o2} (r_{o1} // r_{\pi 2})$

For a given bias current:

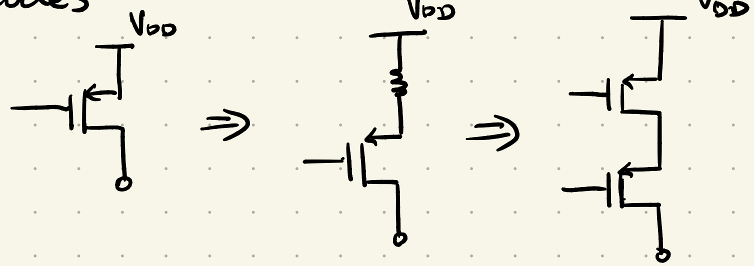
$g_{m,MOS} < g_{m,BJT}$

P-Type Current Sources

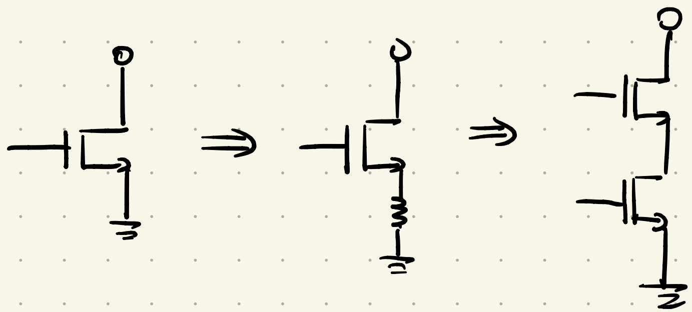




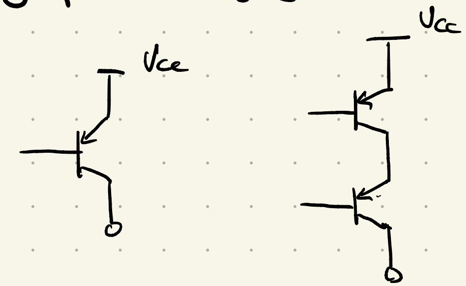
P-Type Cascodes



N-Type Cascodes



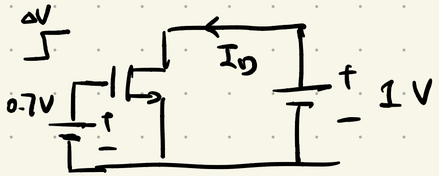
P-Type BJT Cascode



Intro. to Cascode Amplifiers

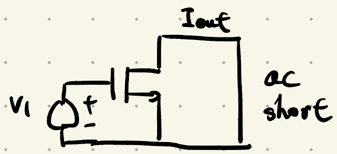
Observations

① Transconductance for General Circuit



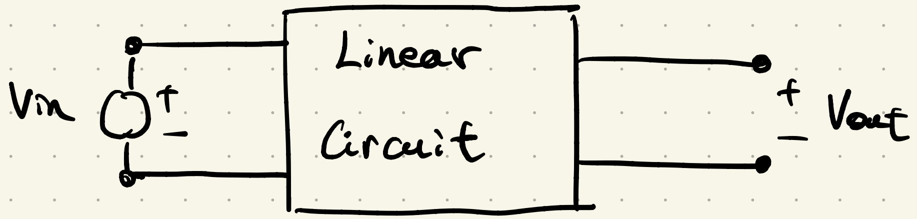
$$g_m = \frac{\partial I_D}{\partial V_{GS}}$$

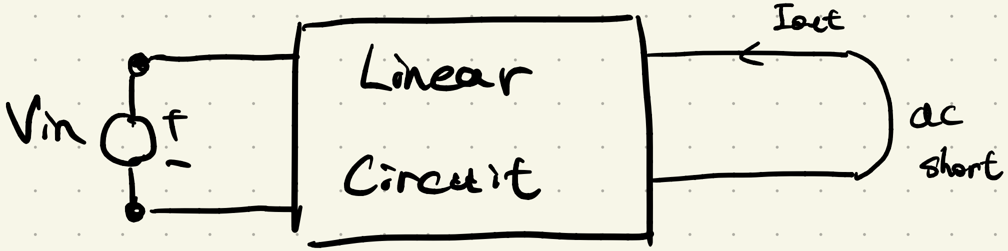
⇒ Small Signal Model:



$$g_m = \frac{i_{out}}{V_1}$$

General Linear Circuit

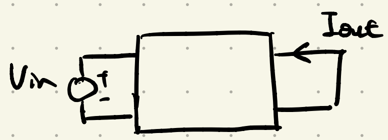




$$G_m = \frac{I_{out}}{V_{in}}$$

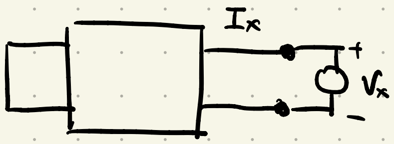
Voltage Gain

Two steps: (a)



$$G_m = \frac{I_{out}}{V_{in}}$$

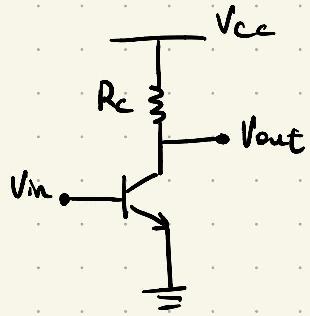
(b)



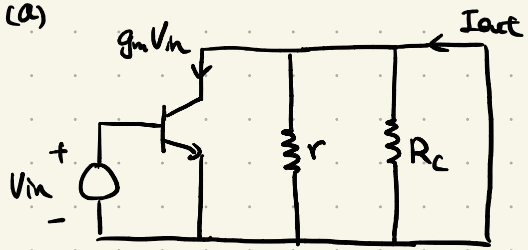
$$R_{out} = \frac{V_x}{I_x}$$

$$A_v = \frac{V_{out}}{V_{in}} = -G_m R_{out}$$

Example

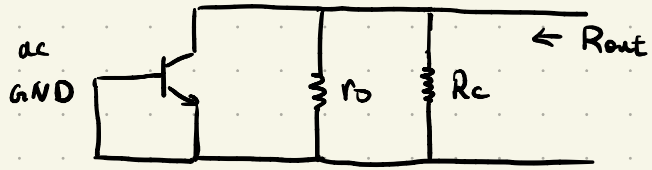


(a)



$$G_m = \frac{I_{out}}{V_{in}} = \frac{g_m V_{in}}{V_{in}} = g_m$$

(b)



$$R_{out} = r_o // R_C$$

then

$$A_v = -g_m(r_o // R_C)$$