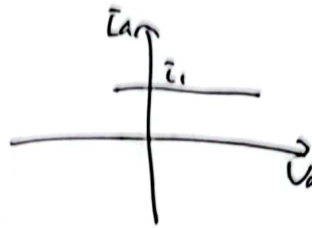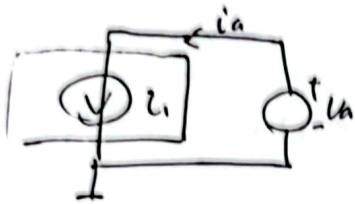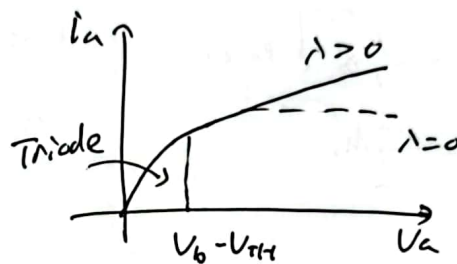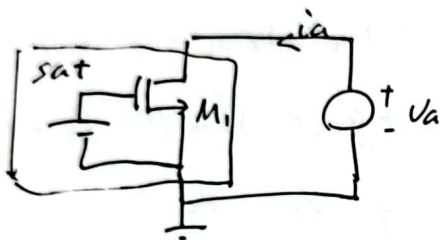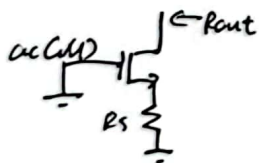# Cascode Current Source

Ideal
Current
Source

Observation

① Let's build a current source

② How do we improve this current source?
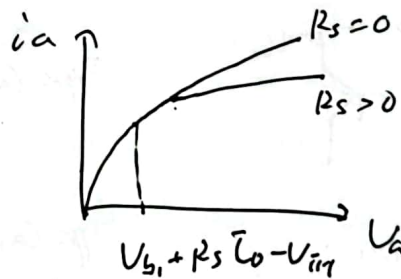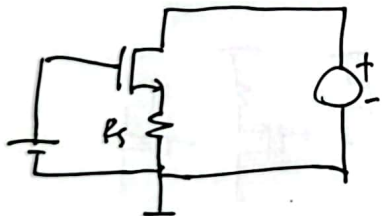
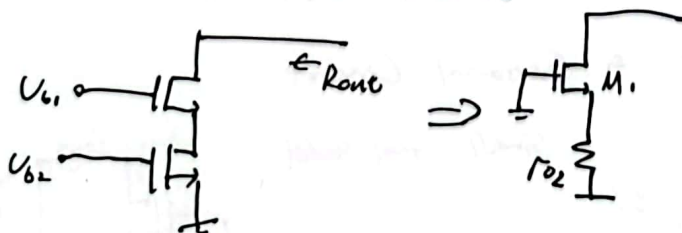$R_{out} = (1 + g_m r_o) R_s + r_o$
Intrinsic Gain

加入 R_s 后, 恒流源的范围变小了. 当 $V_a > V_{b_1} + R_s I_o - V_{TH}$,
恒流恒流特性改善了.

虽然恒流恒流范围不减小,
但相比引起有较强的恒流性能
这时意味一个不合理恒流王现象
恒问 —— Mos.

$\therefore R_{out} = (1 + g_{m_1} r_{o_1}) r_{o_2} + r_{o_1}$

$\approx g_{m_1} r_{o_1} r_{o_2}$

恒好恒大.

③ Cascode Current Source

Bipolar Cascode Current Sources.

V_{b1} α. $R_{out} = (1 + g_m r_{o1})(R_E \| r_{\pi1}) + r_{o1}$

$R_{out} = r_o$

$$R_{out 2} = (1 + g_{m1} r_{o1})(r_{o2} \| r_{\pi1}) + r_{o1}$$

V_{b1}

V_{b2} $= \{ r_{o2}$

~~$\Gamma_{\pi1} \| g \cdot r_o \times J \times g + \text{的} \overset{s}{\sim}$~~ .

Example

$R_{out A}$ M_1, Q_2

$R_{out B}$ Q_2, M_1
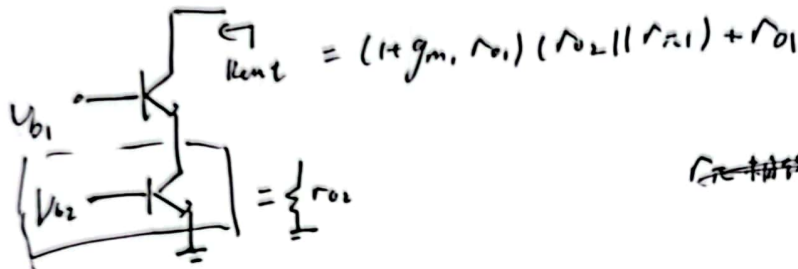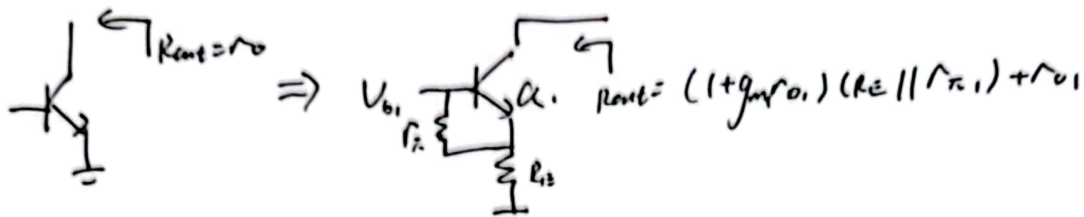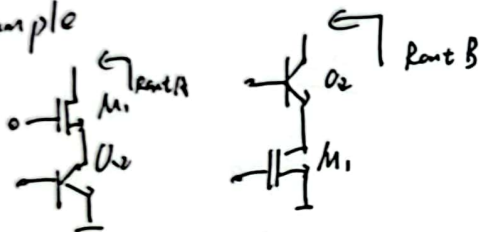
$R_{out A} = (1 + g_{m1} r_{o1}) r_{o2} + r_{o1} \simeq g_{m1} r_{o1} r_{o2}$
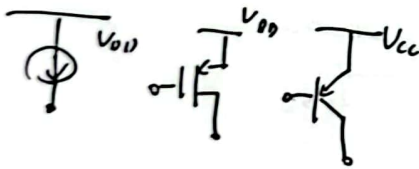
$R_{out B} = (1 + g_{m2} r_{o2})(r_{o1} \| r_{\pi2}) + r_{o2}$

$$\simeq g_{m2} r_{o2}(r_{o1} \| r_{\pi2})$$

for a given bipolar current.
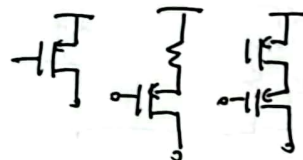
$g_{m, mos} < g_{m, bip}$.

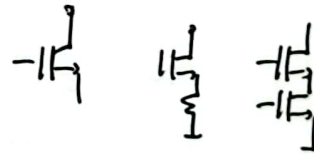## P - Type Current Sources

V_{DD} V_{DD} V_{CC}

P-Type Cascodes
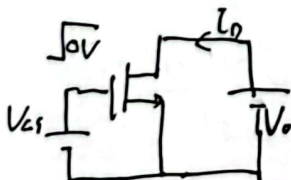

N-Type Cascode

P-Type Bipolar Cascode:

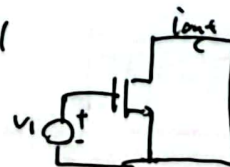## Intro. to Cascode Amplifiers

Observations.

① Transconductance for a General Circuit.

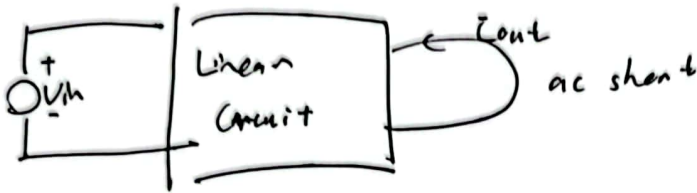$g_m = \dfrac{\partial i_D}{\partial v_{GS}}$ $\Rightarrow$

Small Signal Model

$g_m = \dfrac{i_{out}}{v_1}$
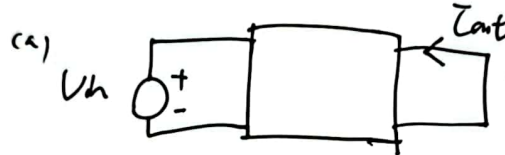
General Linear Circuit

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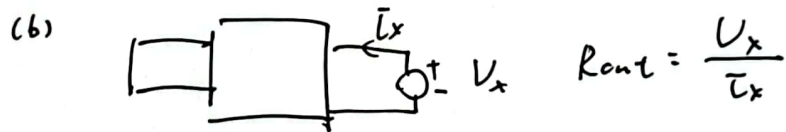

Voltage Gain

Two Steps:

(a)
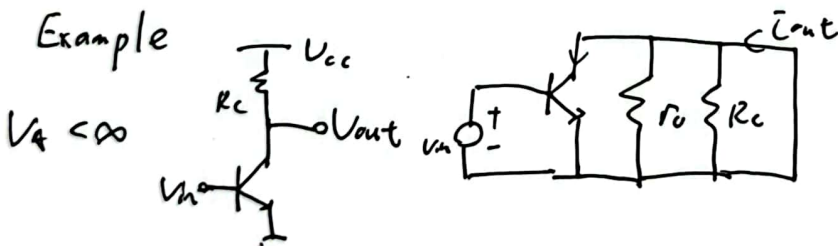

$$G_m = \frac{I_{out}}{V_{in}}$$

(b)

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

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

Example

$V_A < \infty$

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

$$R_{out} = r_0 \| R_c$$

$$A_v = -g_m (r_0 \| R_c)$$