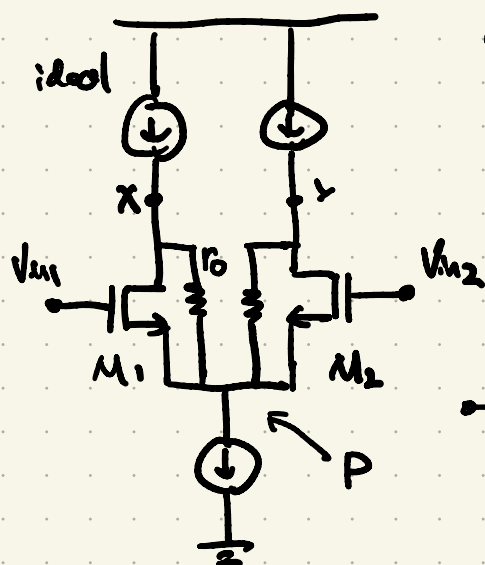


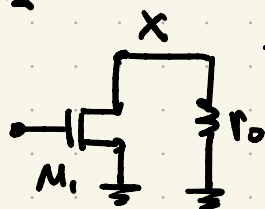
Lec 15

- High-Gain Differential Pair
- Diff Pair with Active Load

• Diff Pair with Current-Source Loads



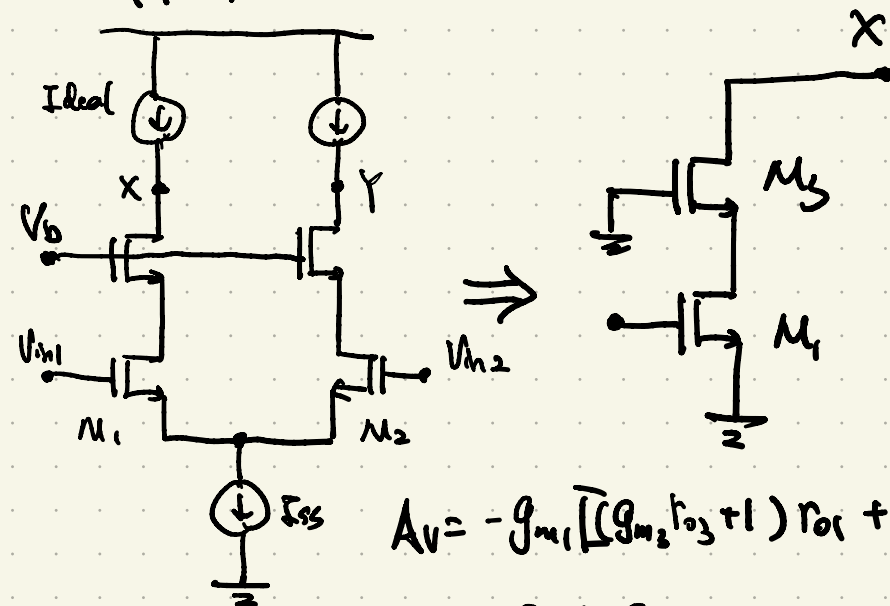
Approach I: V_p is constant
 $\Rightarrow P$ is ac GND



$$\Rightarrow A_v = -g_m r_o$$

$$A_v = -G_m R_{out}$$

• Diff Pair with Cascodes

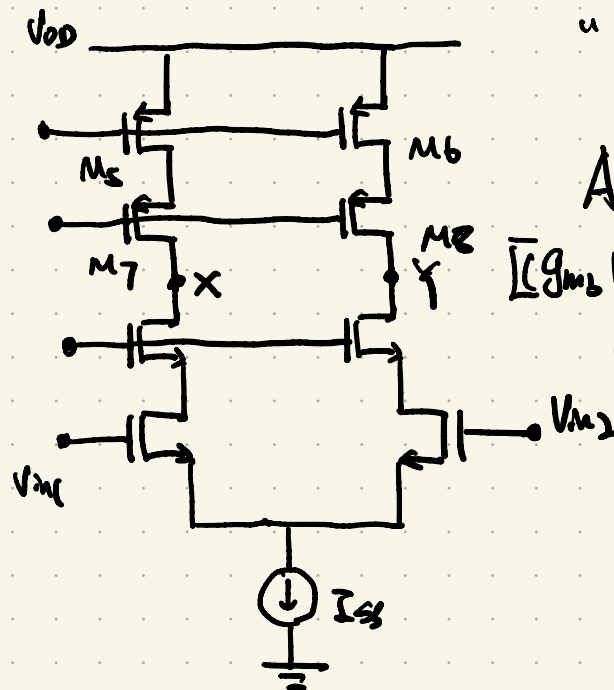


$$A_v = -g_{m1} [(g_{m2} r_{o3} + 1) r_{o1} + r_{o3}]$$

$$= -g_{m1} r_{o1} g_{m2} r_{o3}$$

Implement the Current Source:

"Telescopic Cascode"

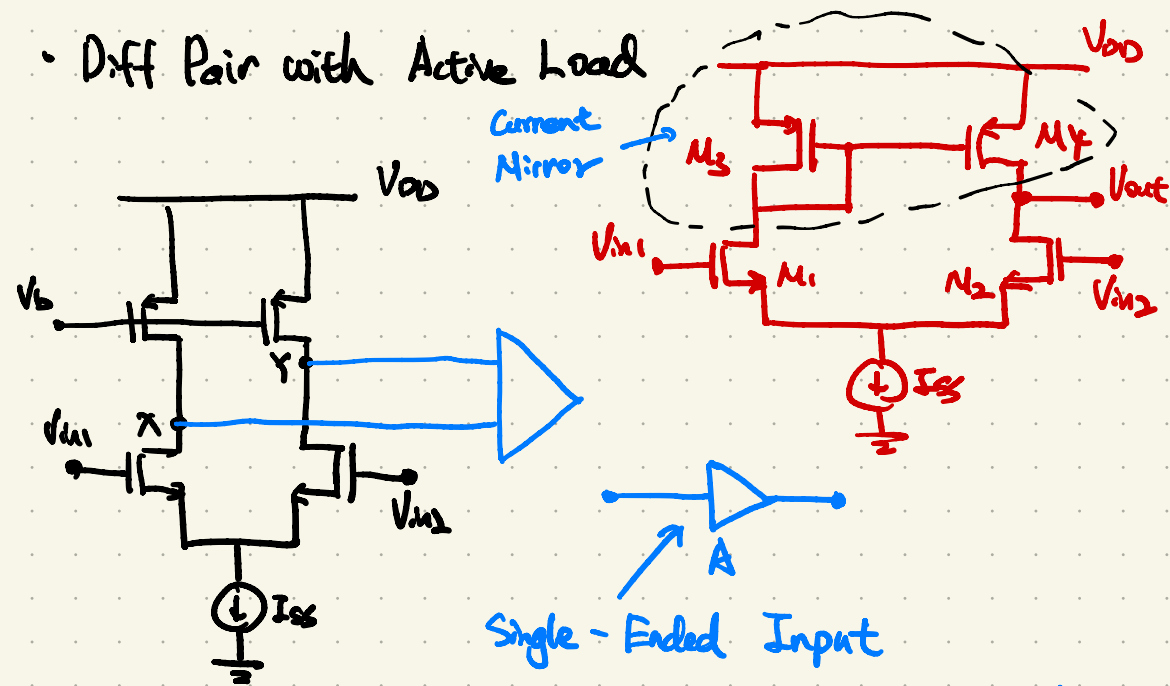


$$A_v = -g_{m1} \times$$

$$[(g_{m2} r_{o3} + 1) r_{o1} + r_{o3}] ||$$

$$[(g_{m7} r_{o3} + 1) g_{m5} + r_{o7}]$$

Diff Pair with Active Load

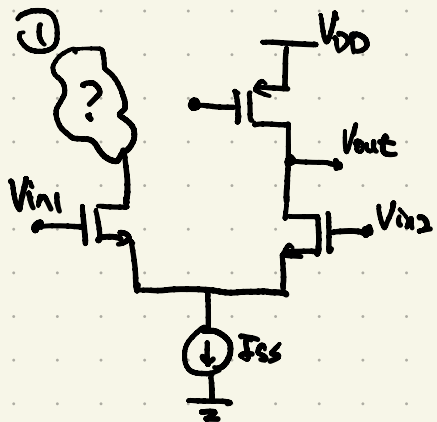


We could connect only X to A and simply not use Y.

⇒ The voltage is halved:

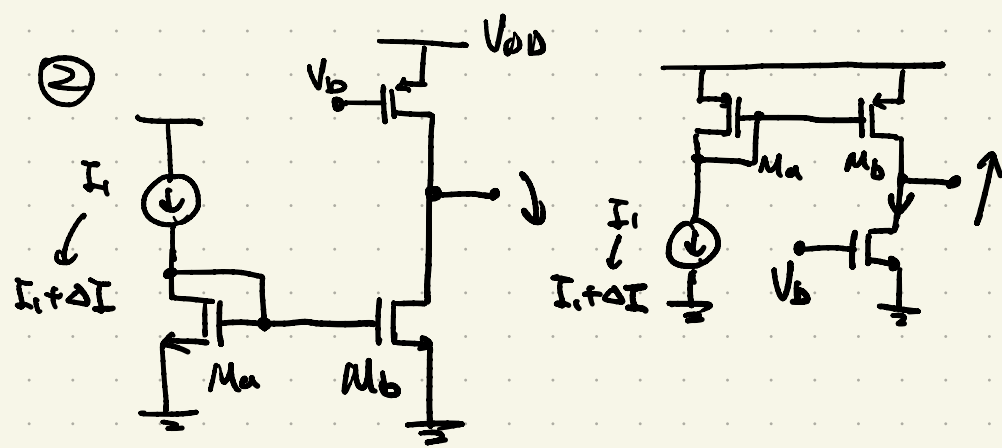
$$\frac{V_x - V_y}{V_{in1} - V_{in2}} = 2 \cdot \frac{V_x}{V_{in1} - V_{in2}}$$

Intuitive Observations

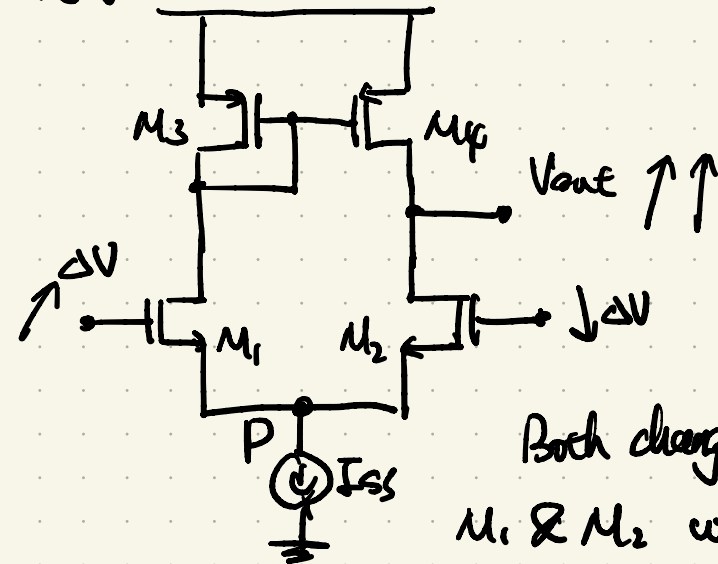


M2 draws less current

Vout ↑



Then:



Both changes in M1 & M2 will want Vout to increase