RUPRECHT-KARLS-
UNIVERSITÄT
HEIDELBERG

Exercise:
Source Follower and Differential Amplifier

Prof. Dr. P. Fischer

Lehrstuhl für Schaltungstechnik und Simulation
Uni Heidelberg

1. NMOS Source Follower

- Implement an NMOS Source follower
  - Use an NMOS with W/L = 1µ / 0.2µ
  - Connect Bulk to Source
  - Use an NMOS mirror with W/L = 1µ / 0.5µ as current source
  - Bias the circuit with 10µA

- Perform a DC and a transient analysis
  - What is the gain?
  - What happens for low input voltages? Why?
  - How does the gain change when you connect the bulk of the SF - NMOS to ground?

2. *PMOS* Source Follower

- Now draw a ***PMOS*** source follower with the same transistor dimensions & current...

- Which input voltages are now problematic?

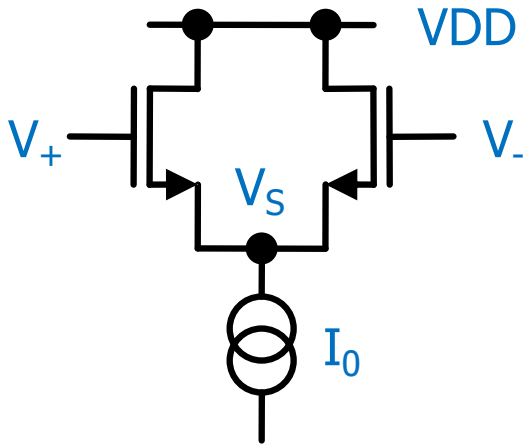
3. (Optional: SF Instability)

- Repeat the situation from the lecture slides:
  - SF driven by a (large) source impedance
  - Added load capacitance
  - Added capacitance between input and output (an exaggerated C_{GS})

- Observe the overshoot in the transient response for a step input or the increased gain in an AC sweep.

4. Differential pair

- Draw a differential NMOS pair

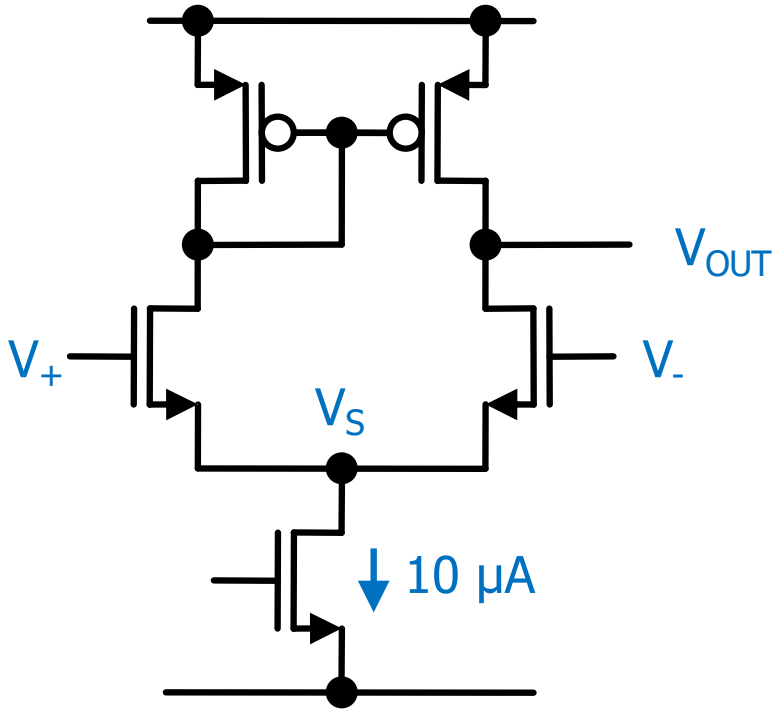


- Set V_- = 1 V and vary V_+ from 0 to VDD = 2 V
  - Observe I_+, I_- and the 'tail' voltage V_S.
  - Explain what you see!

- Change the bias current I_0 or the transistor dimensions.
  - Observe how the switching region changes (i.e. which voltage difference is needed to switch fully). Do you understand?

5. Differential Amplifier

- Draw a full differential amplifier. Start with all W/L = 1u/0.5u



- Start with V_- = 0.5V
- What is the gain at the switching point?
  - Use a DC sweep. Also try an AC sweep with appropriate bias.
- Check the large signal behavior for different V_-.

6. *PMOS* Differential Amplifier

- This exercise is only useful if you have problems to switch from NMOS to PMOS circuits…

- Draw a full differential amplifier with a PMOS input stage
  - You must also change the other MOSs…

7. Mirrored Amplifier

- Implement the mirrored amplifier from page 23 of the lecture slides.

- Sweep V_+ for various constant V-. Observe the output. What is the difference to the normal differential amplifier?
- When used as transconductor (driving in a constant output voltage), what output voltages are possible?