EE105 - Fall 2005
Microelectronic Devices and Circuits

Lecture 11
MOS Transistor
Small-Signal Model
Current Sources

Announcements

› Homework 5 due today
› Homework 6 due next Tuesday
› Lab 4 this week
› Reading: Chapter 4 (4.5-4.6), 8.3
› Midterm 1 in nine days
   › October 13, 6:30-8pm, Sibley
Lecture Material

- Last lecture
  - MOS amplifier example
  - MOSFET small-signal model
- This lecture
  - Finish MOSFET small-signal model
  - MOS current sources

Voltage References

- First topic: voltage and current references (9.4)
- Generating a voltage: use a current source to set $V_{GS}$
Modeling the Voltage Source

Find $i_{OUT}$ versus $v_{OUT}$ MOSFET is off or saturated: why?

$$i_{OUT} = i_{D,SAT} - I_{REF} = \mu_n C_{ox} \left( \frac{W}{2L} \right) (v_{GS} - V_{th})^2 (1 + \lambda_n v_{DS}) - I_{REF}$$

Typical operating point: $i_{OUT} = 0 \ A$

Small-Signal Source Resistance

$$R_S = \left( \frac{di_{OUT}}{dv_{OUT}} \right)_{i_{OUT}=0}^{-1} = \frac{v_l}{i_t}$$

Equivalent Circuit:
Creating a Current Source

Equivalent Circuit for $I$-Source

Find the DC current for “gray circle” equivalent circuit

$$I_{OUT} = \frac{\mu_n C_{ox}}{2} \left( \frac{W}{L} \right)^2 \left( V_{REF} - V_{tn} \right)^2$$

Substitute for $V_{REF}$
Small-Signal Resistance of $I$-Source

Current Sinks and Sources

**Sink:** output current goes to ground

**Source:** output current comes from voltage supply
Current Mirrors

*Idea:* we only need one reference current to set up all the current sources and sinks needed for a multistage amplifier.