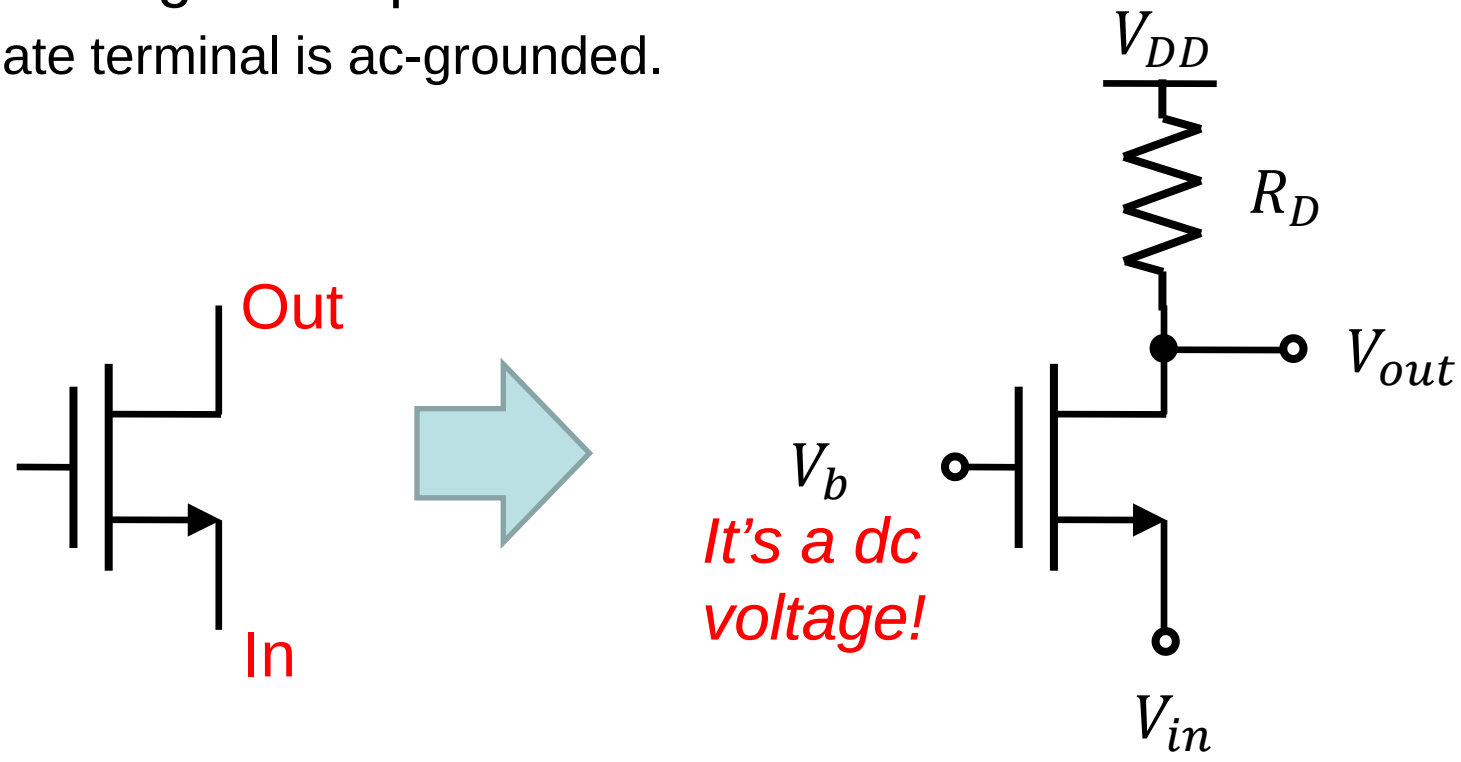
Lecture17:
CMOS amplifier, excercise

Sung-Min Hong (smhong@gist.ac.kr)

Semiconductor Device Simulation Lab.
School of Electrical Engineering and Coumputer Science
Gwangju Institute of Science and Technology

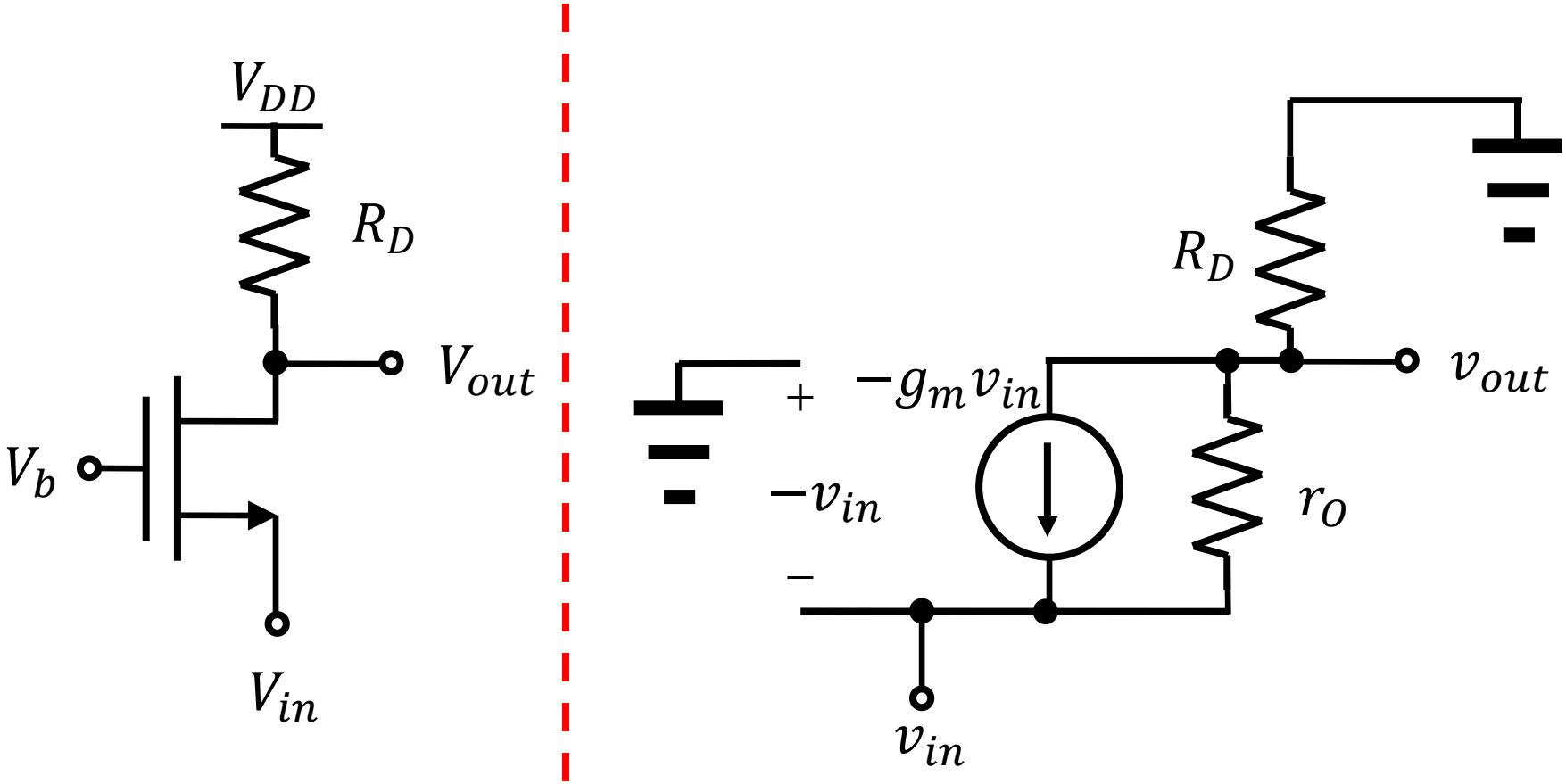
Common-gate amplifier

- Why do we study other amplification topologies?
  - Different circuit properties
- Common-gate amplifier
  - Gate terminal is ac-grounded.



Small-signal model

- Let's draw the small-signal model together!



Gain & input impedance (1/2)

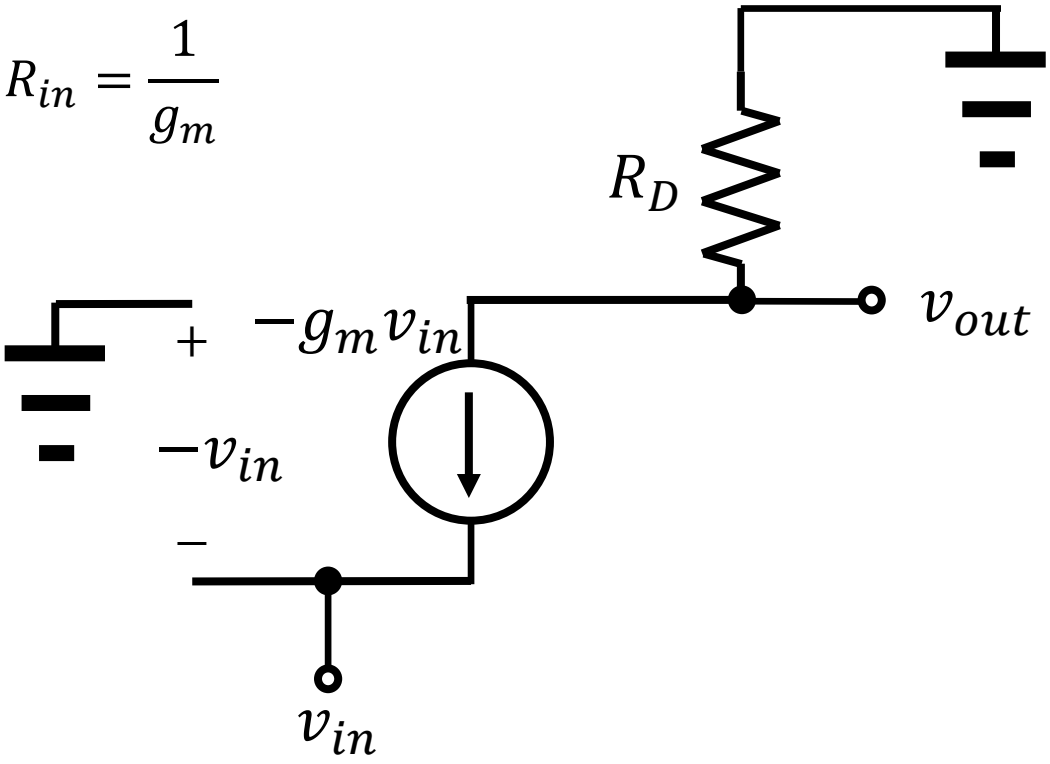
- Neglect the output resistance, r_O.
  - Voltage gain

$$A_v = +g_m R_D$$

  - Input impedance

$$R_{in} = \frac{1}{g_m}$$

It's small!



Gain & input impedance (2/2)

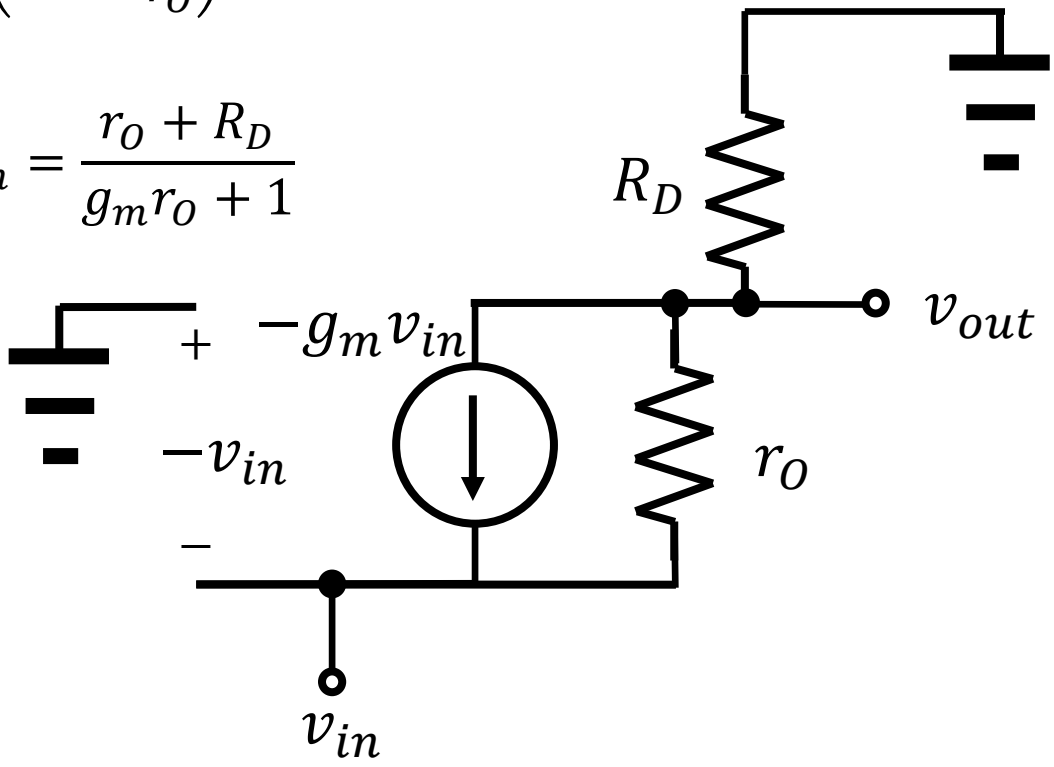
- Consider the output resistance, r_O.
  - Voltage gain

$$A_v = +\left(g_m + \frac{1}{r_O}\right)(R_D || r_O)$$

  - Input impedance

$$R_{in} = \frac{r_O + R_D}{g_m r_O + 1}$$

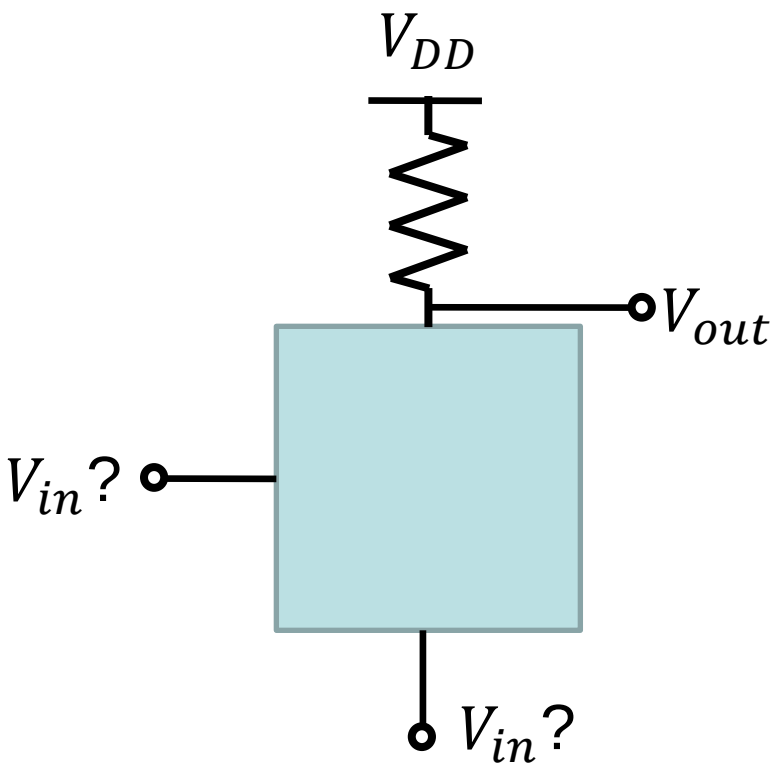
It's small!



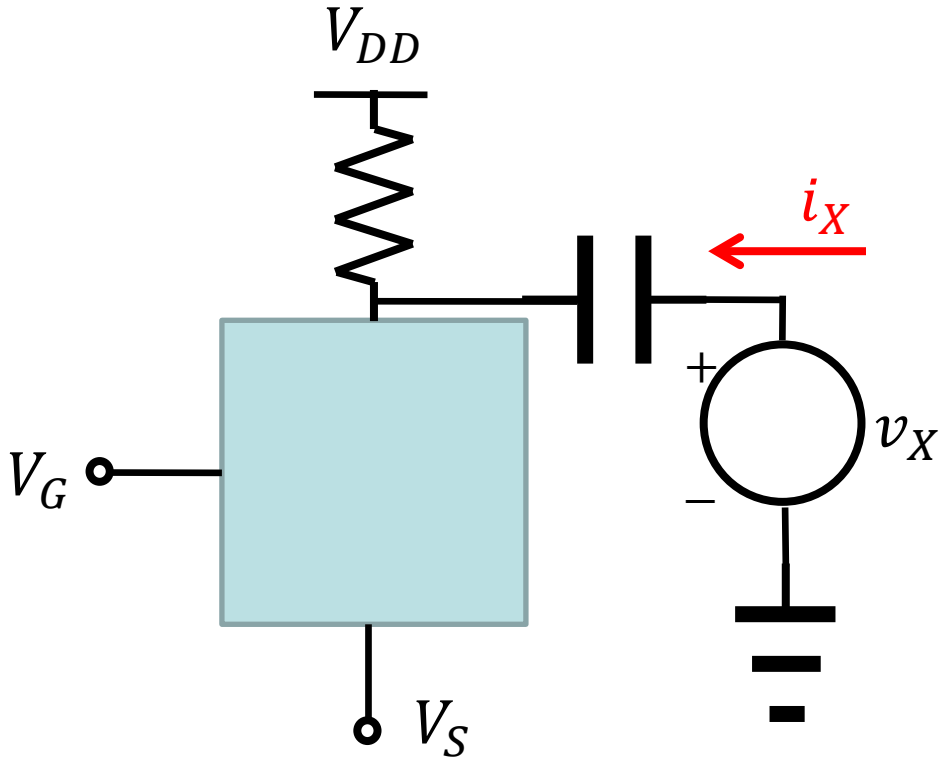
Output impedance

- Same with the CS stage

$$R_{out} = r_O \,||R_D$$



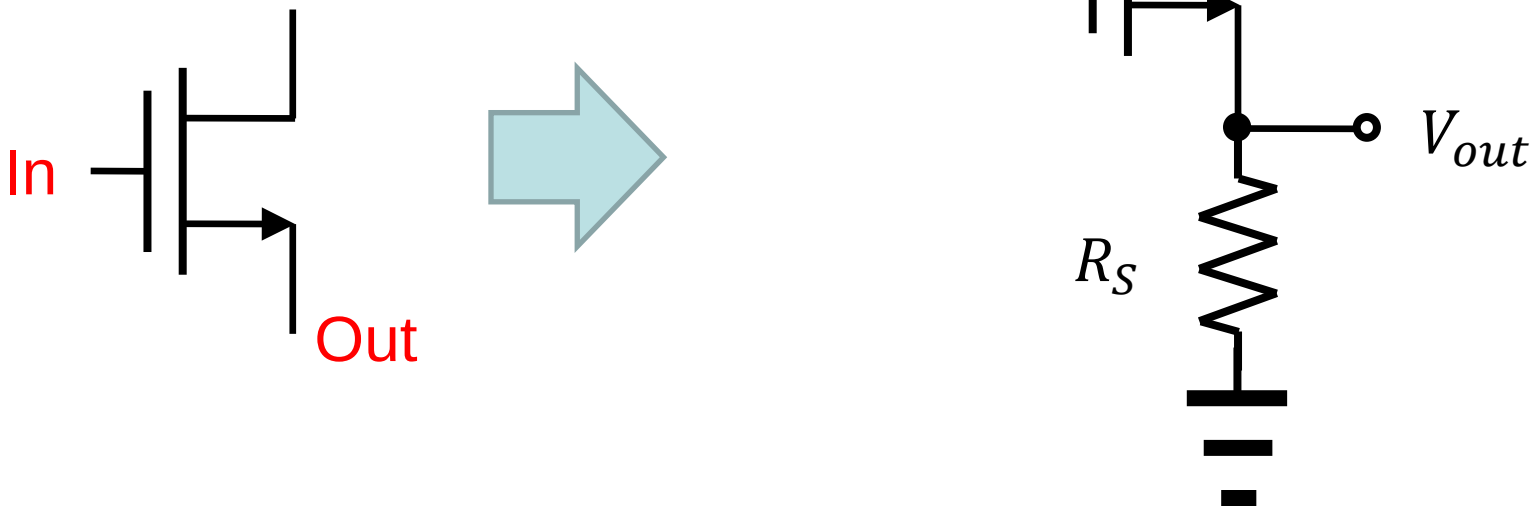
Generic form of CS and CG stages



Setting for calculating R_{out}

Source follower

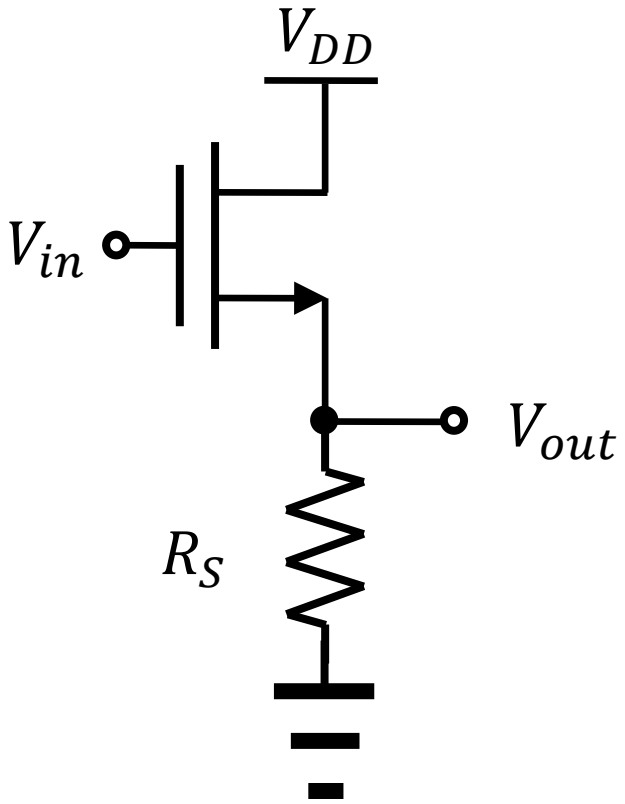
- Also called the “common-drain” stage
  - The drain is ac ground.
- Wait a minute!
  - Is it a real amplifier?



Its core

- Gain is less than 1?? (Neglecting r_O)

$$A_v = +\frac{g_m R_S}{1 + g_m R_S}$$



You should be able to draw the small-signal model.

Useless?

- Calculate the input and output impedances.
  - Since the gate is the input terminal, the input impedance is very high at low frequencies.
  - How about the output impedance?

$$R_{out} = \frac{1}{g_m} || r_O || R_S$$

  - It is relatively low.

- High input imp., low output imp.
  - They can serve as good “buffers.”