Lecture14:
CMOS amplifier, common-source (1)

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

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

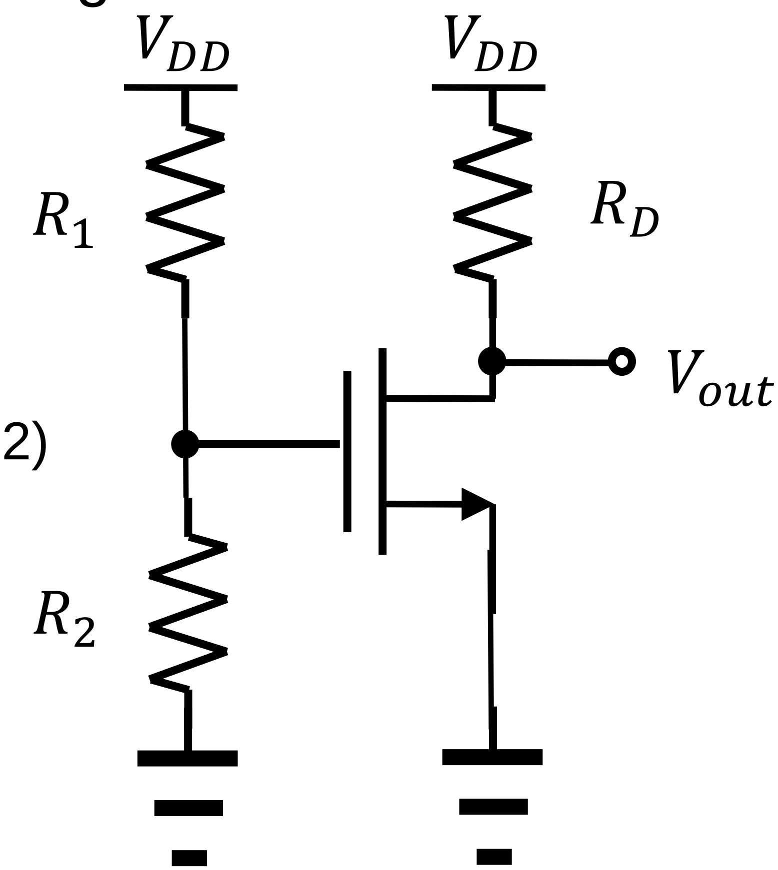
Simple biasing (1/3)

- A better way to provide the gate voltage
  - The gate bias voltage is

$$V_{GS} = \frac{R_2}{R_1+R_2} V_{DD} \qquad (17.10)$$

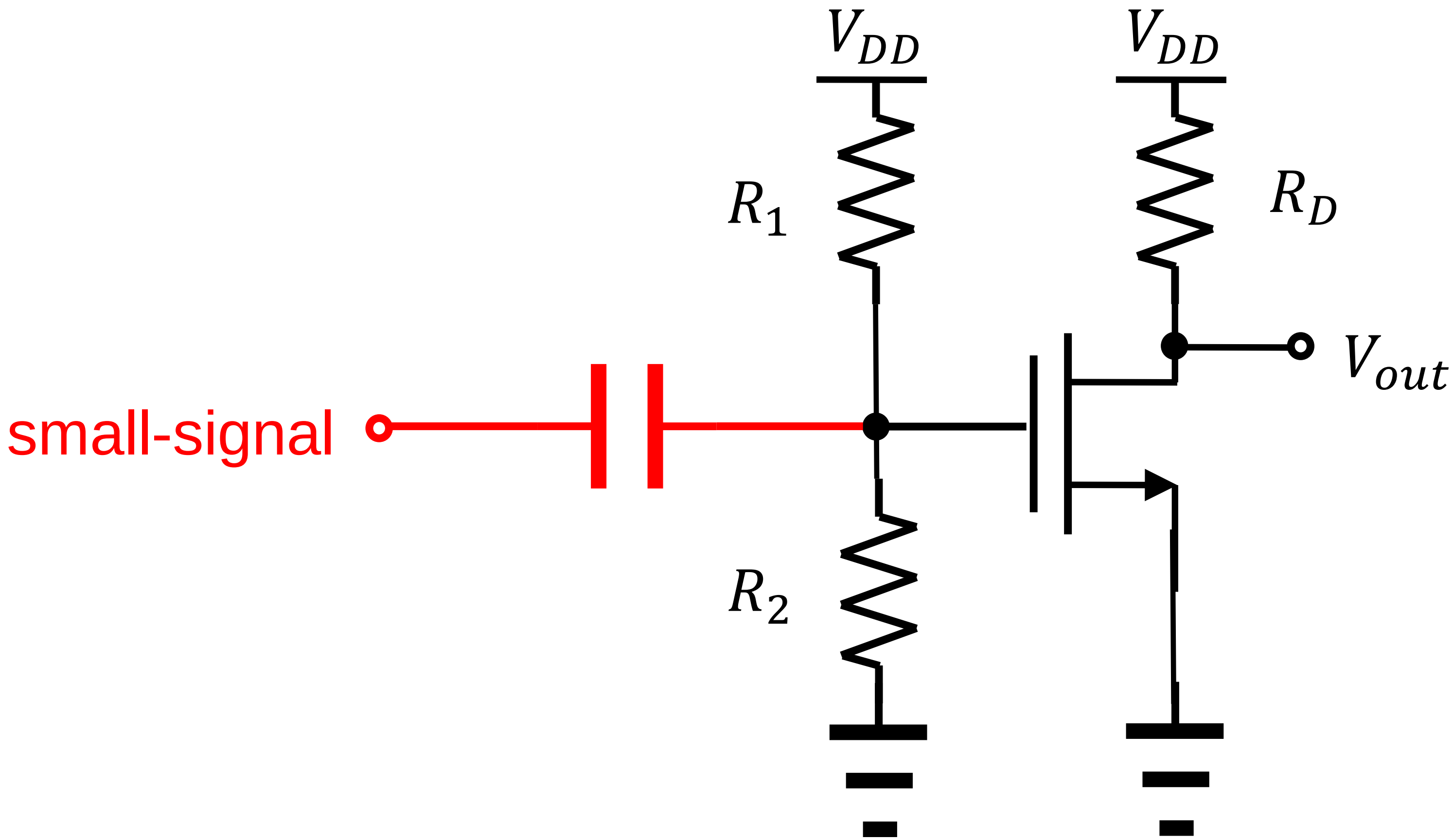
  - The drain current is

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}\left(\frac{R_2}{R_1+R_2}V_{DD} - V_{TH}\right)^2 \qquad (17.12)$$



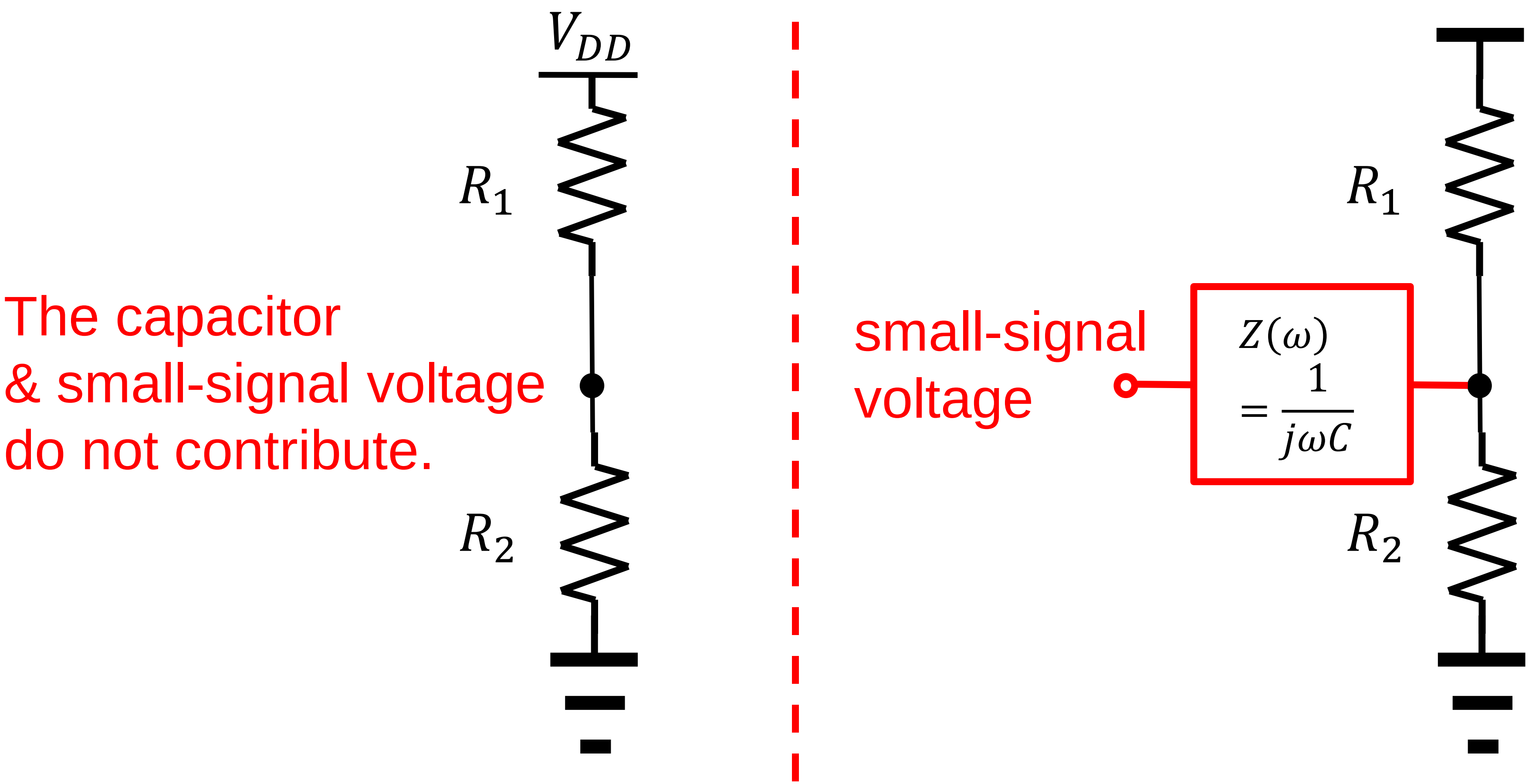
Simple biasing (2/3)

- How to apply the small-signal input
  - Use a capacitor!



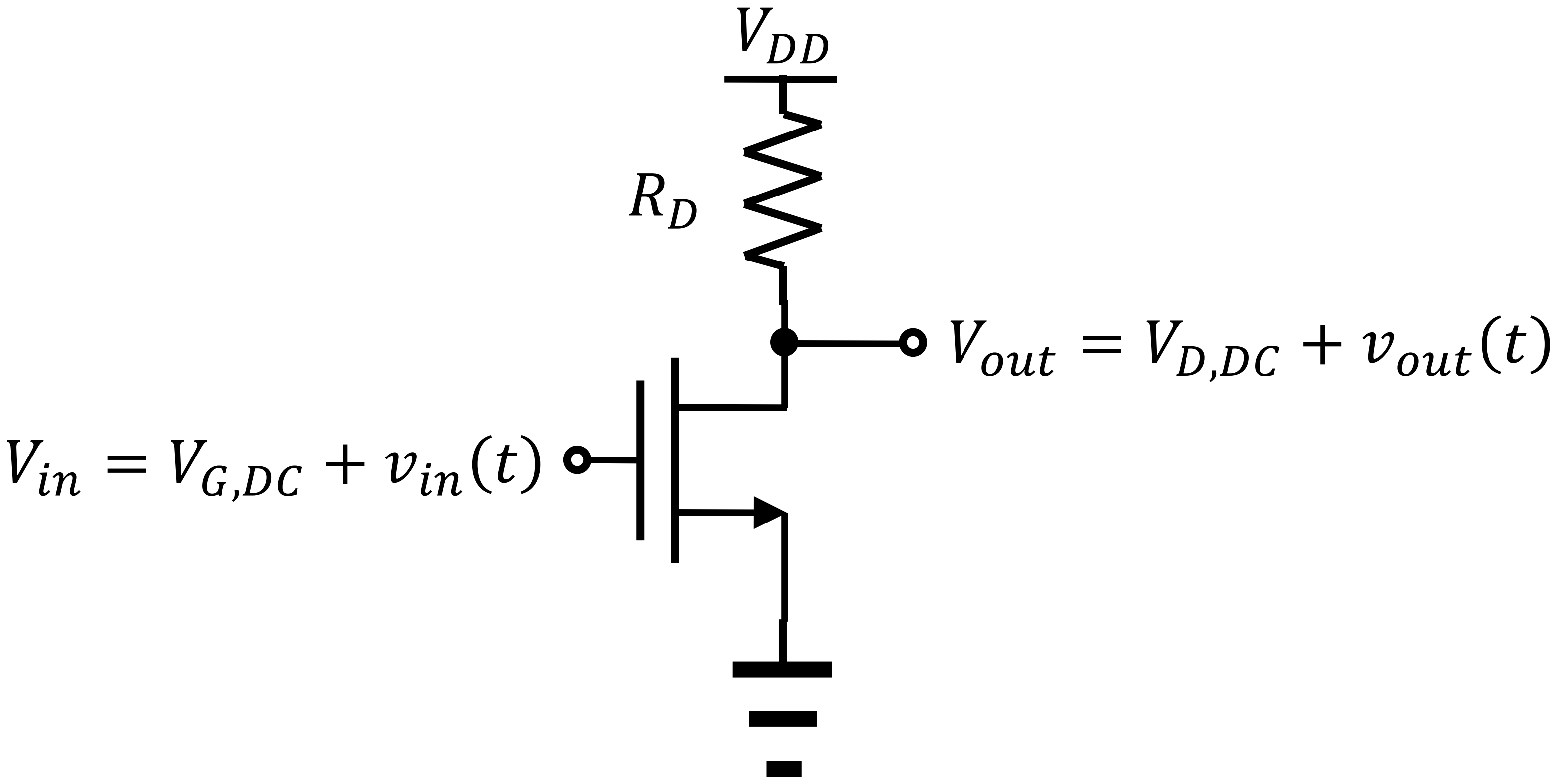
Simple biasing (3/3)

- DC and AC
  - When $\omega C \gg 1$, the small-signal voltage occurs at the gate.



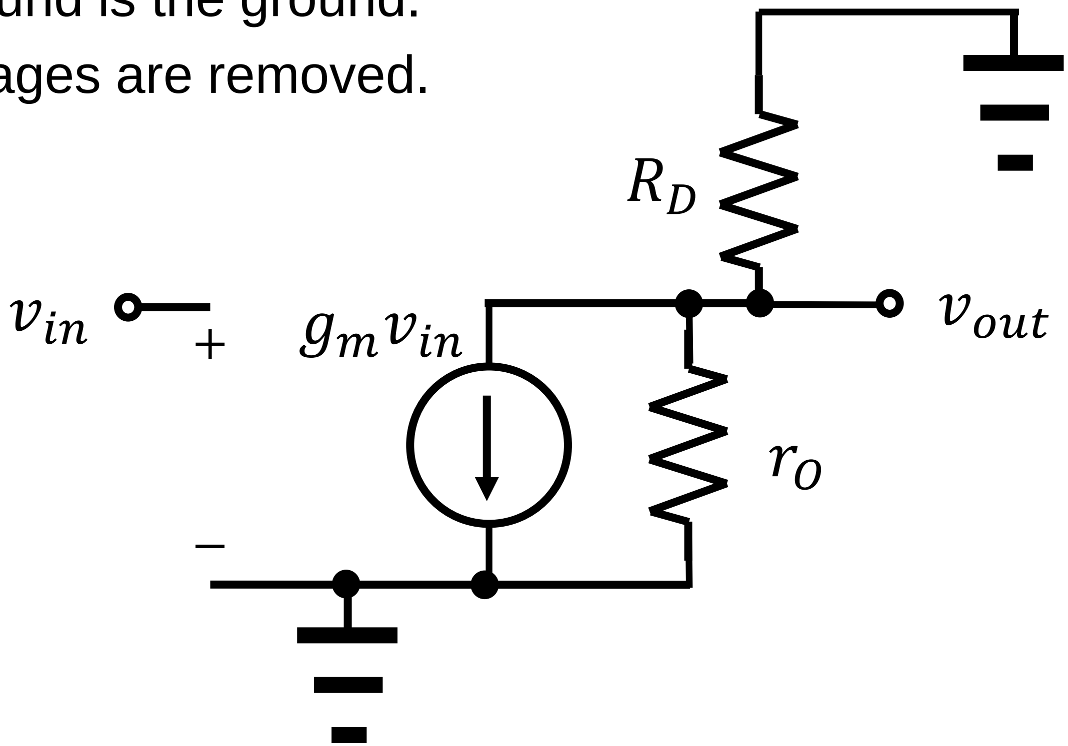
Common-source amplifer

- The source terminal is the reference.
  - The small-signal gate voltage changes the drain current.
  - The output voltage, $V_{out} = V_{DD} - I_D R_D$, is affected.



Small-signal model

- Let's draw its small-signal model together!
  - A transistor small-signal model is introduces.
  - Resistors are resistors.
  - The ground is the ground.
  - DC voltages are removed.



Gain

- Now, calculate the v_{out}.
  - KCL for the v_{out} node gives
$$v_{out} = -g_m(R_D||r_O)v_{in}$$
  - Therefore, the voltage gain, A_v, is
$$A_v = -g_m(R_D||r_O)$$