Lecture15: CMOS amplifier, common-source (2)

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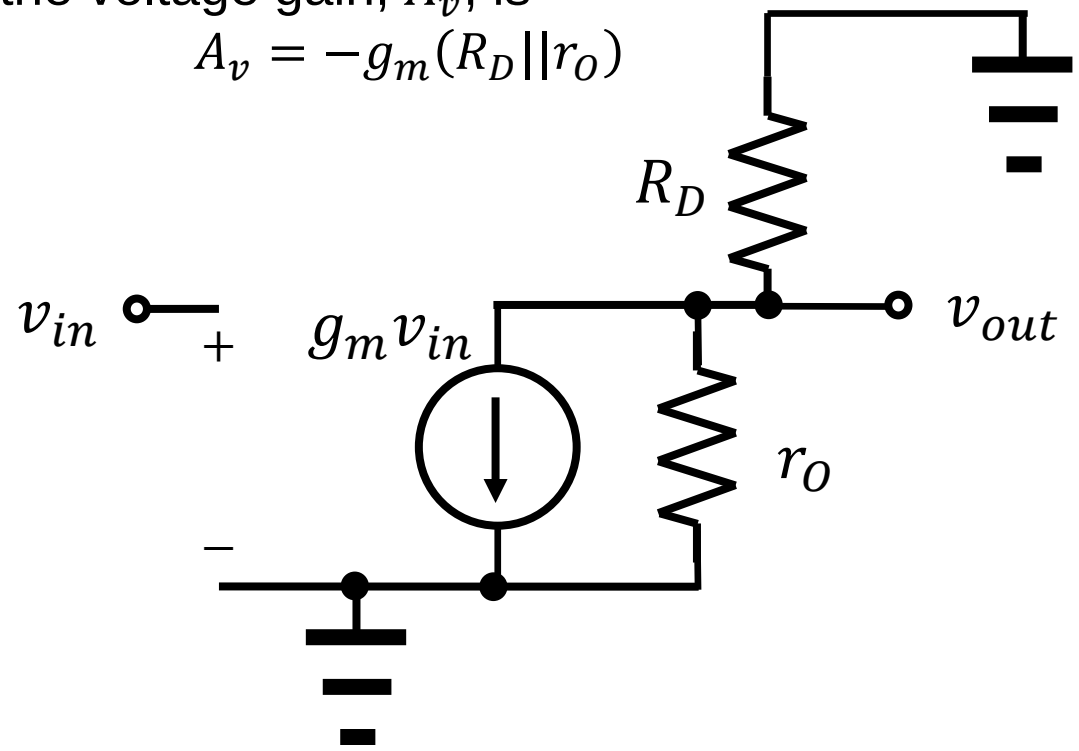
Gain

- 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

$$A_v = -g_m(R_D||r_O)$$



Increasing the gain

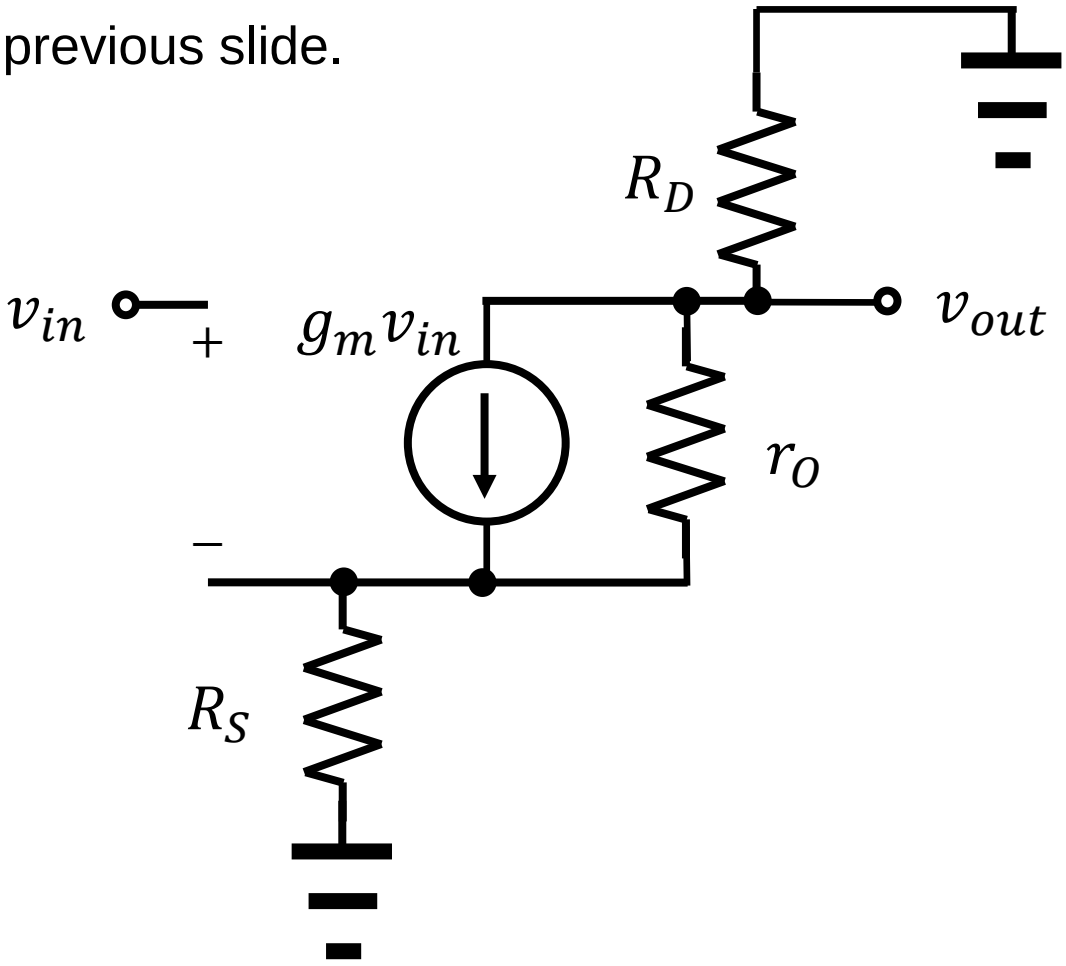
- The voltage gain has two factors.
  - Transconductance(g_m): Selecting W, L, and V_{GS} to maximize the transconductance
  - Resistance($R_D||r_O$): A large R_D value is desirable. However, there is a restrction.

$$V_{D,DC} = V_{DD} - R_D I_{D,DC}$$

  - A too large value of R_D reduces $V_{D,DC}$ too much. The triode mode is not suitable for the amplification due to its smaller transconductance.
  - A drain load other than a simple resistor can be tried.

Impact of R_S

- Consider a source resistance, R_S.
  - Repeat the previous slide.

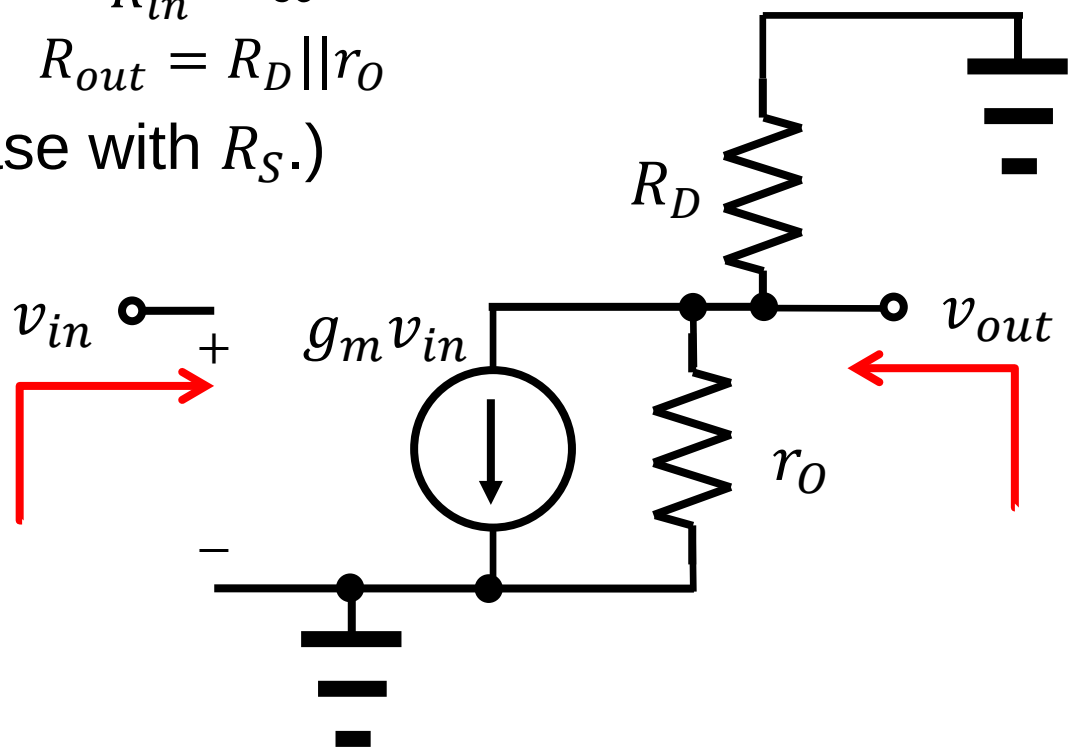


Input/output impedances

- When calculating the impedance, the voltage sources at other terminals are neglected.
- Input and output impedances

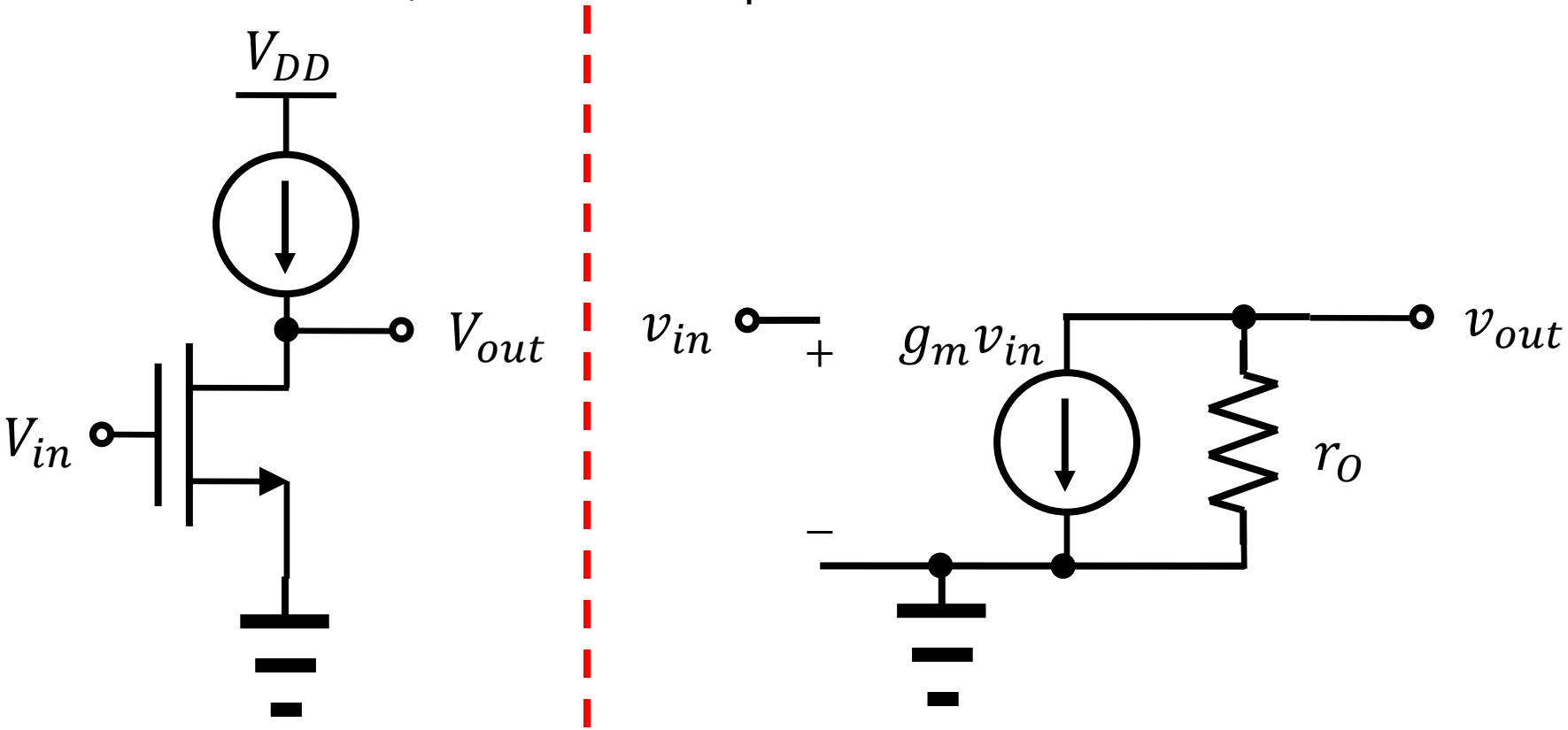
$$R_{in} = \infty$$
$$R_{out} = R_D || r_O$$

- (Also consider a case with R_S.)



Current-source load

- When $R_D \rightarrow \infty$,
  - The gain can be maximized in its absolute value. ($A_v \rightarrow -g_m r_O$)
  - Great! Then, how can we implement a current source?



Homework#7

- Due: 09:00, May 9 (No lecture on May 7)
- Write a program, which reads a netlist file.
  - Only voltages sources and resistors are considered.
  - The program calculates the node voltages and the terminal voltages/currents.
  - Three test netlists will be uploaded. For each of them, show the solution vector.