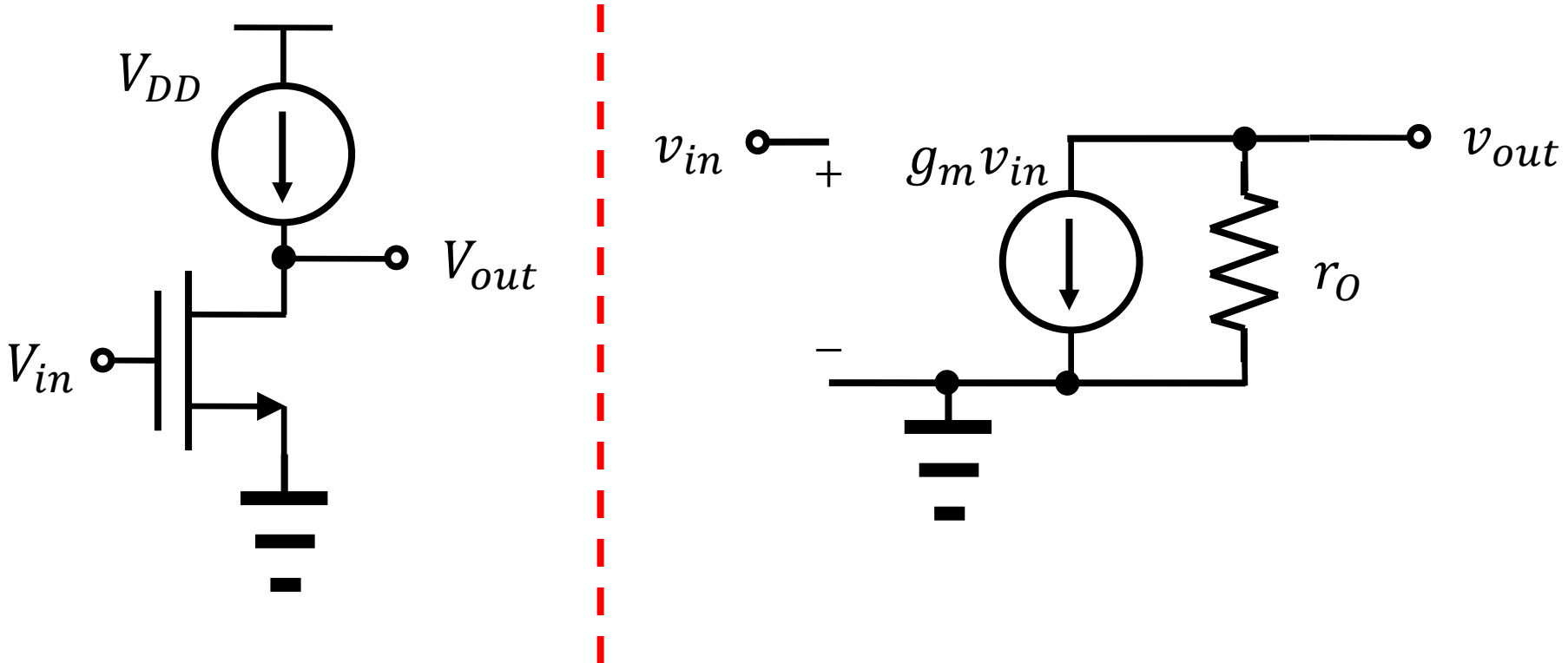# Lecture18:
Common-source amplifier (2)

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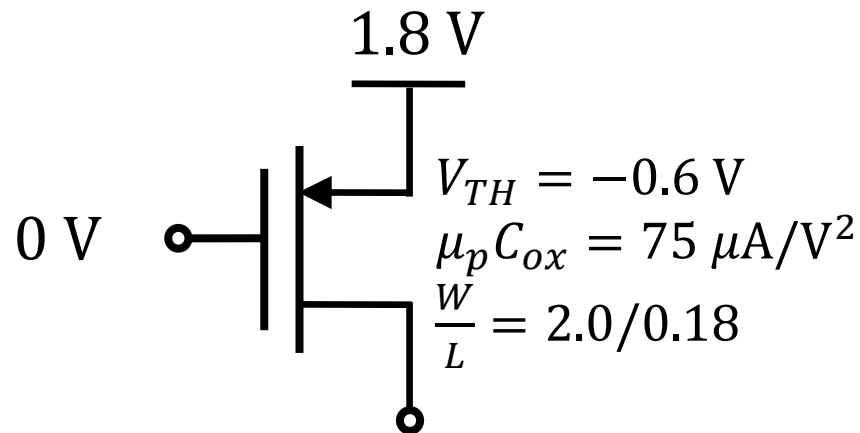Gwangju Institute of Science and Technology

Current-source load

- When $R_D \to \infty$,
  - The gain can be maximized in its absolute value. $(A_v \to -g_m r_O)$

Biasing of PMOS devices

- Use a PMOS as a current source
  - The absolute value of the "gate overdrive" is 1.2 V.
  - Of course, when the drain voltage is higher than 0.6 V, it is operated in the triode mode.

$$1.8 \text{ V}$$

$$0 \text{ V}$$

$$V_{TH} = -0.6 \text{ V}$$
$$\mu_p C_{ox} = 75 \text{ } \mu\text{A/V}^2$$
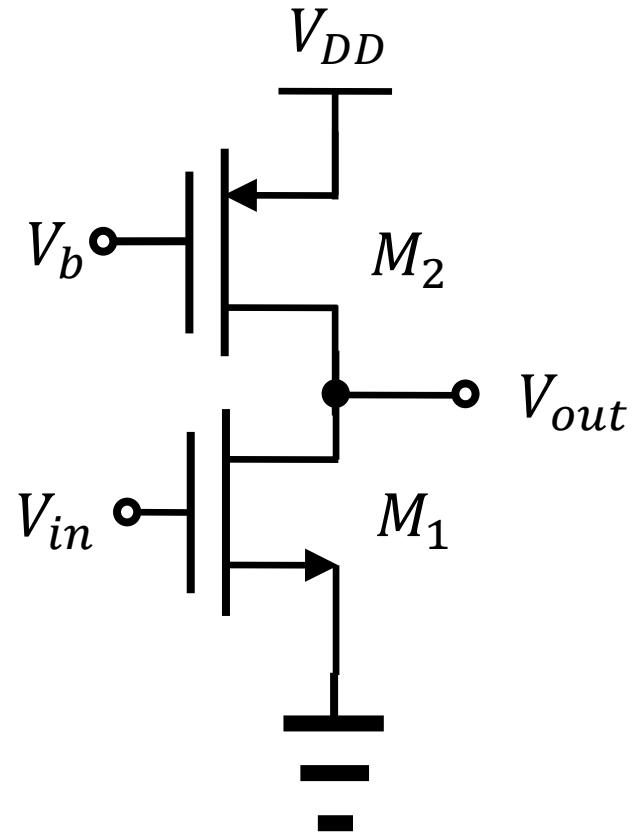$$\frac{W}{L} = 2.0/0.18$$

Real current-source load

- Use a PMOS as a current source.
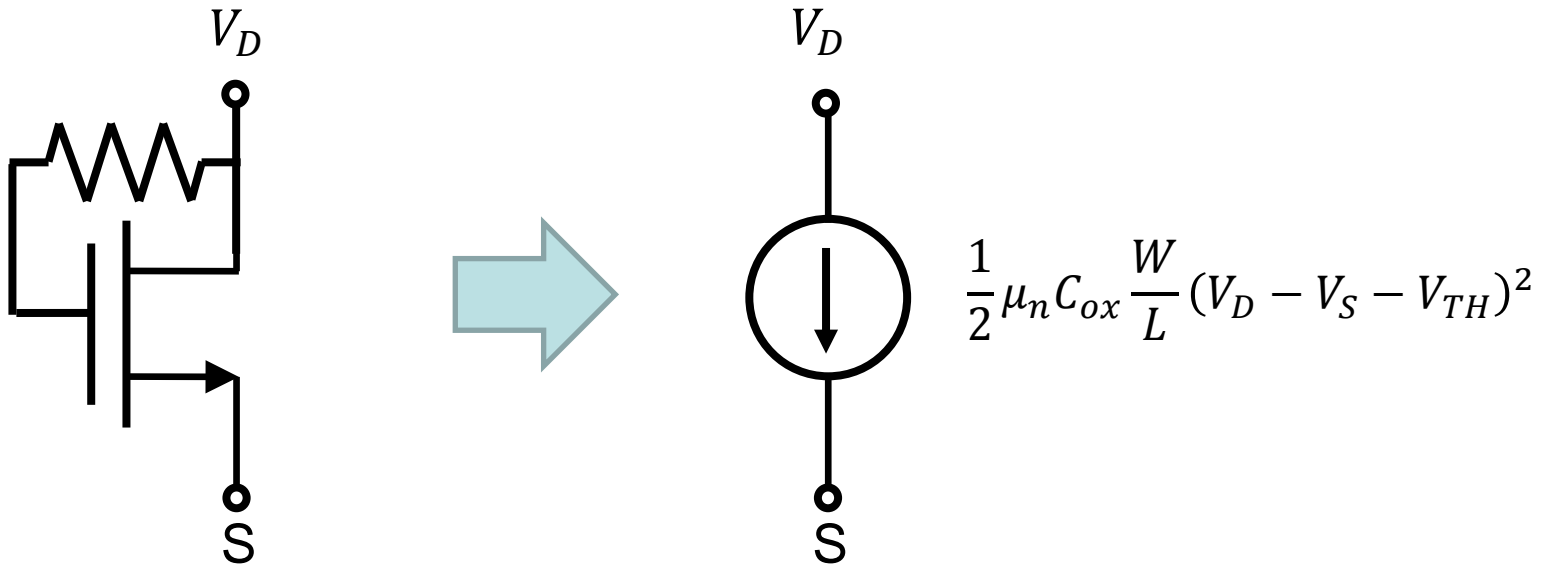 - It is not an ideal current source.

$$v_{out} = -g_{m1}(r_{O1}||r_{O2})v_{in}$$

$$A_v = -g_{m1}(r_{O1}||r_{O2})$$

Self-biasing

- Already covered in Razavi Example 6.13.
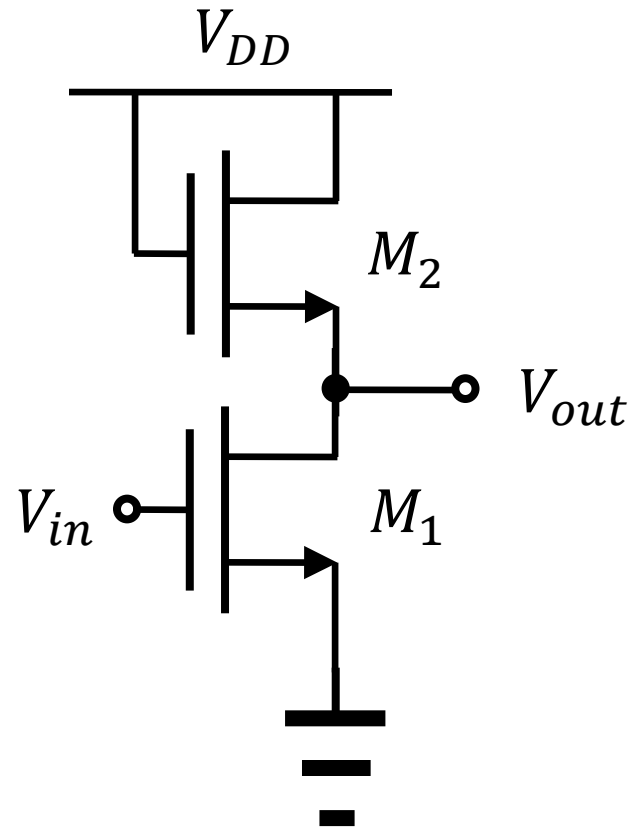 - Always in the saturation region.

$$\frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_D - V_S - V_{TH})^2$$

Gate and drain are tied.

Diode-connected load

- Use a diode-connected load.
  - It is not an ideal current source.

$$v_{out} = -g_{m1}\left(r_{O1}||\frac{1}{g_{m2}}||r_{O2}\right)v_{in}$$

$$A_v = -g_{m1}\left(r_{O1}||\frac{1}{g_{m2}}||r_{O2}\right)$$

Source degeneration

- Consider a case with a source resistor, R_S.
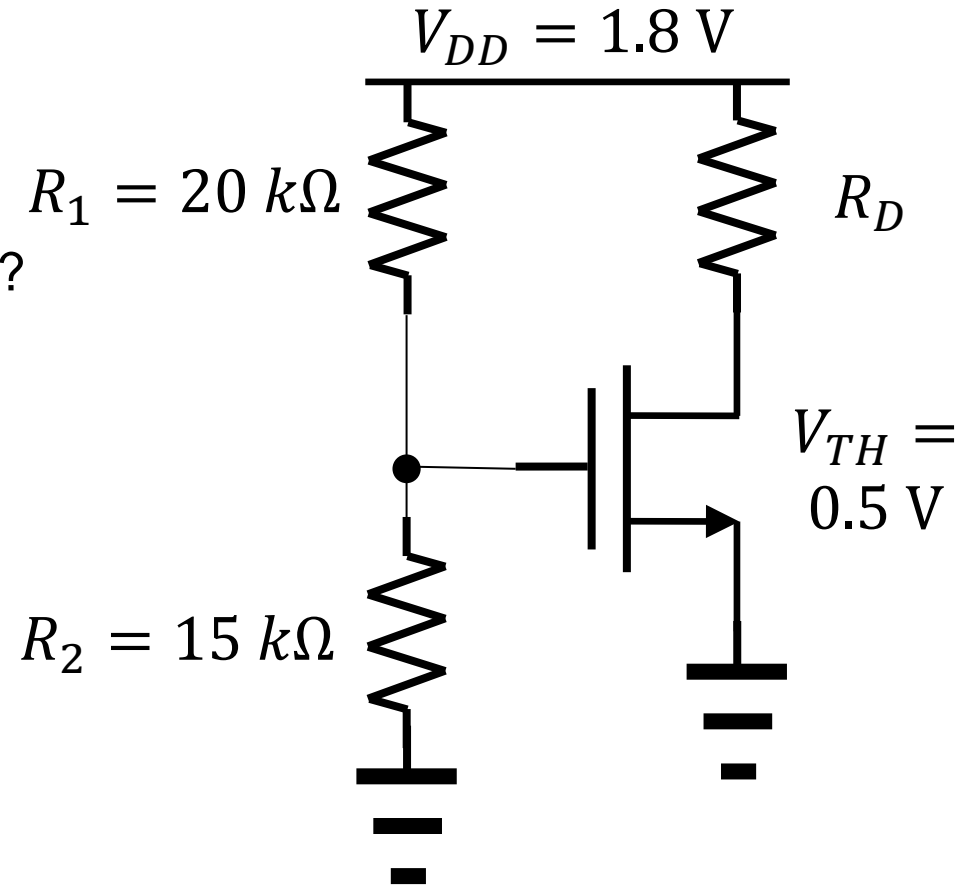 - Caculate the gain and the output impedance.
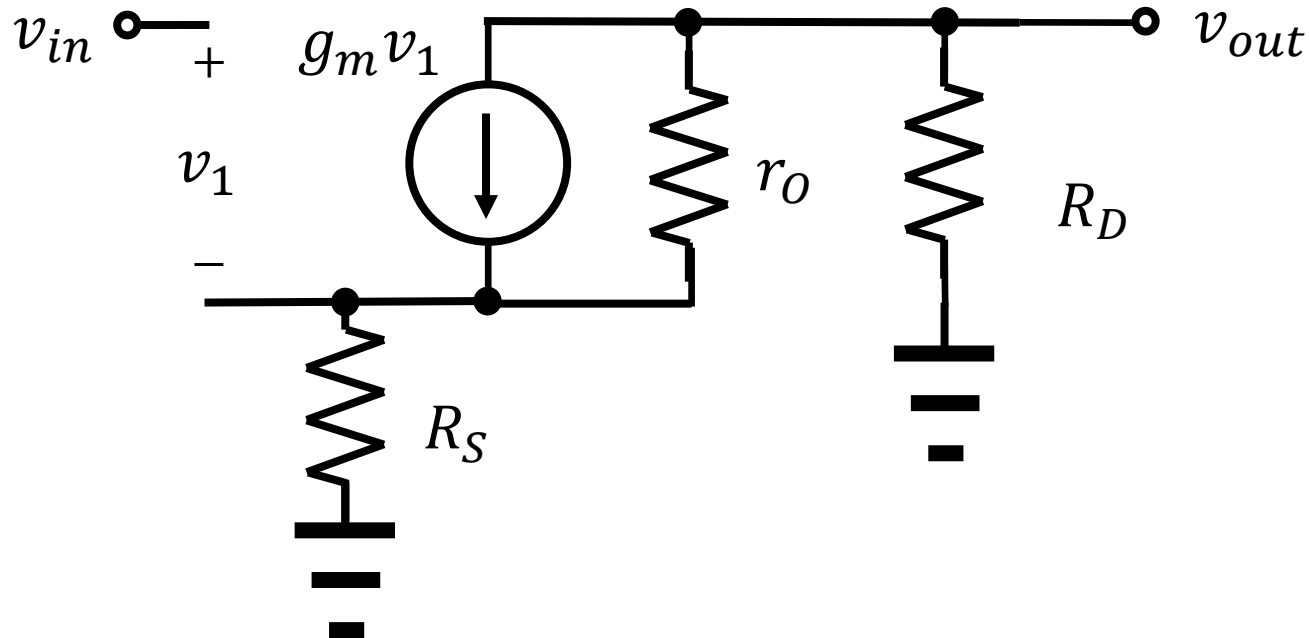
Razavi, example 17.8

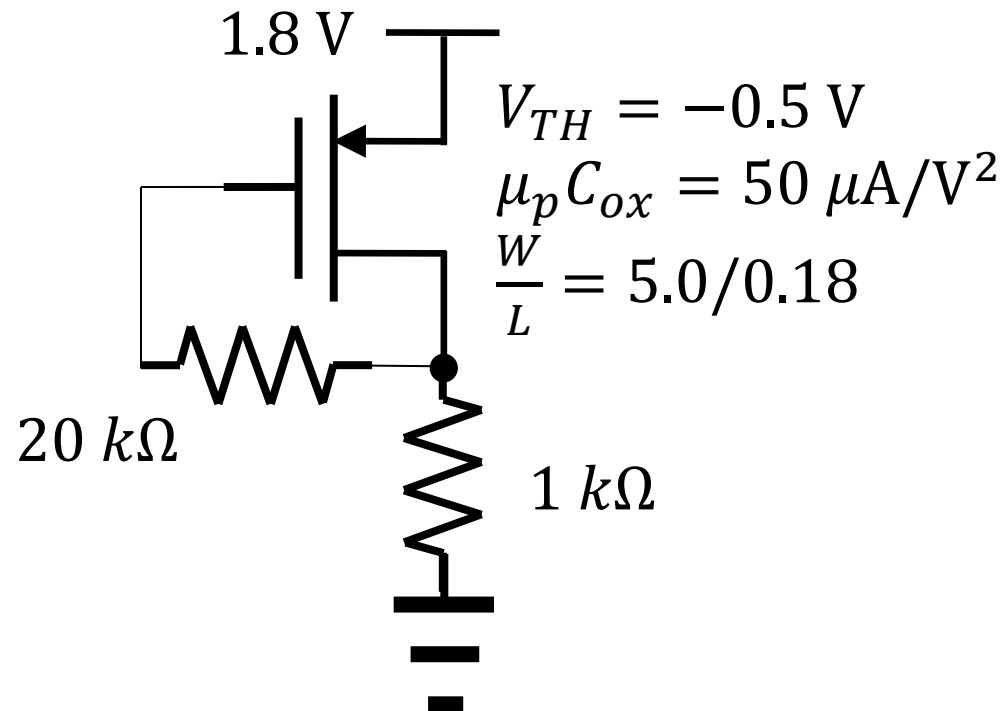- Biasing

  - What is the gate voltage?
  - Condition for saturation mode?

$R_1 = 20\ k\Omega$

R_D

$V_{DD} = 1.8\ \text{V}$

$V_{TH} = 0.5\ \text{V}$

$\mu_n C_{ox} = 100\ \mu\text{A/V}^2$
$W/L = 5/0.18$

$R_2 = 15\ k\Omega$

Razavi, example 17.13

- Calculate the drain current. (BTW, where is the drain?)

$$V_{TH} = -0.5 \text{ V}$$
$$\mu_p C_{ox} = 50 \ \mu\text{A/V}^2$$
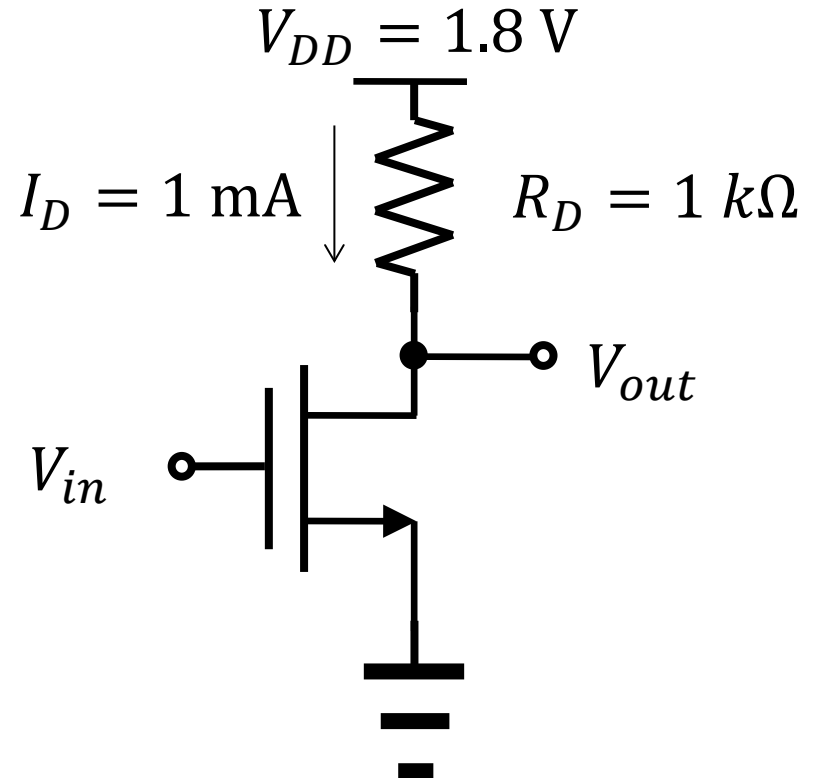$$\frac{W}{L} = 5.0/0.18$$

1.8 V

20 $k\Omega$

1 $k\Omega$

Razavi, example 17.14

- Calculate the gain.
  - The gain is given by $A_v = -g_m R_D$.
  - How can we get the transconductance?

$\mu_n C_{ox} = 100 \ \mu A/V^2$

$V_{TH} = 0.5 \ V$

$W/L = 10/0.18$

$V_{DD} = 1.8 \ V$

$I_D = 1 \ mA$

$R_D = 1 \ k\Omega$

V_{out}

V_{in}

Configurations

- Three terminals of the MOSFET
  - The common terminal, the input terminal, and the output terminal

Source	Gate	Drain	Remark
Common	Input	Output	Common-source amp.
Common	Output	Input	X
Input	Common	Output	It will be covered.
Output	Common	Input	X
Input	Output	Common	X
Output	Input	Common	It will be covered.