Lecture19: Common-source amplifier (3)

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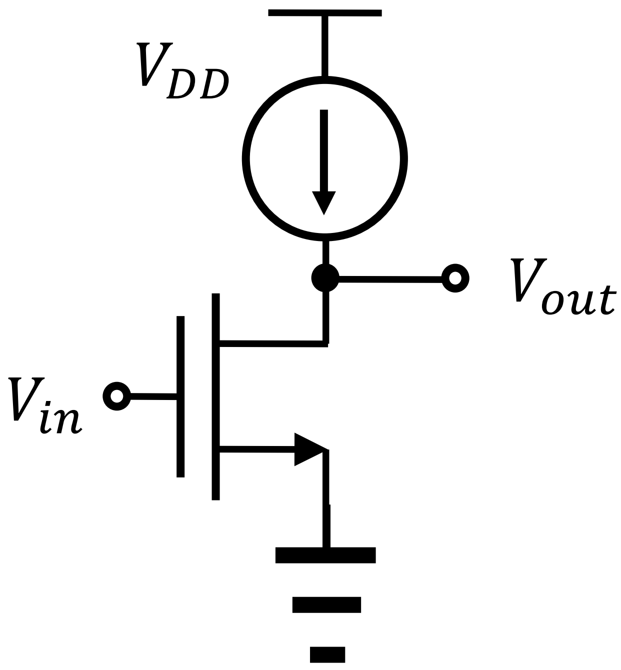
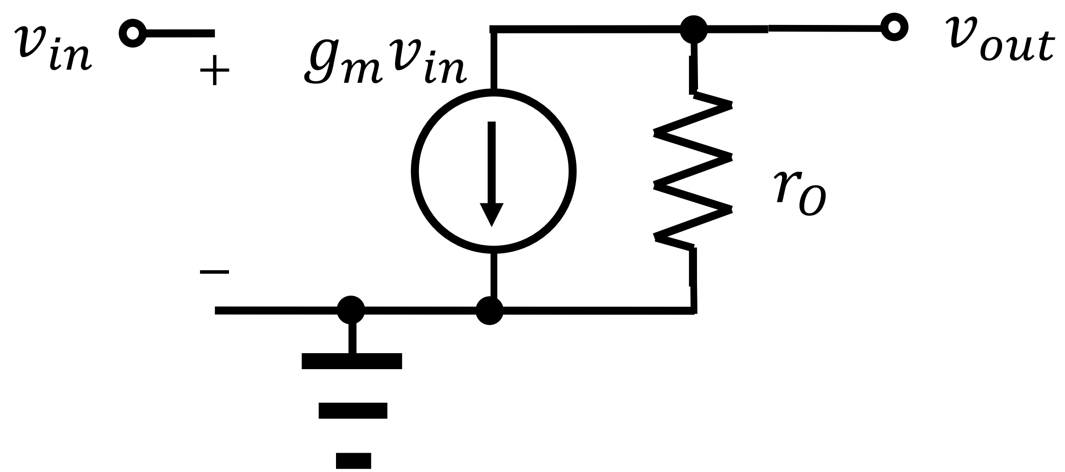
Review of the last lecture

- Why do we consider an active load?
  - A sufficiently large voltage headroom for the DC bias
  - A sufficiently high impedance for the AC current
- When we have R_S,
  - The voltage gain is reduced.

Current-source load

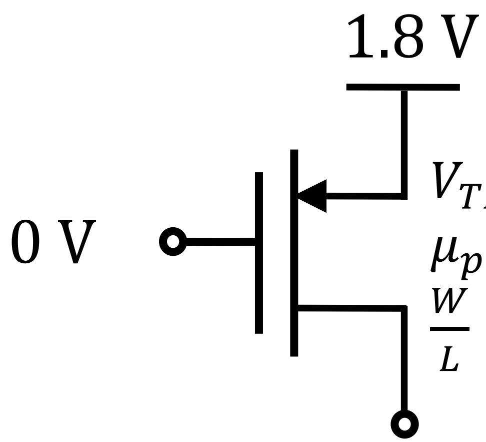
- When $R_D \rightarrow \infty$,
  - The gain can be maximized in its absolute value. ($A_v \rightarrow -g_m r_O$)





Biasing of PMOS devices

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



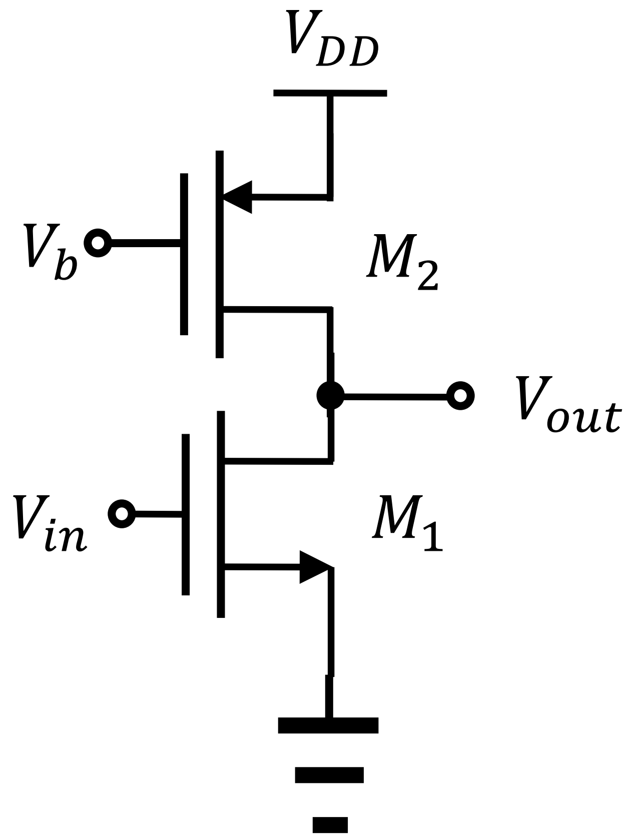
$$V_{TH} = -0.6\ \mathrm{V}$$
$$\mu_p C_{ox} = 75\ \mu\mathrm{A/V^2}$$
$$\frac{W}{L} = 2.0/0.18$$

Real current-source load

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

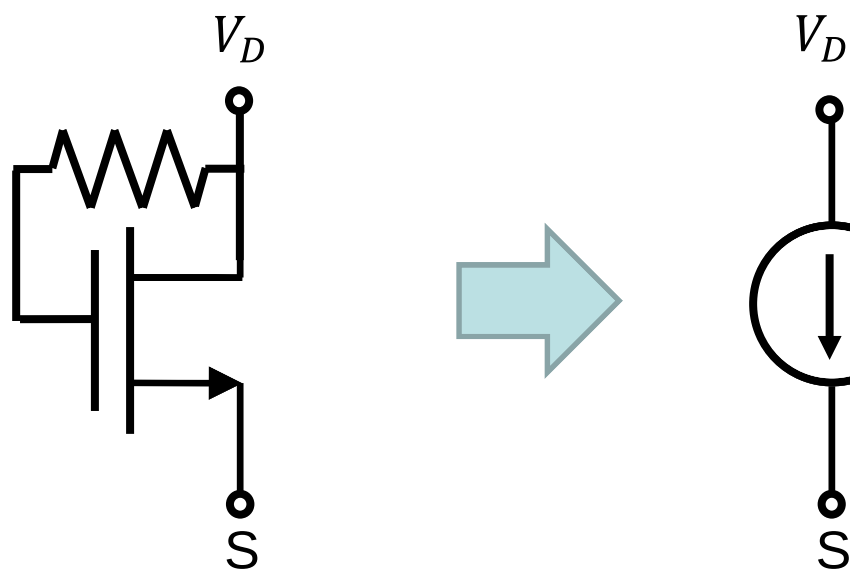
$$v_{out} = -g_{m1}(r_{O1}||r_{O2})v_{in}$$

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



Self-biasing

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



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

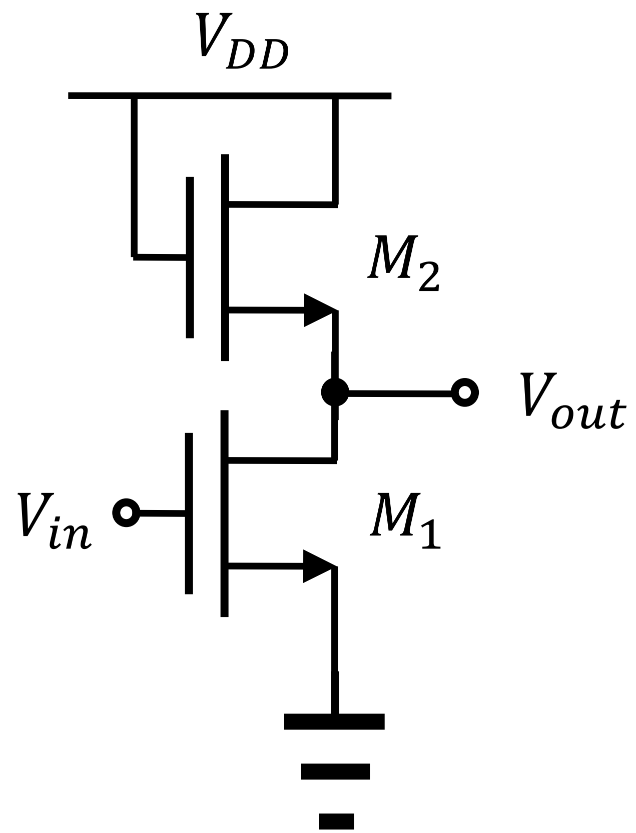
Gate and drain are tied.

Diode-connected load

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

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

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

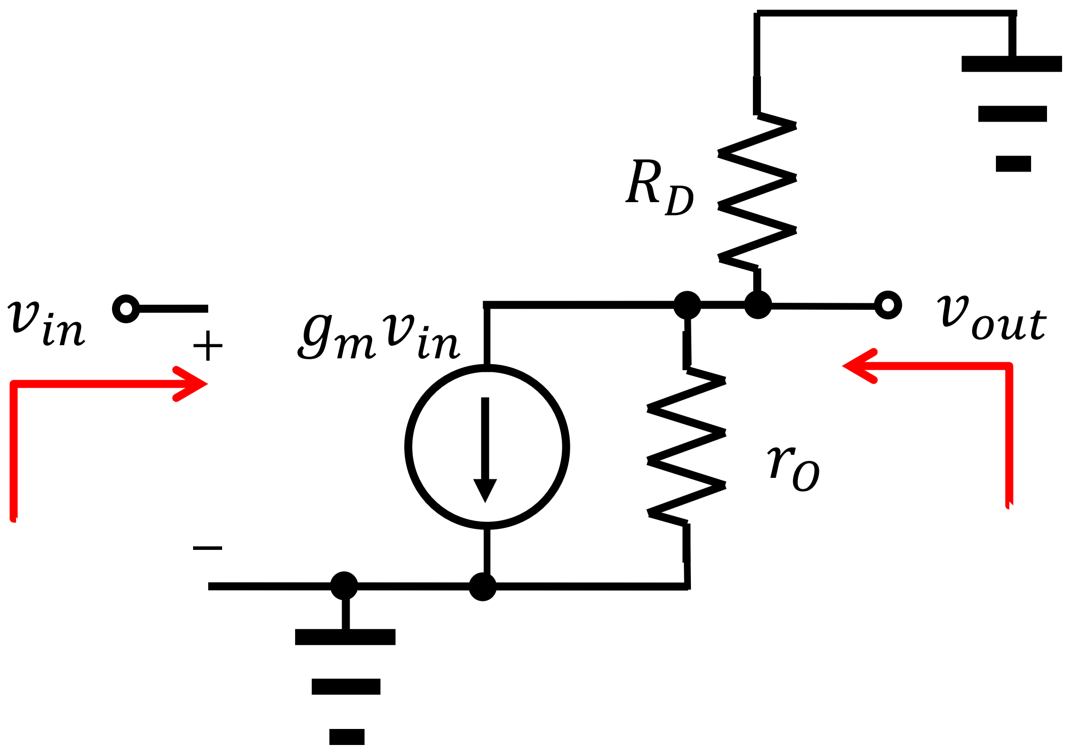


Input/output impedances

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

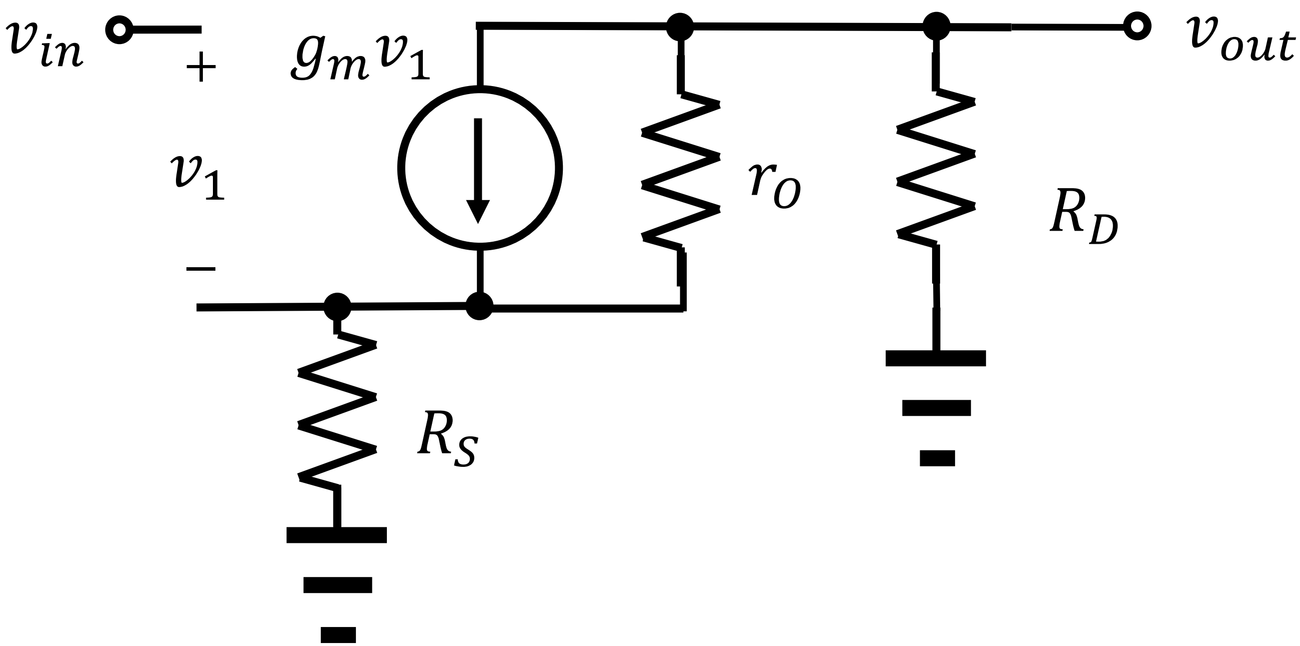
$R_{in} = \infty$

$R_{out} = R_D || r_O$



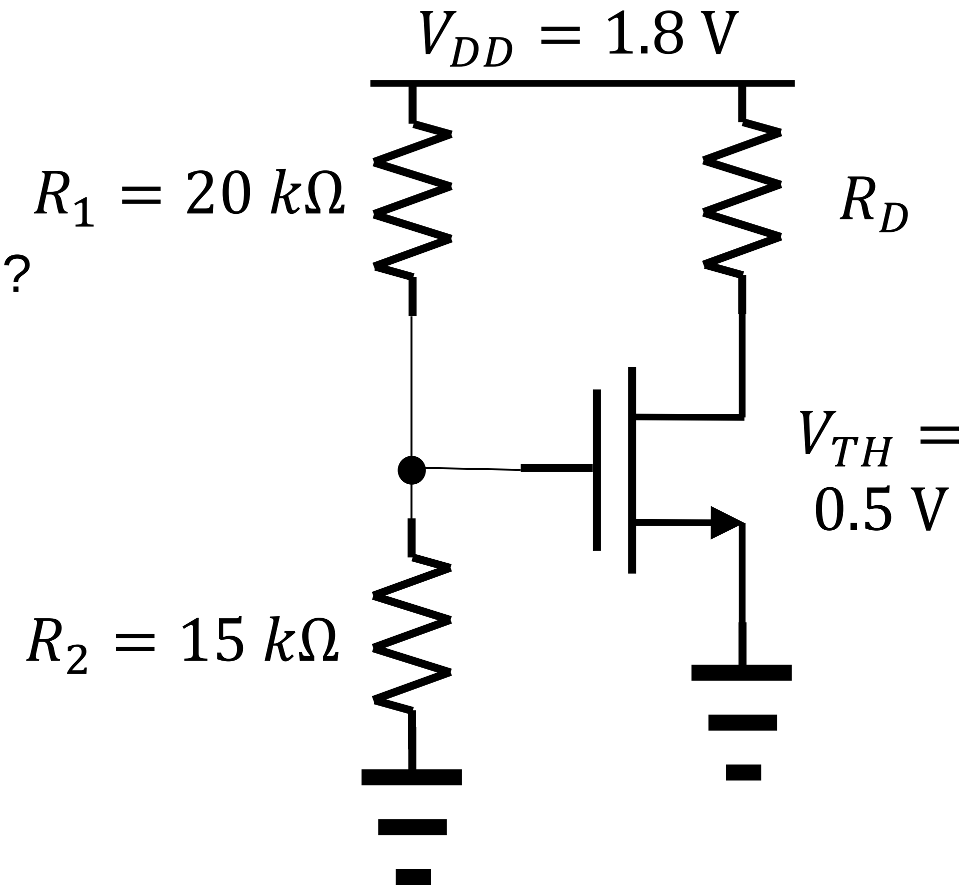
Source degeneration

- 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?



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

Razavi, example 17.13

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