

Lesson 30: Common-Source Stage 1

youtube: Lec 35 34min to end, Lec 36 ~25min

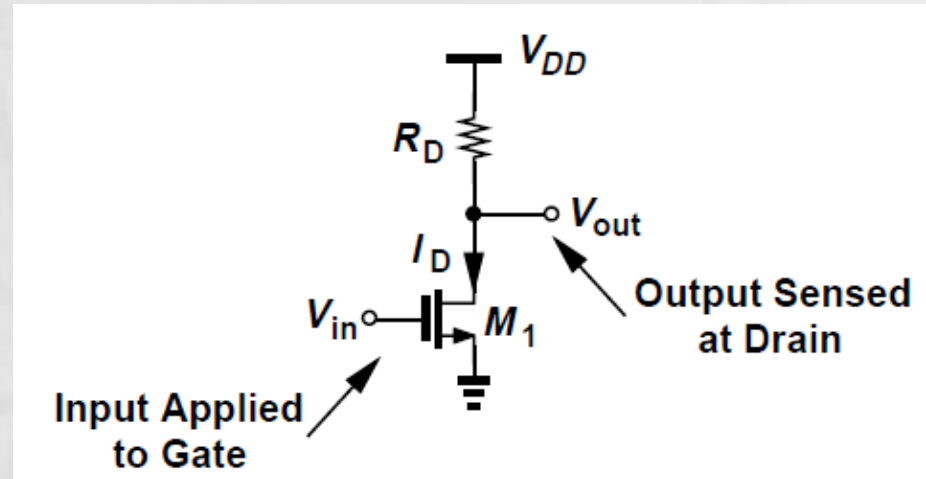
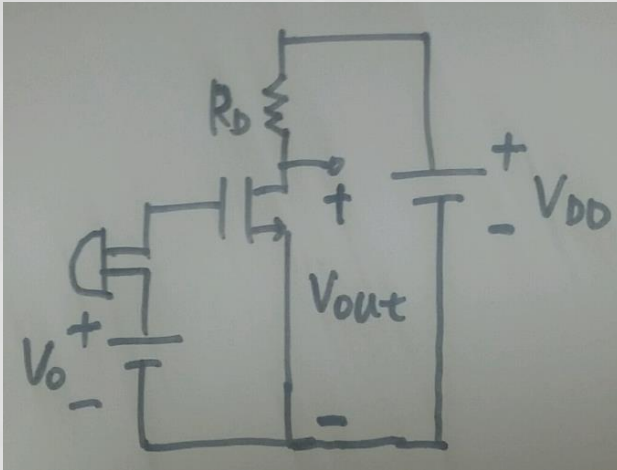
2013144084 장필재

CMOS Amplifiers

- Like BJT, CMOS has
 - 1) common-source(CS) stage
 - 2) common-gate(CG) stage
 - 3) source follower

Common-source stage

- CS Topology

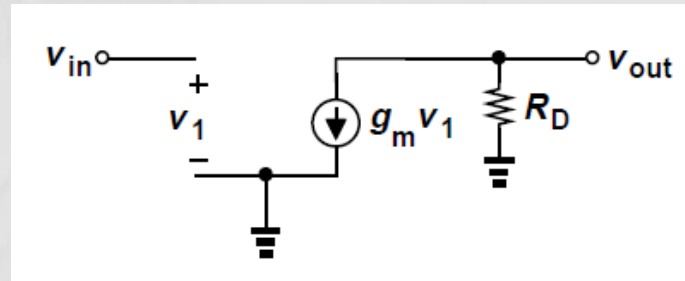


<simplification of circuit>

* V_{out} 's another node is connected to ground.

Common-source stage

- Small signal model



- To get gain

$$v_{in} = v_1$$

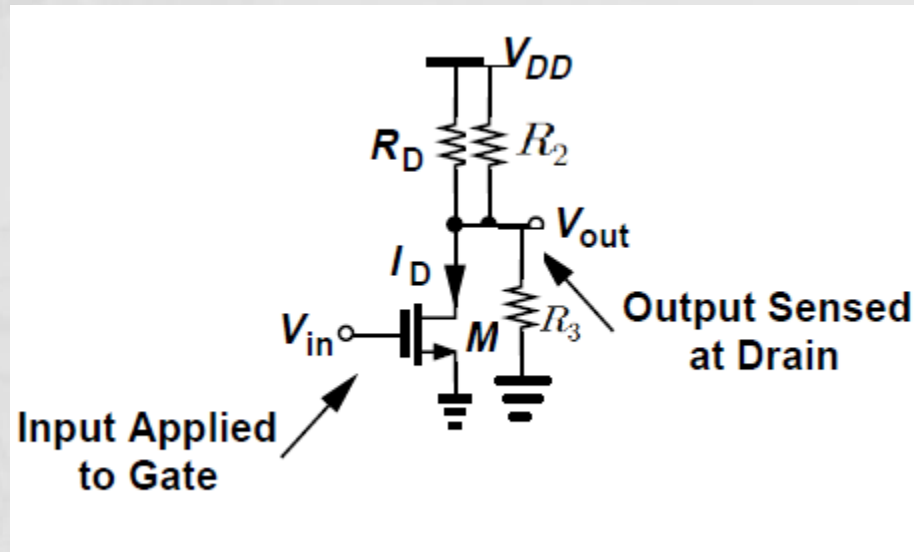
KCL at output node :

$$g_m v_{in} + \frac{v_{out}}{R_D} = 0$$

$$\text{Thus, we get } A_v = \frac{v_{out}}{v_{in}} = -g_m R_D$$

Common-source stage

- If another resistors are parallel to R_D in small signal model



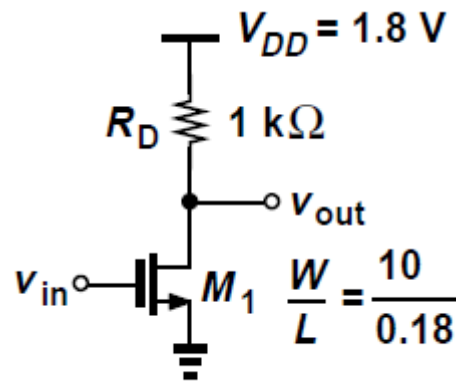
$$A_v = -g_m [R_D \parallel R_2 \parallel R_3]$$

$$A_v = -g_m (\text{total Resistance tied from drain to ground})$$

Common-source stage

● Example

Calculate the small-signal voltage gain of the CS stage. If $I_D = 1 \text{ mA}$, $\mu_n C_{ox} = 100 \mu\text{A}/\text{V}^2$, $V_{TH} = 0.5 \text{ V}$, and $\lambda = 0$.



1) calculate gain

$$g_m = \sqrt{2\mu_n C_{ox} \frac{W}{L} I_D}$$

$$A_v = -g_m R_D$$

2) check whether it is saturated

$$V_{GS} = V_{TH} + \sqrt{\frac{2I_D}{\mu_n C_{ox} \frac{W}{L}}} = 1.1 \text{ V.}$$

$$V_{DS} = V_{DD} - R_D I_D = 0.8 \text{ V}$$

$$V_{GS} - V_{TH} = 0.6 \text{ V.}$$

$$V_{GS} - V_{TH} < V_{DS} \therefore \text{saturated}$$

Thank you for listening