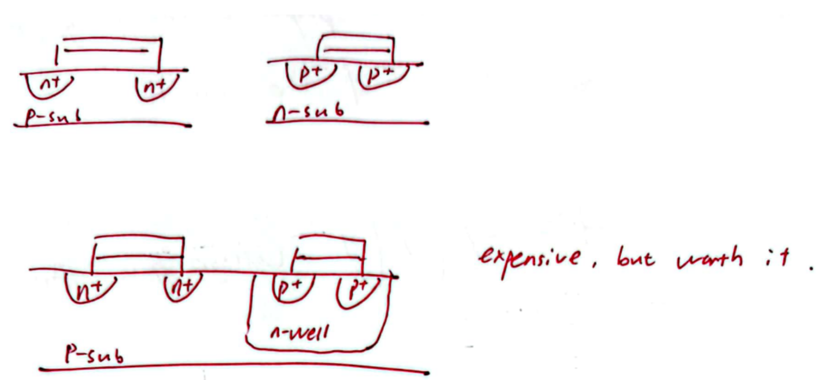
Common-Source Stage I

zrrraa

2023.11.18

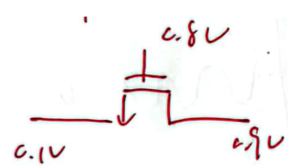
CMOS Technology



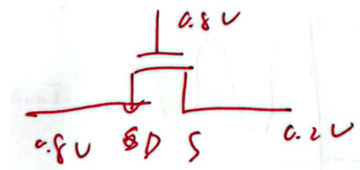
In the 1960s, it was thought that only NMOS would be sufficient because the cost of manufacturing PMOS on a P-type substrate was too high. But with the development of the times, people have discovered that the performance of the combination of PMOS and NMOS is very good, which cannot be achieved with NMOS alone.

Judgment of the MOS's working status

Assume that $V_{THN} = 0.5V$, $V_{THP} = -0.6V$.

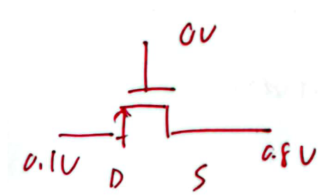


NMOS, $0.8 - 0.9 < 0.5$, SAT.



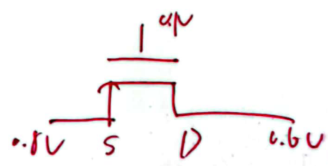
The arrow only indicates the N/PMOS, but not the D/S. NMOS has a current flowing from D to S. So here the left is D, the right is S.

NMOS, $0.8 - 0.8 < 0.5$, SAT.



In the same way, this PMOS's left is Drain and the right is Source.

PMOS, $0.1V - 0V < |-0.6V|$, SAT.



PMOS, $0.6V - 0.1V < |-0.6V|$, SAT.

CMOS Amplifiers

Amp design procedure

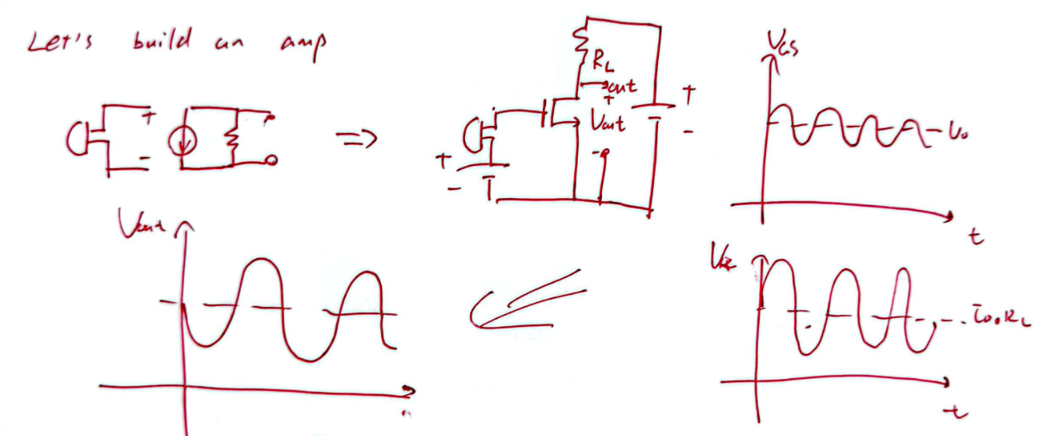
- select an amp topdogy
- Bias the transistor(s) to obtain proper values for g_m, r_o
- Determine the characteristics of the circuit

Amp Characteristics

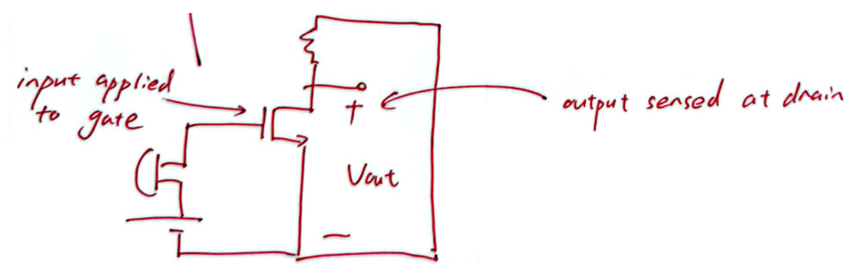
- Gain, usually referred as A_v
- Power dissipation, etc.

Let's build an amp

The process is the same as what we talked about before.

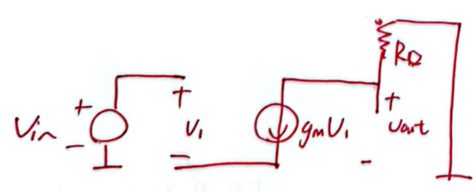


However, here we pick the V_{DS} as the V_{out}. This way the amp we build is related to MOS but not the resistor.



$V_{out} + V_{R_L} = V_2$, So V_{out} is negatively related to the V_{in}.

Let's look at its small-signal model.



The amp's small-signal model

$$V_{in} = V_1$$

$$\frac{V_out}{R_D} + g_m V_1 = 0$$

In this way we can derive:

$$\frac{V_{out}}{V_{in}} = -g_m R_D$$

Link

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