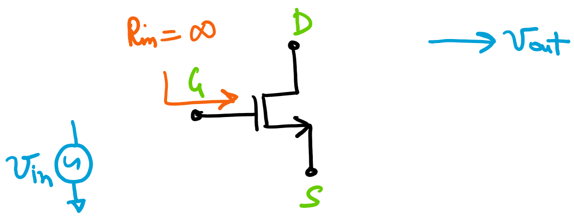
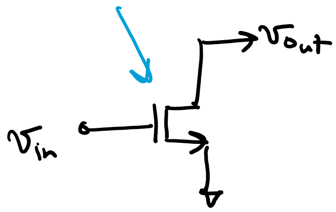
ECE310 - Lecture 22

Wednesday, March 7, 2018 10:31 AM

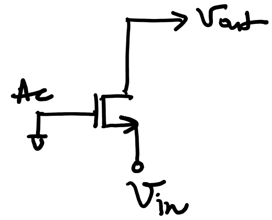
$^3C_2 = \frac{3\cdot 2}{1\cdot 2} = 3$

* Small signal analysis

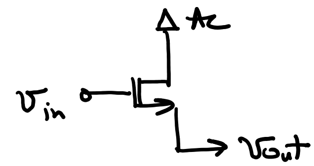




Common-source (CS)



Common-gate (CG)

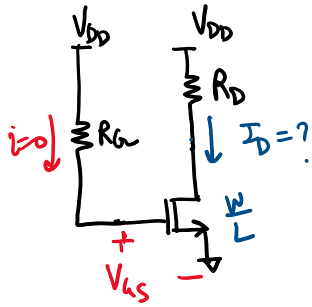


Common-Drain (Source-follower) (SF)

Wednesday, March 7, 2018 10:39 AM

Common Source Amplifier (stage)

$V_{DD} = 1.8\,V$
180nm CMOS



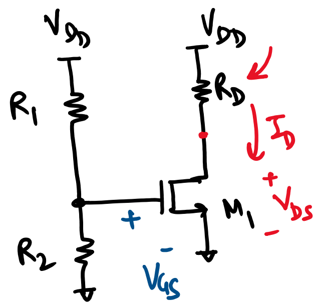
$V_{GS} = V_{DD}$

$\lambda \approx 0$

SAT: $I_D = \frac{1}{2} k'_n \frac{W}{L} (V_{GS} - V_{THN})^2$

$V_{GS} \rightarrow V_{DD}$

3-R biasing



$$V_{GS} = \frac{R_2}{R_1+R_2} V_{DD}$$

for M_1 in SAT

$$I_D = \frac{1}{2} k'_n \frac{W}{L} \left[V_{DD} \cdot \frac{R_2}{R_1+R_2} - V_{THN} \right]^2$$

with proper choice of $\frac{W}{L}$, R_2, R_1 & R_2 we can set a desired I_D.

To keep M_1 in SAT:

$$V_{DS} \geq \underbrace{V_{GS} - V_{THN}}_{V_{DS,sat}}$$

$$V_{DD} - I_D \cdot R_D \geq \frac{R_2}{R_1+R_2} V_{DD} - V_{THN}$$ ← Satisfy this to keep M_1 in SAT

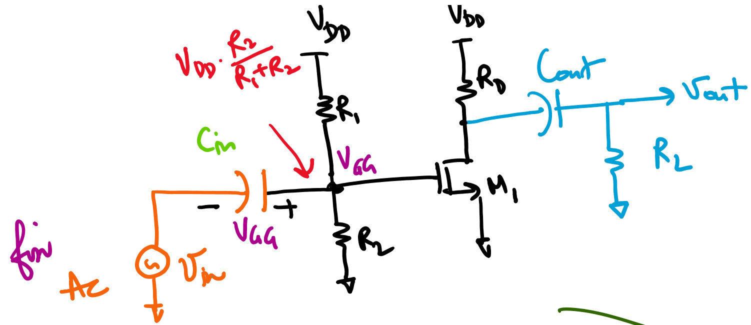
$$I_D R_D \leq -\frac{R_2}{R_1+R_2} V_{DD} + V_{DD} + V_{THN}$$

$$\Rightarrow \quad I_D R_D \leq V_{DD} \left(\frac{R_1}{R_1+R_2} \right) + V_{THN}$$

$I_D \uparrow$

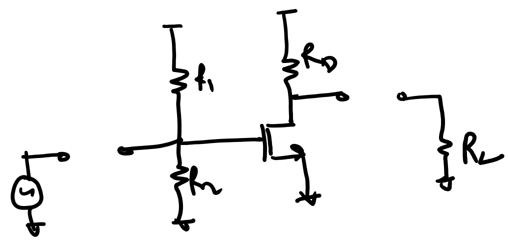
$$V_{GG} = \frac{R_2}{R_1+R_2} V_{DD}$$

$C_{in} \Rightarrow$ DC Blocking

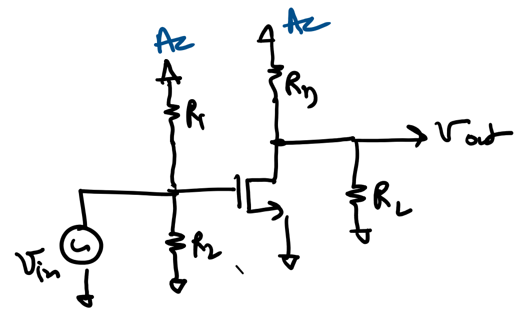


$C_{in} \Rightarrow$ { Dc Blocking, Ac coupling, Capacitive Coupling }

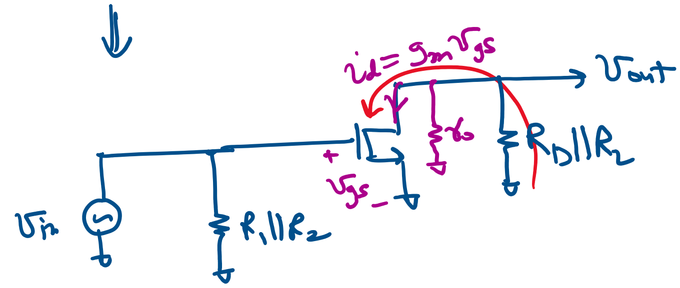
Dc picture



Ac picture



"lumping"



$$v_{out} = -g_m \overset{v_{in}}{v_{gs}} \cdot (r_o \| R_D \| R_L)$$

$$v_{out} = -g_m v_{in} (r_o \| R_D \| R_L)$$

$$A_v = \frac{v_{out}}{v_{in}} = -g_m (r_o \| R_D \| R_L)$$

$r_o \gg R_D \| R_L$

$$-g_m (R_D \| R_L)$$

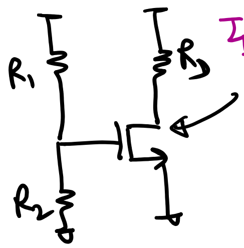
See Book Examples

17.5, 6 & 7 for numerical Examples.

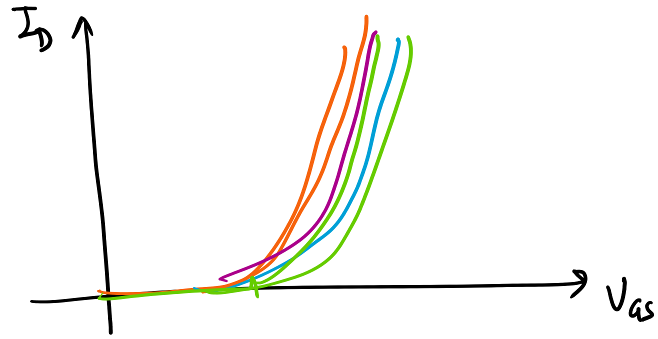
$$\tau = R_{eq} C > \frac{10}{f_{in}} \Leftarrow$$

Bias RC time constant > 10x input time-constant

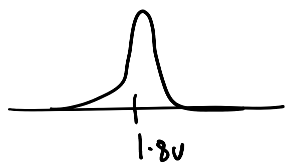
Wednesday, March 7, 2018 11:04 AM



$I_D = ?$



V_{THN}

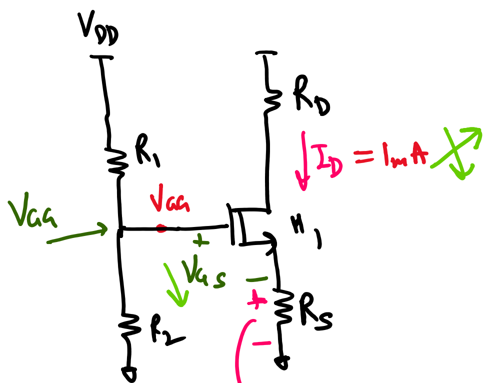


Biasing is sensitive to MOSFET parameter variations

↳ $\underline{\underline{V_{THN}}}$

× Need to desensitize I_D to variations in V_{THN}.

"4-R Biasing" ⇒ Source Degeneration



$$V_{GG} = \frac{R_2}{R_1+R_2} V_{DD} = V_{GS} + \underbrace{I_D R_S}_{\text{large part of } V_{GG} \text{ is dropped across } R_S}$$

precise

$$I_D = \frac{1}{2} KP_n \frac{W}{L} (V_{GS} - V_{THN})^2$$

$0.35 \downarrow 0.3V$

$I_D R_S \downarrow$

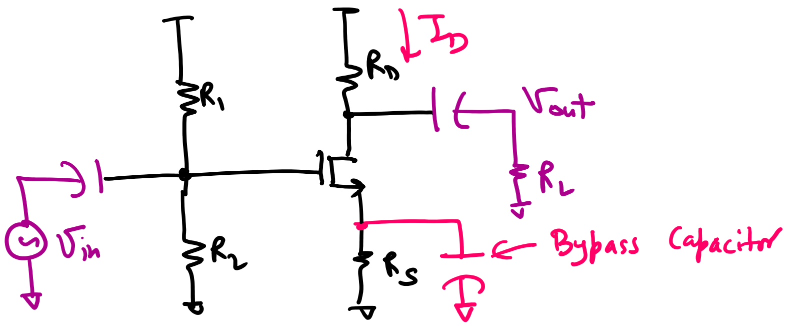
$V_{THN} = \cancel{0.35}\ V$

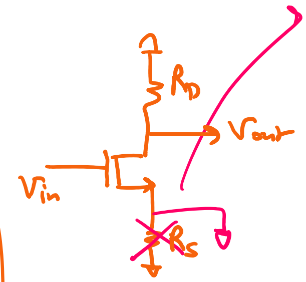
$V_{THN} = 0.3V$

Negative feedback stabilizes I_D & V_{GS} & V_{DS} in this circuit

$$\Delta V_{THN} \Rightarrow \frac{\Delta I_D}{1 + g_m R_S}$$

$-g_m R_D$





$$V_{DS} = V_{DD} - I_D(R_D + R_S) \longleftrightarrow I_D = \frac{1}{2} k_n' \frac{W}{L}(V_{GS} - V_{Th})^2$$

$$V_{GS} = \frac{R_2}{R_1 + R_2} V_{DD} - I_D R_S$$

$$A_v \simeq -\frac{g_m R_D}{1 + g_m R_S}$$

$$\simeq -\frac{R_D}{R_S}$$

Do Both Ex. 17.9, 10

Simple Biasing