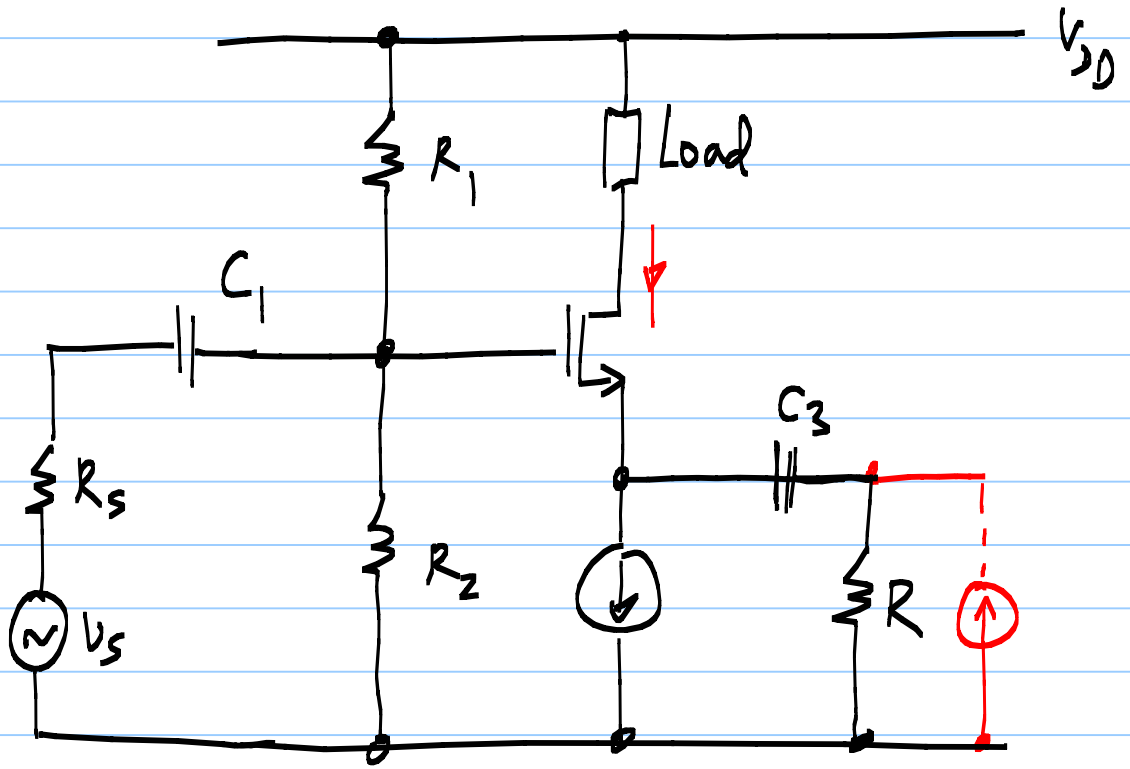
Lecture 26



Opamp: VCVS

CCVS

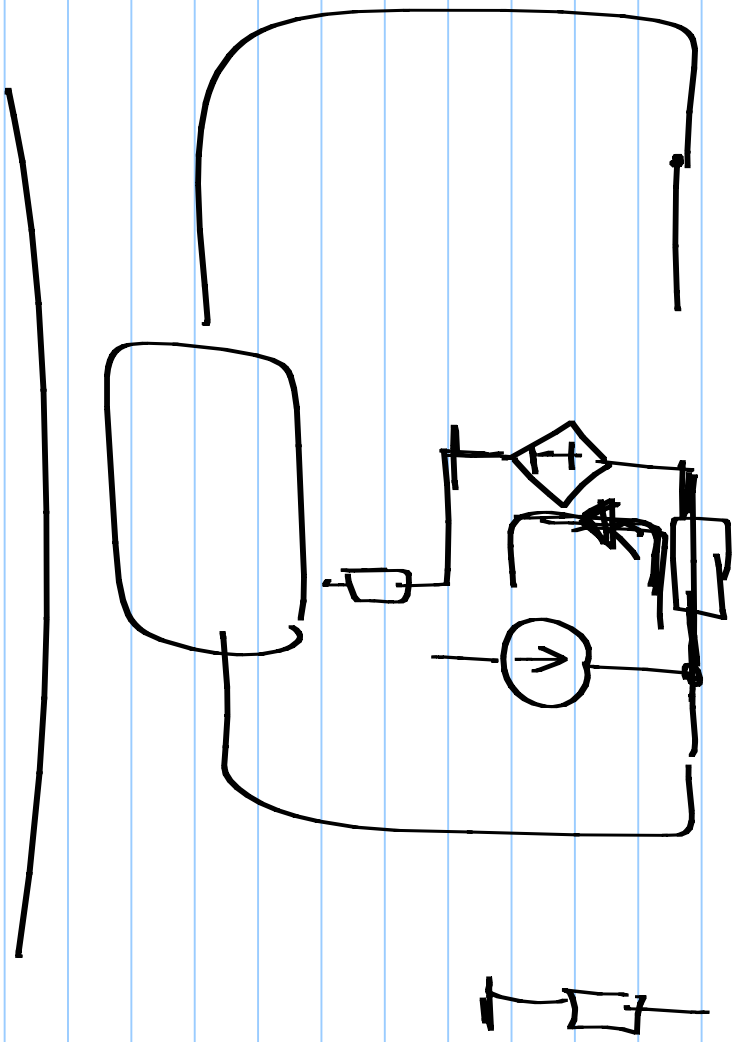
Transistor: VCVS k=1

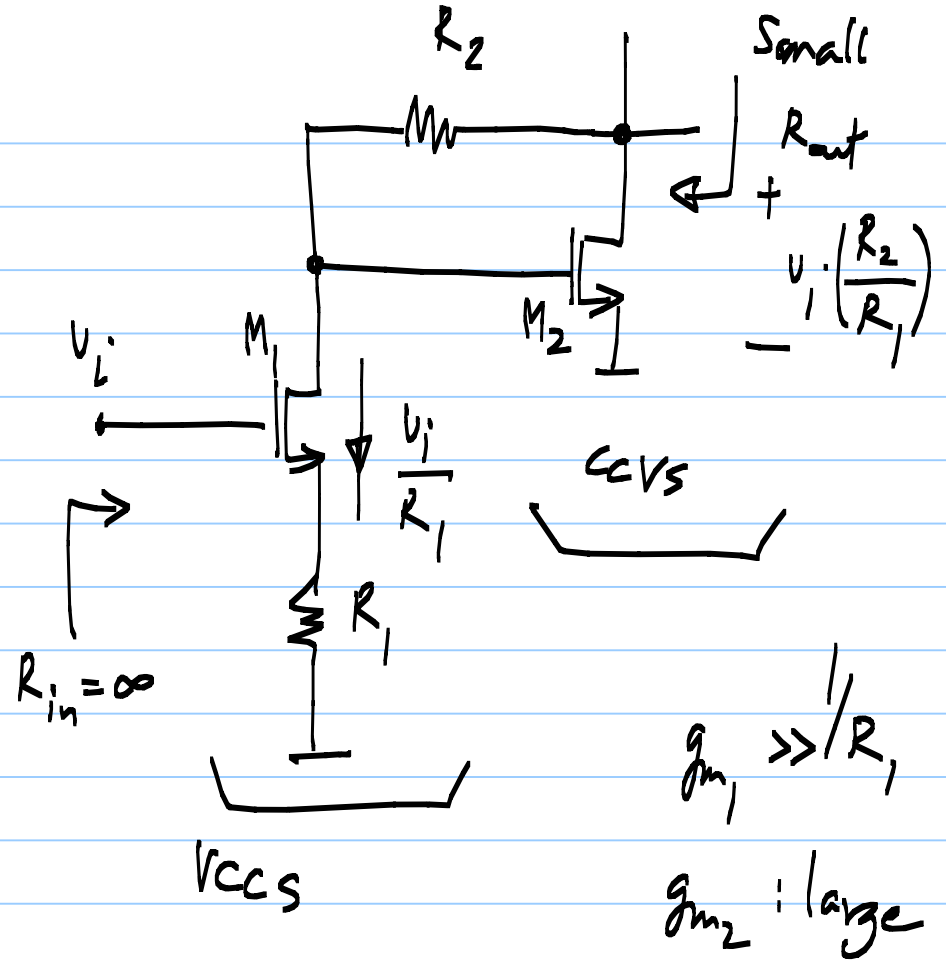
CCVS

VCCS

CCCS k=1

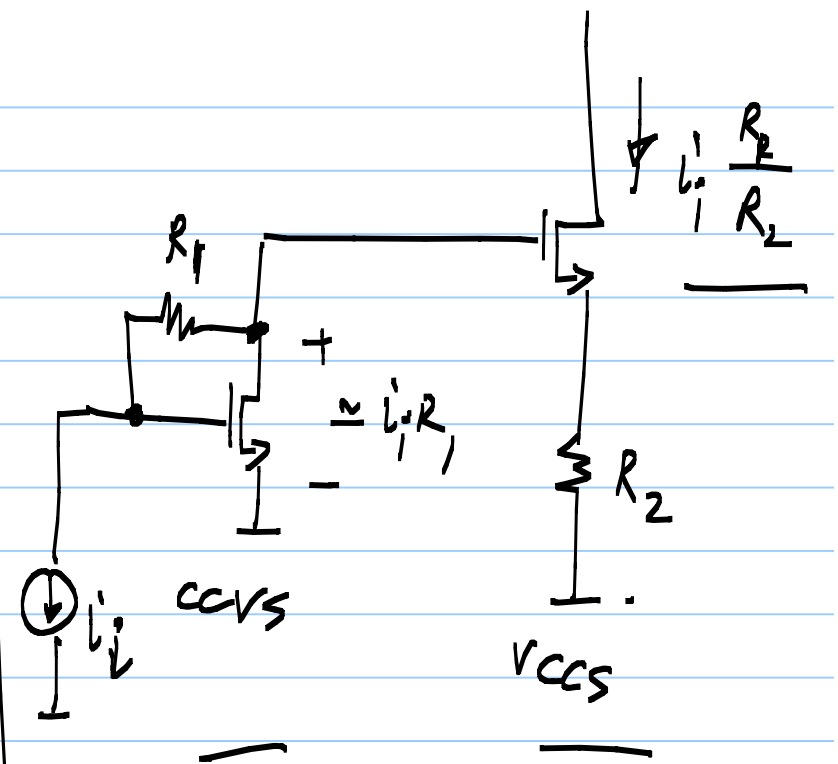
Example: one terminal of the source is grounded

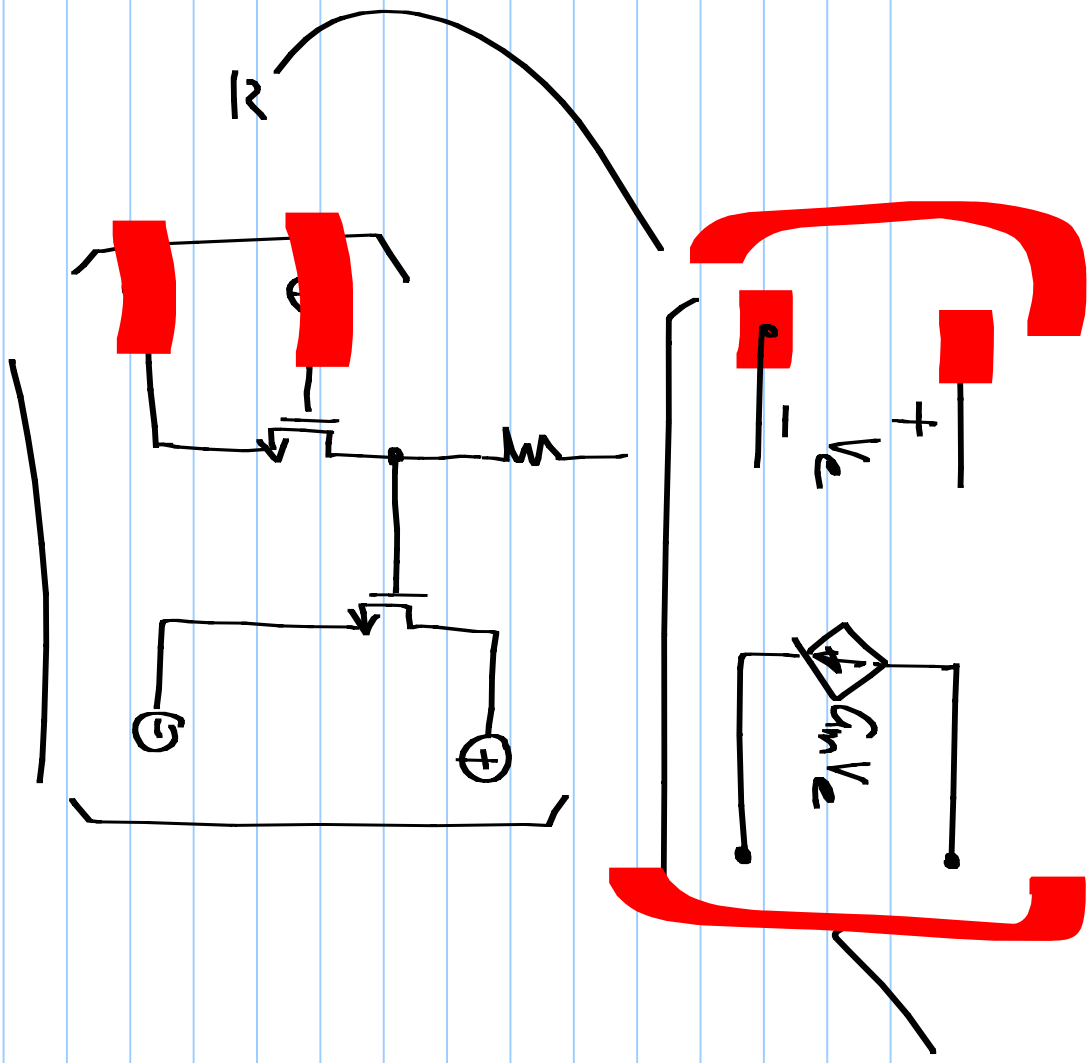


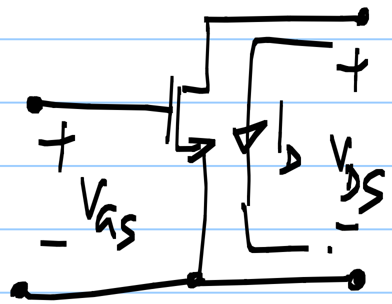


$g_{m_1} \gg 1/R_1$

g_{m_2} : large




R
-
+
V_e
$g_m V_e$



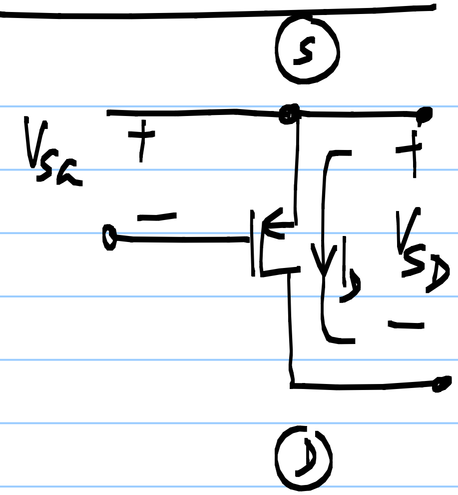
$V_{GS} > 0$

$V_{DS} > 0$

$I_D > 0$ (drain to source)

pMos transistor

I_D : source to drain

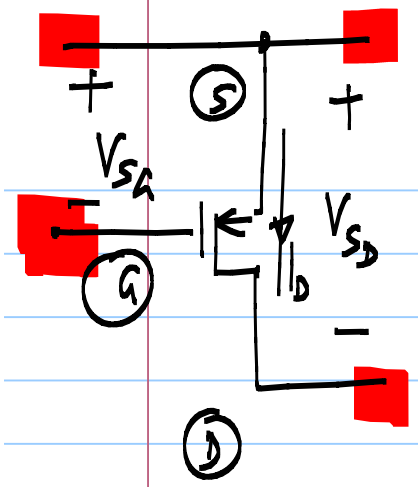


$V_{SG} \geq 0$, $V_{SD} \geq 0$; $V_{Tp} > 0$

$I_D = 0$ $\quad V_{SG} < V_{Tp}$

Triode/linear $\quad \mu_p C_{ox} \frac{W}{L}\left[(V_{SG} - V_{Tp}) V_{SD} - \frac{V_{SD}^2}{2}\right]$ $\quad V_{SG} > V_{Tp}$, $V_{SD} < V_{SG} - V_{Tp}$

$\frac{\mu_p C_{ox}}{2} \frac{W}{L} (V_{SG} - V_{Tp})^2$ $\quad V_{SG} > V_{Tp}$, $V_{SD} > V_{SG} - V_{Tp}$



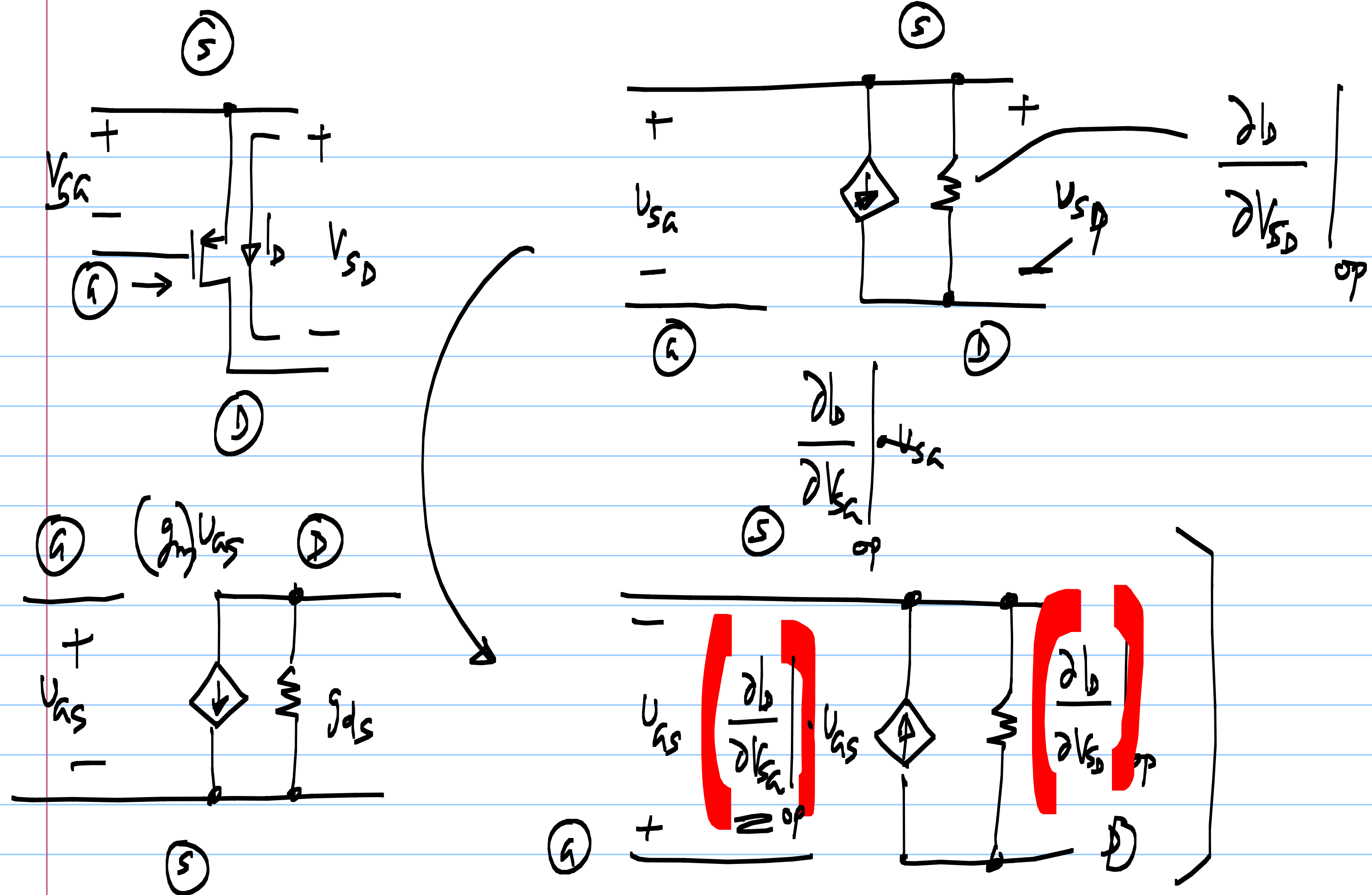
$I_D = 0$ $\quad V_{SG} < V_{TP}$

Triode/linear: $\mu_p C_{ox} \frac{W}{L}\left[(V_{SG} - V_{TP})V_{SD} - \frac{V_{SD}^2}{2}\right]$ $\quad V_{SG} > V_{TP}$, $V_{SD} < V_{SG} - V_{TP}$

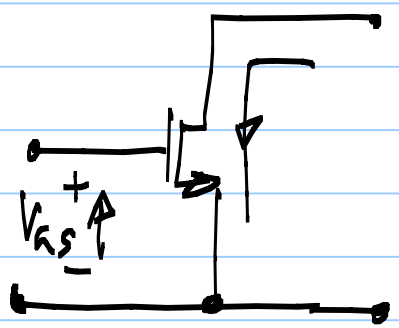
(Saturation) $\frac{\mu_p C_{ox}}{2} \frac{W}{L}(V_{SG} - V_{TP})^2$ $\quad V_{SG} > V_{TP}$, $V_{SD} > V_{SG} - V_{TP}$

$\frac{\mu_p C_{ox}}{2} \frac{W}{L}(V_{SG} - V_{TP})^2(1 + \lambda_p V_{SD})$

V_{GS}, V_{DS}


S
G
D
I_D
V_SG
V_SD
g_m U_GS
g_ds
U_GS
U_SG
V_SD
op

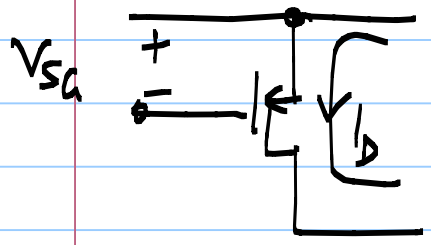
nMOS: +ve increment v_{GS} $\Rightarrow$ V_{GS} increases



I_D (going into the drain) increases

$\Rightarrow$ +ve incremental current into the drain

pMOS: +ve increment v_{GS} $\Rightarrow$ V_{SG} decreases



I_D (coming out of the drain) decreases

$\Rightarrow$ +ve incremental current into the drain