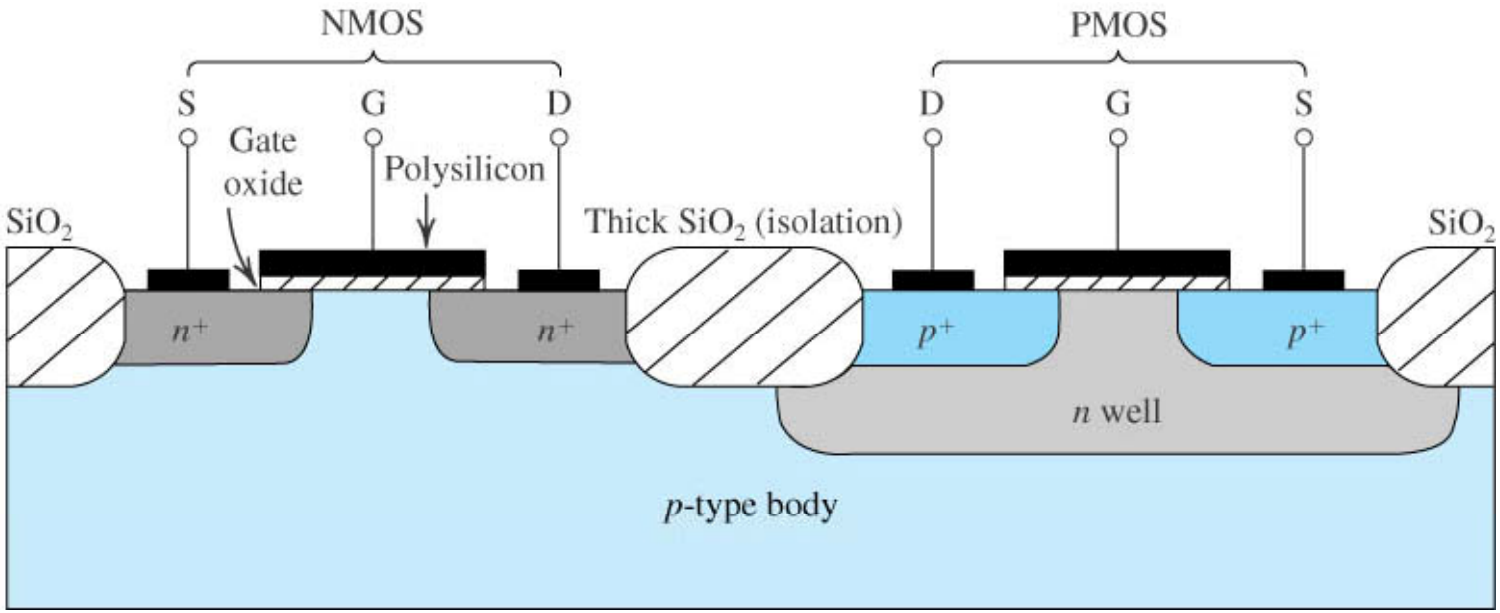
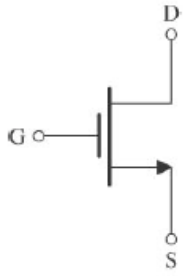
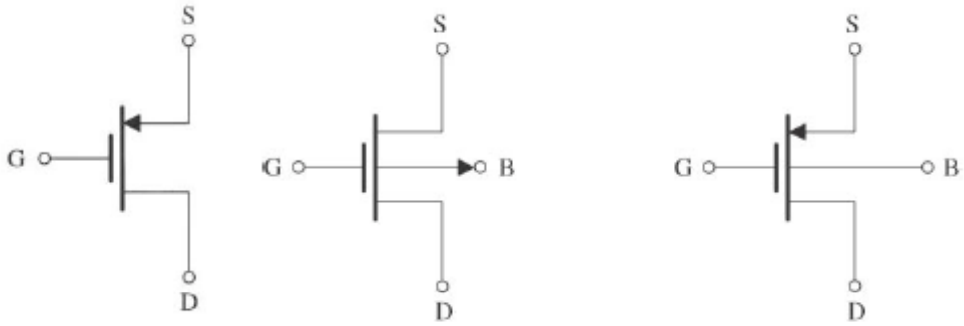
Lect. 20: PMOS



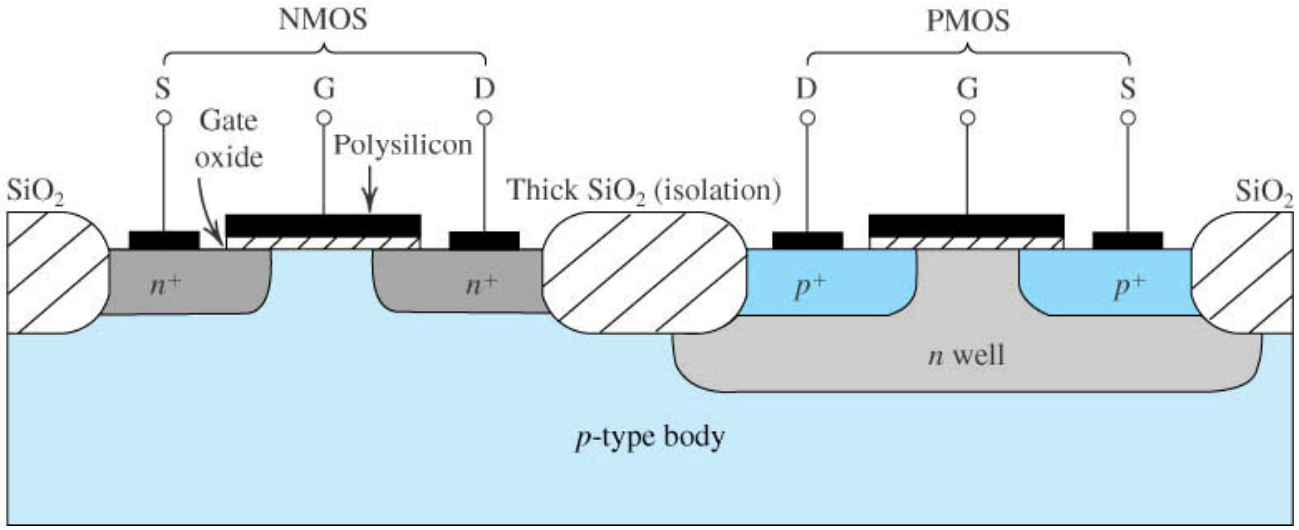
NMOS: electrons flow from Source to Drain

PMOS: holes flow from Source to Drain

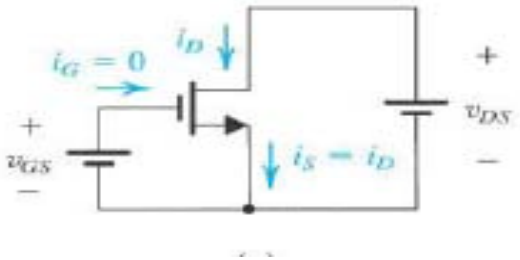




Lect. 20: PMOS

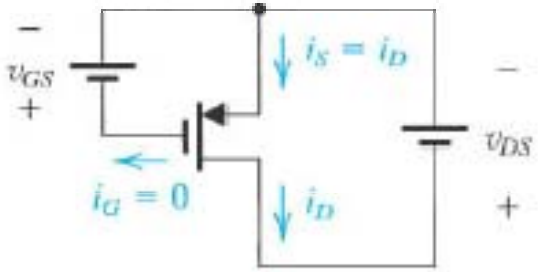


NMOS



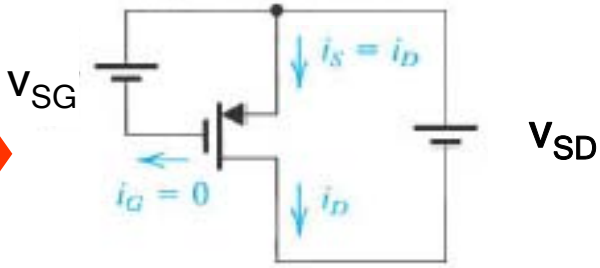
v_{GS}>0 and v_{DS}>0

PMOS



v_{GS}<0 and v_{DS}<0

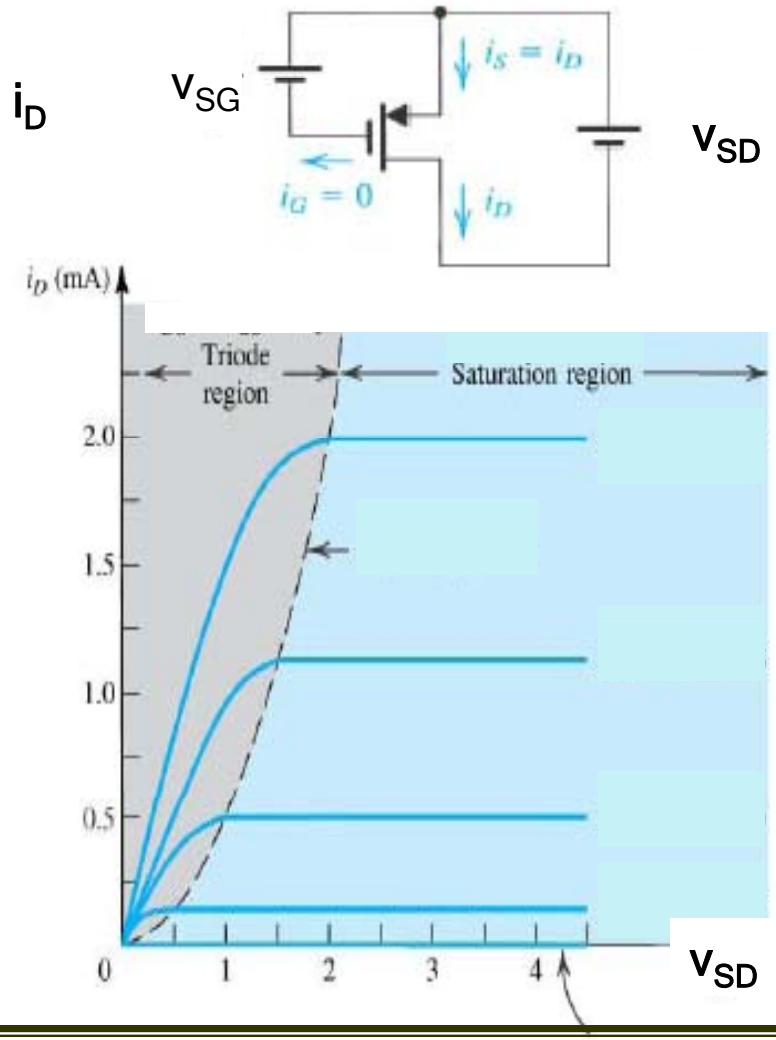
PMOS



v_{SG}>0 and v_{SD}>0

Lect. 20: PMOS

PMOS



$$v_{SG} < |V_t| : \; i_D = 0$$

$$v_{SG} > |V_t| \text{ and } v_{SD} < v_{SG} - |V_t| \text{ (triode)} :$$

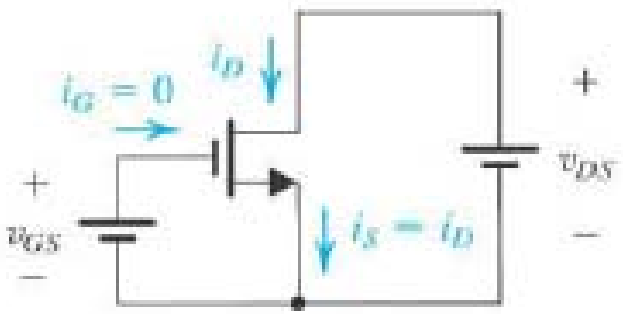
$$i_D = \mu_p C_{ox} \frac{W}{L}\left[(v_{SG} - |V_t|) \cdot v_{SD} - \frac{1}{2} {v_{SD}}^2\right]$$

$$v_{SG} > |V_t| \text{ and } v_{SD} > v_{SG} - |V_t| \text{ (saturation):}$$

$$i_D = \frac{1}{2} \mu_p C_{ox} \frac{W}{L} (v_{SG} - |V_t|)^2$$

Lect. 20: PMOS

NMOS



$v_{GS} < V_t : \; i_D = 0$

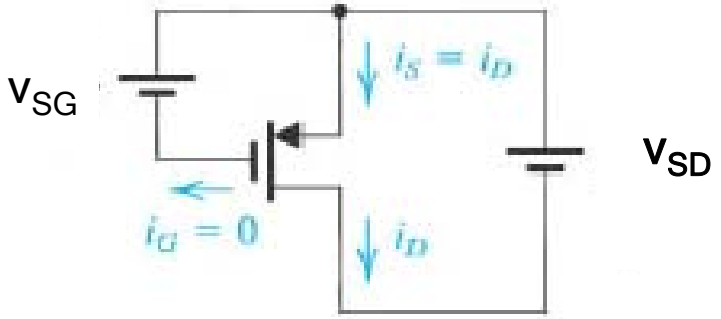
$v_{GS} > V_t$ and $v_{DS} < v_{GS} - V_t$ (triode) :

$$i_D = \mu_n C_{ox} \frac{W}{L}\left[(v_{GS} - V_t)\cdot v_{DS} - \frac{1}{2} {v_{DS}}^2\right]$$

$v_{GS} > V_t$ and $v_{DS} > v_{GS} - V_t$ (saturation):

$$i_D = \frac{1}{2}\mu_n C_{ox} \frac{W}{L}(v_{GS} - V_t)^2$$

PMOS



$v_{SG} < |V_t| : \; i_D = 0$

$v_{SG} > |V_t|$ and $v_{SD} < v_{SG} - |V_t|$ (triode) :

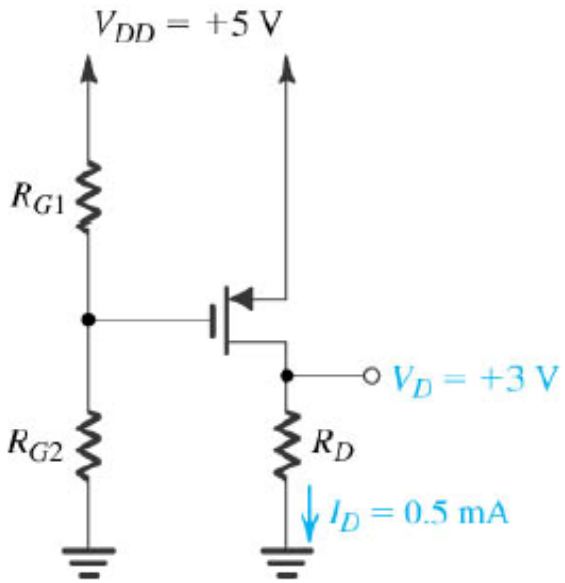
$$i_D = \mu_p C_{ox} \frac{W}{L}\left[(v_{SG} - |V_t|)\cdot v_{SD} - \frac{1}{2} {v_{SD}}^2\right]$$

$v_{SG} > |V_t|$ and $v_{SD} > v_{SG} - |V_t|$ (saturation):

$$i_D = \frac{1}{2}\mu_p C_{ox} \frac{W}{L}(v_{SG} - |V_t|)^2$$

Lect. 20: PMOS

Example 4.6

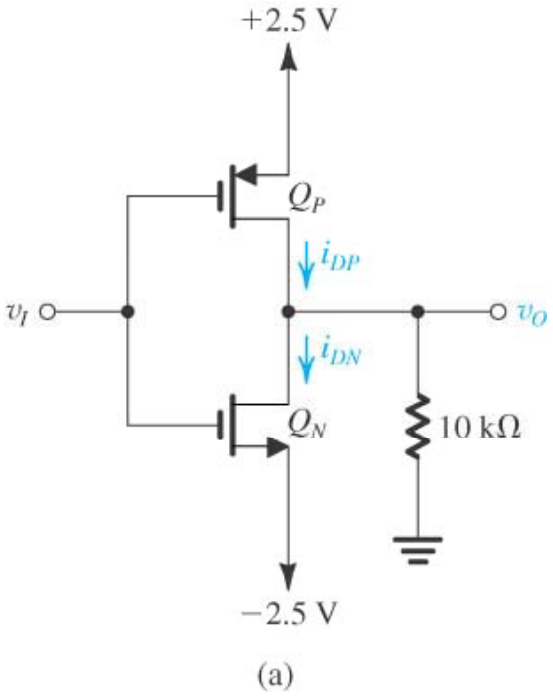


Design the circuit so that PMOS is in saturation and I_D=0.5mA, v_D=3V. What is the max. R_D possible?

V_T= -1V, k'(W/L)=1mA/V^2

1. What is v_G?
2. What is R_{G2}/ R_{G1}?
3. What is R_D?
4. What happens when R_D increases?

Lect. 20: PMOS



(a)

Determine i_{Dn}, i_{Dp}, v_O for v_I = 0, 2.5, -2.5V.

v_{Tn}=1V, v_{Tp}= -1V, both transistors have k'(W/L)=1mA/V^2.

With v_I=0V,

-Top and bottom symmetric
- v_O=0V
- Both transistors in saturation
- i_{Dn}, i_{Dp}=1.125mA

With v_I=2.5V,

-Q_P is off and Q_N is in triode
- i_{Dp}=0, i_{Dn}= 0.244mA

With v_I=-2.5V,

-Q_N is off and Q_P is in triode
- i_{Dn}=0, i_{Dp}=0.244mA

Lect. 20: PMOS

Homeworks:

For the following MOS circuits, determine V_1 … V_7. Use $|V_t| = 2V$, k' W/L = $1mA/V^2$.