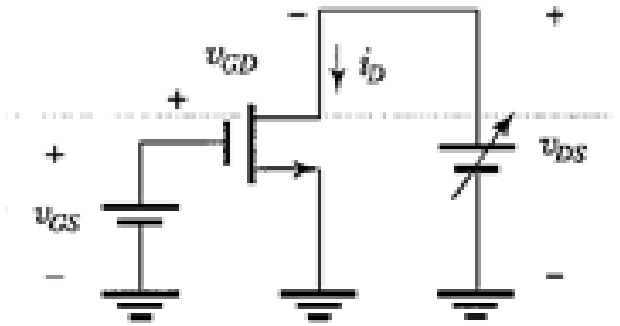
Last Lecture → MOS DC Analysis

- $v_{GS} > v_{th}$
- $v_{DS} > v_{GS} - v_{th} = v_{ov}$
- $i_G = 0$



- $v_{GS} > v_{th}$
- $v_{DS} < v_{GS} - v_{th} = v_{ov}$
- $i_G = 0$

Channel Length Modulation Parameter [1/V]

K_n

$$I_D = \frac{1}{2} k_n{}' \frac{W}{L} (V_{GS} - V_{th})^2 (1 + \lambda V_{DS})$$

$$\approx \frac{1}{2} k_n{}' \frac{W}{L} (V_{GS} - V_{th})^2$$

Transconductance Parameter [A/V²]

$$k_n{}' = \mu_n C_{ox}$$

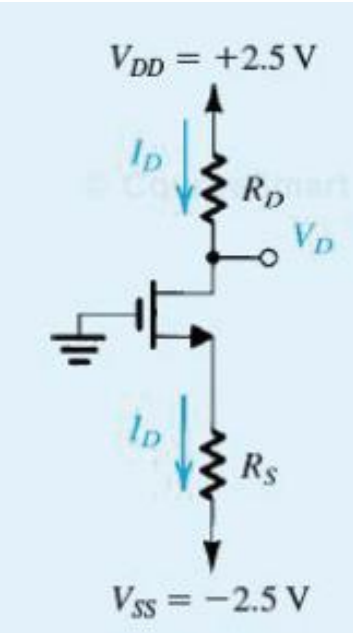
$$I_D = k_n{}' \frac{W}{L} \left[(V_{GS} - V_{th})(V_{DS}) - \frac{1}{2} V_{DS}{}^2 \right]$$

$$\approx k_n{}' \frac{W}{L} (V_{GS} - V_{th}) \cdot V_{DS}$$

$$r_{ds} = \frac{1}{k_n{}' \frac{W}{L} (V_{GS} - V_{th})}$$

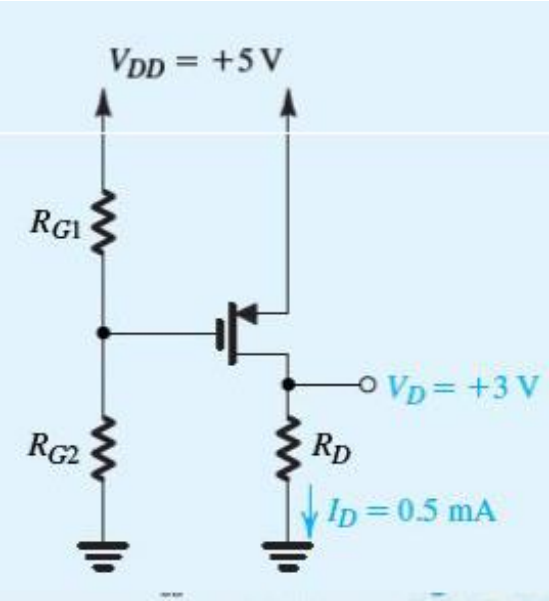
Example 5.3

Assuming λ=0, design the circuit below, that is, determine the values of R_D and R_S, so that the transistor operates at I_D=0.4mA and V_D=0.5V. The NMOS transistor has V_{th}=0.7V, $\mu_n C_{ox}$=100μA/V², and W/L=32.



Example 5.7

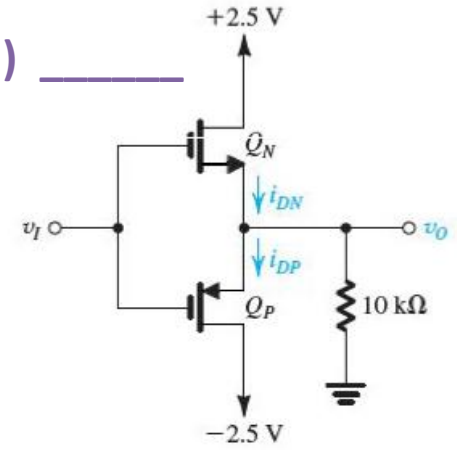
Assuming λ=0, design the circuit below, so that the transistor operates in saturation with I_D=0.5mA and V_D=3V. The PMOS transistor has V_{th}=-1V, K_p=1mA/V². What is the largest value that R_D can have while maintaining saturation-region operation?



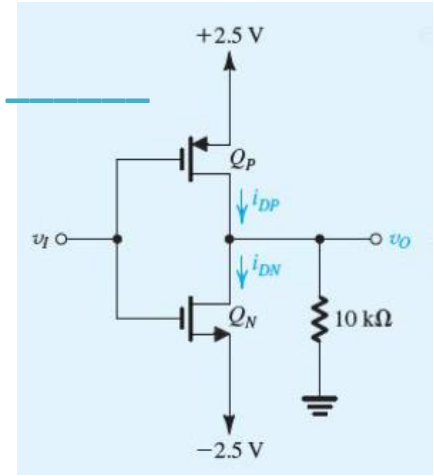
MOS Behavior → Intuitively

Choose the plot that best represents each circuit behavior!

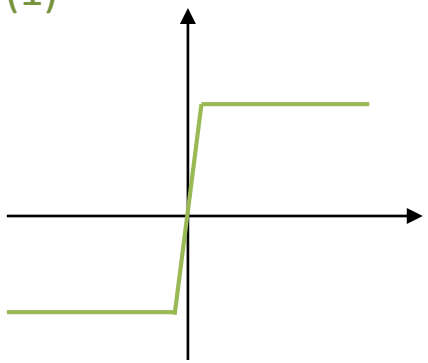
Circuit (a) _____



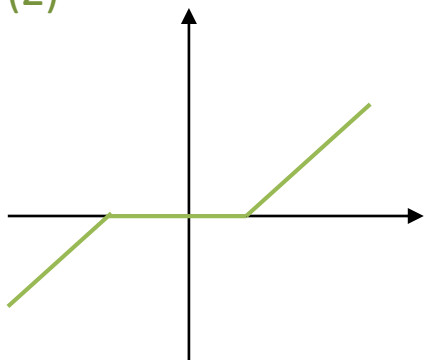
Circuit (b) _____



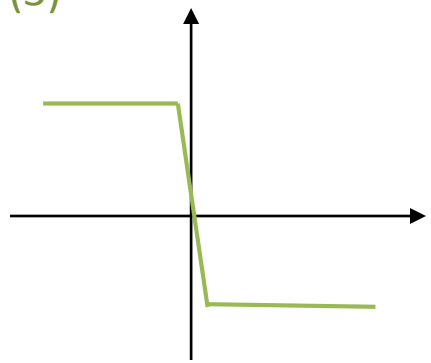
(1)



(2)



(3)



Example 5.8

Assuming matched NMOS and PMOS transistors with $V_{thn}=-V_{thp}=1V$, $K_n=K_p=1mA/V^2$ and $\lambda=0$, find the drain currents I_{Dn} and I_{Dp}, as well as the voltage v_o, for $v_I=0V$, +2.5V, and -2.5V.