Last Lecture → Large Signal Model

10/30/2019

Condition

- **Strong Inversion – Ohmic**

$$I_D = \mu C_{ox} \frac{W}{L}\left[(V_{GS} - V_{th})V_{DS} - \frac{V_{DS}^{\,2}}{2}\right]$$

$V_{GS} > V_{th}$
$V_{DS} < V_{OV}$

- **Strong Inversion - Saturation**

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

$V_{GS} > V_{th}$
$V_{DS} > V_{OV}$

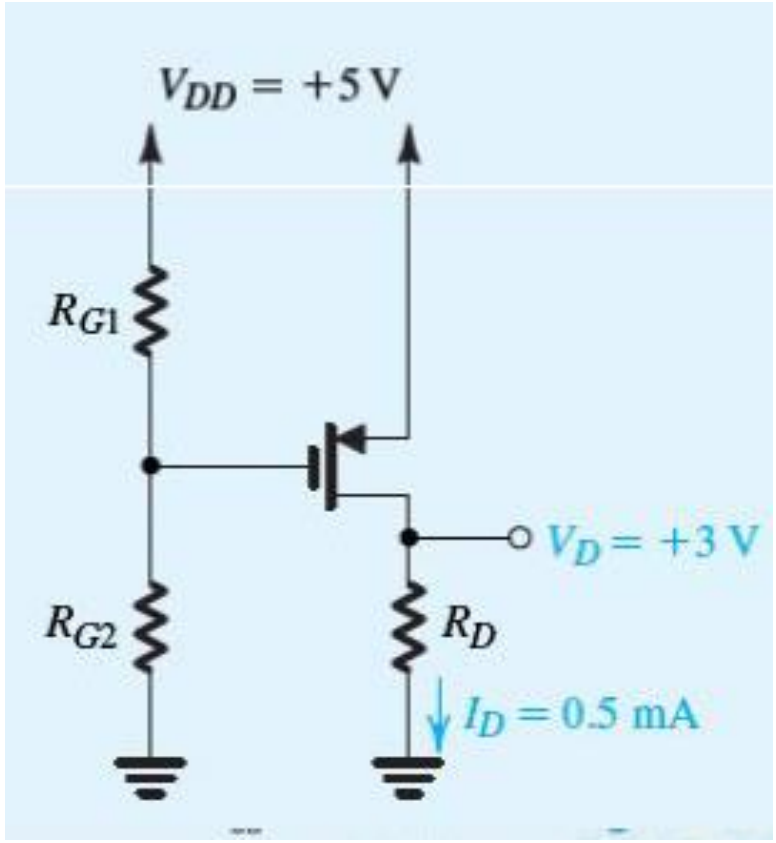
- **Weak Inversion - Saturation**

$$I_D = I_0 . e^{\frac{V_{GS} - V_{th}}{nU_T}}$$

$V_{th} - 5 \cdot U_T < V_{GS} < V_{th} - 2 \cdot U_T$

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/V^2. What is the largest value that R_D can have while maintaining saturation-region operation?



Example 5.5

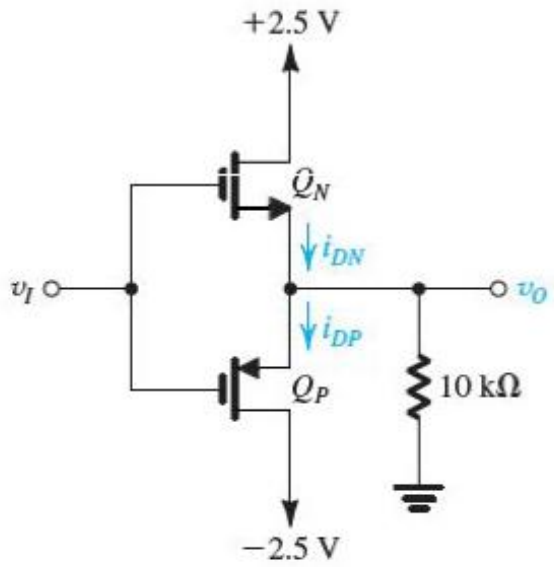
An n-channel MOSFET operating with V_{ov}=0.5V exhibits a linear resistance r_{DS}=1kΩ when v_{DS} is very small.

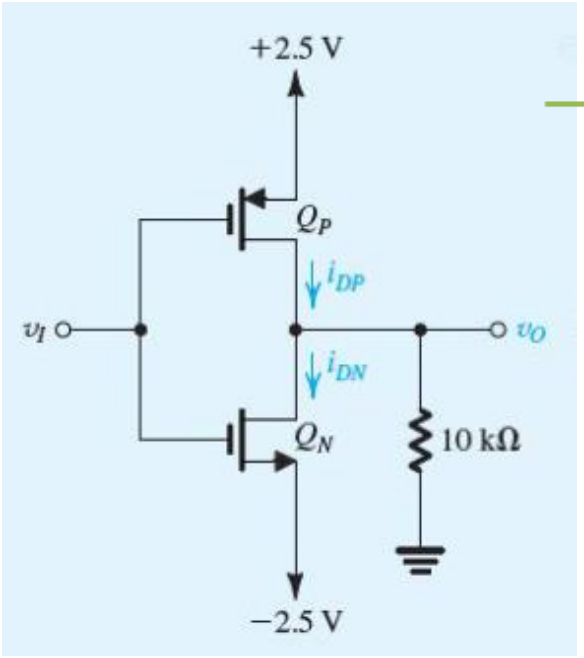
a) **What is the value of the device trans-conductance parameter K_n?**
b) **Assuming λ = 0, what is the value of the current I_D obtained when v_{DS} is increased to 0.5V? And to 1V?**
c) **Assuming an λ = 0.1V^{-1}, what is the value of the current I_D obtained when v_{DS} is increased to 0.5V? And to 1V?**

MOS Behavior → Intuitively

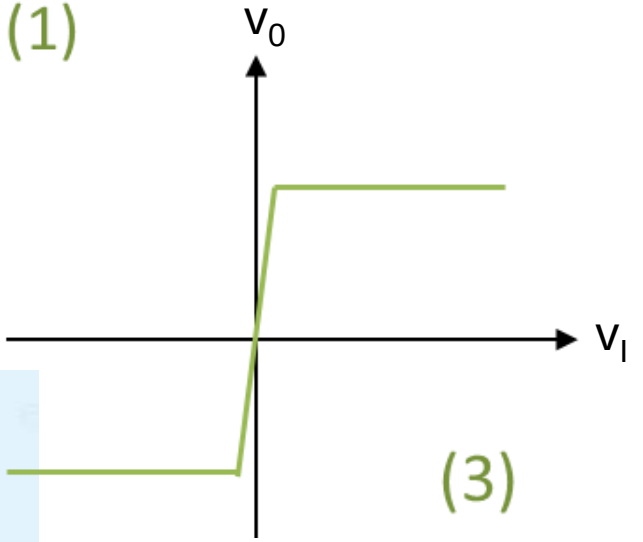
Choose the plot that best represents each circuit behavior!

Circuit (a) _____ **Circuit (b)** _____





(1)



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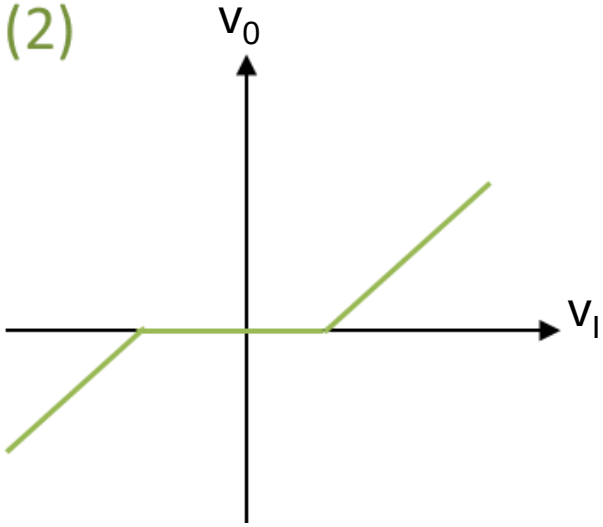

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