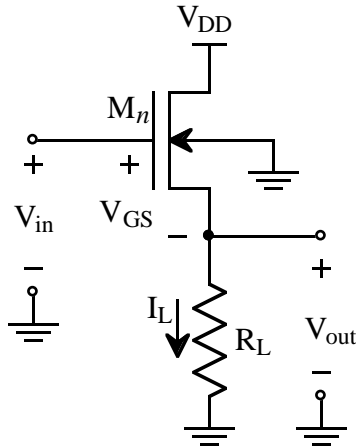


Homework #4

Consider the circuit below which consists of an n MOS device and a resistor R_L . The input voltage V_{in} can be varied from 0V up to V_{DD} .



Derive an expression for the maximum value of V_{out} . Then calculate this maximum V_{out} . Do **not** neglect bulk bias effects. You may neglect channel length modulation. Since V_{Tn} is a function of V_{out} , you will have to iterate to the solution. First guess a value for V_{out} , calculate the corresponding value of V_{Tn} , then recalculate V_{out} using the calculated V_{Tn} value, and compare "old" V_{out} to the "new" V_{out} . Repeat this procedure until the "old" and "new" values of V_{out} agree within 10mV. Record your iterations within a table. Use $V_{DD} = 5V$, $\beta_n = 525 \mu A/V^2$, $\gamma = 0.36 V^{1/2}$, $V_{TOn} = 0.80V$, $2|\phi_F| = 0.56V$, and $R_L = 40k\Omega$. For convenience, the threshold expression is provided below.

$$V_{Tn} = V_{TOn} + \gamma(\sqrt{2|\phi_F| + V_{SB}} - \sqrt{2|\phi_F|})$$