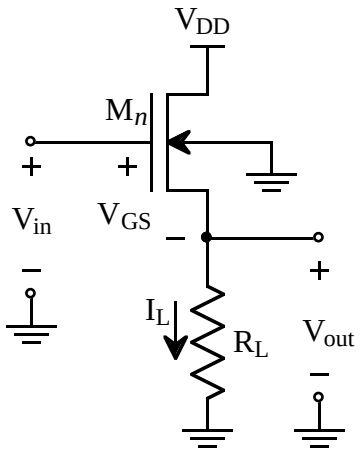
Homework #4

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, ß$_n$ = 525 μA/V^2, γ = 0.36 V$^{1/2}$, V_{TOn} = 0.80V, 2|ø$_F$| = 0.56V, and R_L = 40kΩ. For convenience, the threshold expression is provided below.

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