

Open book, open notes, 100 points, 75 minutes (15 minutes for checking); if stuck go on to the next problem. Your signature guarantees the work is your own - only signed exams will be graded. "May the most you wish for be the least you get [St. Patrick saying]"

For all MOS transistors assume $K_P=2 \text{ mA/V}^2$, $2V_{T0n}=1V=-V_{T0p}$, $\lambda=0.01$, $W=L=10\mu$.

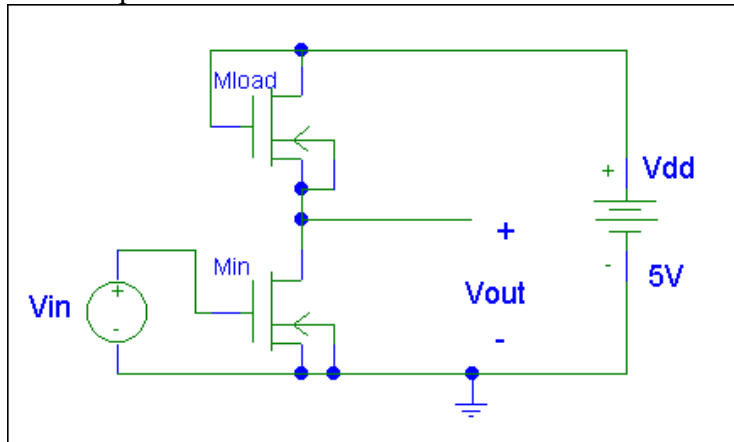
1. (35 points, 20 minutes)

For the following circuit ignore the Early effect and

a) Determine the range of V_{in} such that M_{in} is turned on and in the saturation region. Assume DC operation.

b) Give an equation for V_{out} versus V_{in} when in the range found in a).

c) Sketch this equation and discuss problems you may see in using this as an inverter for computer use.



2. (30 points, 20 minutes)

The following circuit is proposed as a current mirror to handle input currents of any polarity. Ignore the Early effect for parts a) and b)

a) Find the value of I_{bias} needed such that the current in M_{nout} is the same as that in M_{nin} when $I_{in} = 0$ and no load is on the output.

b) Using that I_{bias} and assuming that $I_{out}=I_{in}=0.1\text{mA}$ what will be the voltage V_o at the output node if the Early effect is ignored?

c) The same as b) but set up the equation to solve if the Early effect is not ignored.

