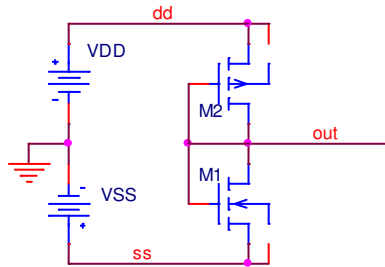303H Fall 2009 – Homework 2 Due Tu 09/22/09

1.  [40 points] [a DC voltage/current source]



For the above circuit assume that the transistors are the 4007 ones, the output voltage, Vout, is measured with respect to ground and VSS=-VDD, VDD>2|VTOp|>0 where VTOp is the PMOS VTO. [note that VSS is negative, VDD is large enough to insure the transistors are turned on]

a) Show that the transistors are in saturation.
b) Ignore the Early effect, that is assume LAMBDA=0. Calculate Vout in terms of VDD.
c). Calculate the current flowing in the drain of M1.
d). If the gate and ~~drain~~ source of M3, another identical NMOS, are placed in parallel with the gate and source of M1, as a load on the output & ss leads, respectively, find the voltage on the drain of M3 needed to give the drain current in M3 to be the same as that in M1; M3 acts as a current source "sink."

2.  [60 points] [load lines/running Spice for  multi-valued curves]
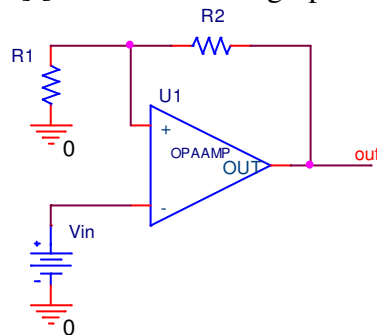


Assume that the op-amp is biased with VCC=-VEE>0, so that it saturates at these two voltages, and has otherwise infinite gain.

a)  Sketch as a set valued function the opamp curve of Vout versus Vd where Vd is the opamp input voltage. Label the saturation values.
b). Give the equation for Vout versus Vd in terms of R1, R2 and Vin. This acts as a load line so sketch it for various values of Vin as a parameter. Sketch it on the sketch of the opamp characteristics.
c) Choose the resistors so that hysteresis results, sketch the resulting hysteresis and give its width. Label saturation and jump points along with saturation values.

d) Use a uA741 with VCC=10V, R1=R2=10KOhm and run PSpice to obtain this hysteresis. Since the DC curve is multi-valued you will need to do a transient analysis by first replacing the DC source, Vin, by a piecewise linear voltage source, VPWL in PSpice,  to give a triangular voltage (of peaks above and below the hysteresis breaks). Submit the hysteresis curve.