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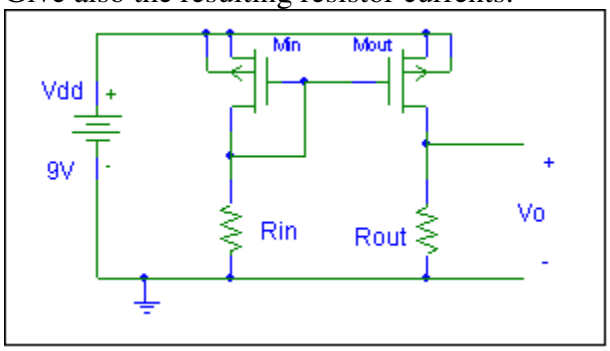
303H Spring 2009 – Midterm Exam Th 03/26/09

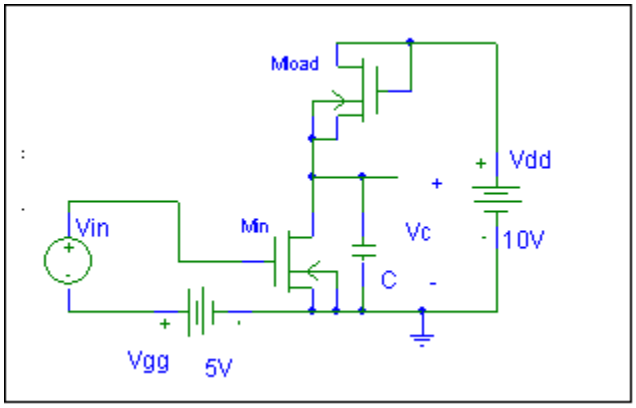
Open book open notes but not open computers (calculators ok but only for calculations); 100 points total; if stuck go on to the next problem. Good luck

For DC characterization of CMOS transistors use the data for the 4007s.
Here are the key 4007 parameters:
NMOS: KP=20.54u, W=144u, L=8u, VTO=1.3, LAMBDA=15m
PMOS: KP=10.32u, W=328u, L=8u, VTO=-1.5, LAMBDA=15m

1. (25 points, 15 min) The following circuit is a current mirror designed for Vo=3V. Here the two transistors are identical and Rin=Rout=R. Take into account the Early effect..
   a) Find Rin to give the desired Vo (the transistors are 4007s).
   b) Give also the resulting resistor currents.



2. (35 points, 25 min)
   For the following circuit [Vin is small signal of DC value 0; the transistors are 4007s, But keep answers in literals, i.e., go, gm, C until part e)]
   a) Explain why the bias value for Vc is 5V.
   b) Draw the small signal equivalent circuit ignoring transistor capacitors (but not C).
   c) Redraw it as a 2-port with Vin externally feeding port 1 and C internally across port 2.
   d) Give the resulting 2-port admittance matrix, Y(s).
   e) Evaluate the entries of Y(s) for the 4007 when C=100pFd.



3. (40 points, 25 min) The following is an equivalent circuit for an emitter follower (operating at room temperature) for which the input admittance Yin(s)=Iin(s)/Vi(s) is desired. Assume the transistor is properly biased with collector current, Ic=2.6mA, and has beta=100, VA=100 (giving Ro through the Early effect) and Re=Ro.

a) Find Yin(s) and give its poles and zeros as a function of Cpi.
b) Sketch its poles and zeros when Cpi=10pFd .
c) By physical reasoning on capacitor behavior give the high frequency behavior of Yin and use this as a check on your Yin(s).