

303 Fall 2008 – Midterm Exam Th 10/23/08

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.

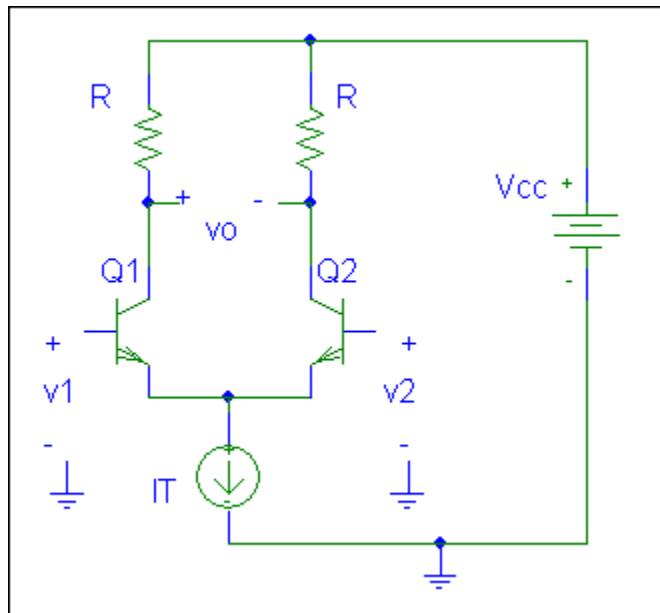
Here are the key 4007 parameters:

NMOS: $K_P=20.54\mu$, $W=144\mu$, $L=8\mu$, $V_{TO}=1.3$, $LAMBDA=15m$

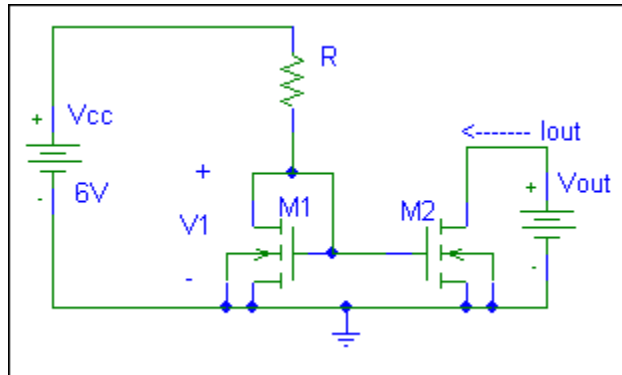
PMOS: $K_P=10.32\mu$, $W=328\mu$, $L=8\mu$, $V_{TO}=-1.5$, $LAMBDA=15m$

1.(25 points, 10 min)

The following circuit uses the BJT differential pair but gives an output difference voltage rather than the output difference current of the OTA. Assume the transistors are equal and biased properly in the forward active region. Give the equation for the output voltage, v_o , in terms of the input voltage difference, $v_d=v_1-v_2$, resistance R , tail current I_T , thermal voltage V_T & transistor α ..



2. (25 points, 15 min) The following circuit is a current mirror designed for $V_1=3V=V_{cc}/2$ (take into account the Early effect)..
- Find R to give the desired V_1 (the transistors are 4007s)
 - Find the output current when $V_{out} = 3V$ and again when $V_{out} = 4V$.



3. (25 points, 10 min) A given transistor circuit has the (normalized) transfer function
- $$[V_o(s)/V_i(s)] = T(s) = \frac{5(s^2 - 2s + 3)}{(s^2 + 2s + 3)}$$
- Give the zeroes and poles of $T(s)$ and plot them in the s -plane
 - If, for $-\infty < t < +\infty$, $v_i(t) = 0.03e^{j2t}$ give $v_o(t)$.
 - Using the result of b) give $v_o(t)$ when $v_i(t) = 0.03\cos(2t)$.
4. (25 points, 15 min) The following is an equivalent circuit for a source follower for which the transfer function $T(s) = V_o(s)/V_i(s)$ is desired. Find $T(s)$ and give and sketch its poles and zeros when the R_g , R_s , C_g and g_m are all positive. Give the very low frequency gain and compare with that $g_m R_d$ for the grounded source amplifier in the case $R_s = R_d$ (where R_d is the [load] resistance connected to the drain in the grounded source amplifier)..

