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303H Fall 2009 – Homework 3 Due Tu 09/29/09

1. [60 points] [an OTA using 4007s]

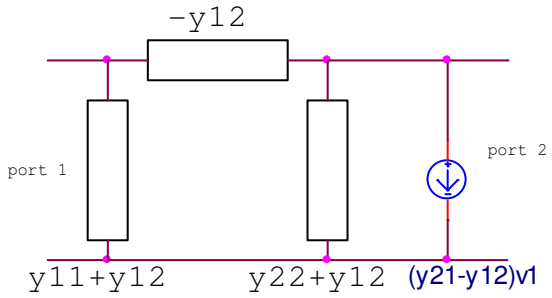
   a) Design an MOS current source "sink" with a 4007 transistor to give a current of 2mA by using a voltage source at the gate-source of a transistor.

   b) Use that for the tail current in an OTA made with the 4007 transistors, as per Figure 7.28 (a), p. 728, of the text except that the output is the current, Io, flowing into the vo node [the input is Vd=vG1-vG2]. Sketch Io versus Vd.

   c) Put your circuit into PSpice using 4007 transistors (including one the tail current) and run a DC plot of Io versus Vd. For this use VDD=-VSS=9V, ground the vG2 node, and put the vo node at ground potential (you can measure the current to that ground by inserting a zero voltage voltage source and monitoring its current; run vG1 from VSS to VDD). Submit your curves of Io versus Vd.

2. [40 points] [2-port Ys, power]

   The pi-equivalent circuit for any 2-port having an admittance matrix Y(s), Y(s)=[y11(s) y12(s); y21(s) y22(s)], is the following



   a) Draw this for the OTA which has Y=[0 0; g_m 0] and also for the OTA turned around, having Y=[0 g_m; 0 0].

   b) Repeat a) for the gyrator which has Y=[0 g; -g 0].

   c) Calculate the port power into the gyrator, v1i1+v2i2, where these voltages and currents are those at the ports. Find the power into each branch of the gyrator pi-equivalent and compare with the port power.

[As the OTA and gyrator admittances are independent of s, the branches in the rectangles of the equivalent circuit are resistors and all the powers are instantaneous ones in time].