

ENEE 307 in Laboratory “Final” Spring 2013

- a) Individually design and build on your own bread board the following analog multiplier (which consists of three outlined five terminal differential pairs). For identical input signals each of V_T volts peak design to obtain an output voltage peak which in millivolts is the last three digits of your Student ID [or if not obtainable you can multiply or divide your ID by a positive *integer*]
It is known that ideally the output voltage is given by

$$v_o = I_T \cdot R_c \cdot \tanh\left(\frac{V_1}{2V_T}\right) \cdot \tanh\left(\frac{V_2}{2V_T}\right)$$

Here V_T is thermal voltage, I_T is the bottom tail current and for small x , $\tanh(x)=x$.

- b) Check your design in Spice.
c) Test it with input sinusoidal signals for V_1 and V_2 of equal amplitudes at equal and non-equal frequencies below their 3db cut-off.
d) Set V_1 and V_2 of the same amplitude near V_T and with V_1 of frequency 1KHz. Vary the frequency of V_2 to determine the 3db cut-off frequency with respect to input 2.
e) Submit print-outs of your Spice (circuit and runs) and scope displays showing input and output time-domain voltages. Give the cut-off frequency of your multiplier and include the last three digits of your Student ID [and how modified for your v_o]. Print and sign your name [to certify that the work is your own] on all submissions.

