

1. (50points, BJT OTA)

Using the 2N3904s for the differential pair, design an OTA to give

$$i_{\text{out}} = I \cdot \tanh\left(\frac{v_d}{2V_T}\right)$$

Choose $I = 5\text{mA}$ and use 2N3904 & 2N3906 for current mirrors (along with a resistor for obtaining I). Check your design using PSpice for which you can run the output current into a bi-directional current mirror. Use two batteries, $V_{CC} = -V_{EE} = 10\text{V}$.

Plot on your output current trace the formula for i_{out} and in your discussion compare the analytic with the circuit realized i_{out} .

2. (50points, BiCMOS inverter)

Design BiCMOS inverters following the circuits of Fig. 14.37(a), p. 1191 and Figs. 14.38(c), (d) & (e), p. 1192 [note that Fig. 14.38 is really a misprint for Fig. 14.37]. Compare Spice runs of the four circuits and comment upon them.

In this use 4007 CMOS transistors and 2N3904s and try values of R_1 & R_2 around 1Kohm with $V_{DD} = 10\text{V}$.