

# Homework 4

ECE 5411 — CMOS Analog IC Design (Spring 2011)

Due on Monday, Feb 14, 2011.

**Note:** Use Cadence schematic capture, layout and Spectre simulation tools, available on the AMS servers for the homework problems.

**Problems 1-4:** Do problems A20.1,A20.2,A20.5,A20.6 from the extra problem set available on the textbook website.

**Problem 5:** Using the TSMC 180n CMOS models ( $V_{DD} = 1.8V$ ,  $L_{min} = 0.18\mu$ ):

- a) Regenerate the Table 9.2 in the textbook for an overdrive ( $V_{OV} = V_{GS} - V_{THN}$ ) equal to 5% of  $V_{DD}$ . Use  $L = 2 \cdot L_{min}$  and state your assumptions. Show all the relevant simulation plots. Save all your neatly done simulation test-benches for future use.
- b) For the NMOS and PMOS devices in your table, plot  $f_T$ ,  $g_m r_o$  and  $g_m r_o f_T$  as a function of overdrive. Use Spectre sweeps and/or ocean scripts to generate the plots. Interpret each of these graphs
- c) For the NMOS and PMOS above, plot  $\frac{g_m}{I_D}$  as a function of overdrive. Explain these plots. Let's define a composite figure of merit ( $FoM_1$ ) as  $FoM_1 = f_T \cdot \frac{g_m}{I_D}$ . Find the overdrive voltage which maximizes this figure of merit. You may read reference P.5 for the significance of these metrics.

(You may want to refer to the Cadence OCEAN scripting information on the course reference page (reference D.3)).