

# Homework 3

ECE 5411 — CMOS Analog IC Design (Spring 2011)

Due on Monday, Feb 7, 2011.

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

**Problems 1-3:** Do problems A9.20, A9.27-A9.28 from the extra problem set available on the textbook website.

**Problem 4:** For a MOSFET,

- a) Show that the transition frequency ( $f_T$ ) is given by (use square law equations)

$$f_T = \frac{g_m}{2\pi(C_{gd} + C_{gs})} = \frac{\mu_n}{2\pi} \frac{V_{GS} - V_{THN}}{L^2}$$

and interpret the dependence of  $f_T$  on the overdrive voltage and transistor length.

- b) Let the gate resistance,  $R_G$ , is significant and the device is modeled as a distributed set of  $n$  transistors each with a gate resistance equal to  $R_G/n$ . Prove that the  $f_T$  of the device is independent of  $R_G$  and is still equal to the expression given above.
- c) Calculate the  $f_T$  of the MOSFET in the subthreshold region and compare the results with the one in part (a).

**Problem 5:** For an NMOS device operating in saturation, plot  $W/L$  versus  $V_{GS} - V_{THN}$  if (a)  $I_D$  is constant, (b)  $g_m$  is constant.