ECEn 450, Winter 2009
Homework # 14
Due April 14, 5:00 pm

From the text Semiconductor Devices, Physics and Technology, do the following problems:

Chapter 6, problems 30, 31

Chapter 14, problem 8

Also complete the following problems:

14.1 Consider an ideal n-channel MOSFET with a width-to-length ratio of (W/L) = 10, an electron mobility of $\mu_n = 400$ cm^2/V-s, an oxide thickness of $t_{ox} = 475$ Angstroms, and a threshold voltage of $V_T = 0.65$ V. (a) Determine the maximum value of source resistance so that the saturation transconductance g_{ms} is reduced by no more than 20 percent from its ideal value when $V_{GS} = 5$ V. (b) Using the value of r_S calculated in part (a), how much is g_{ms} reduced from its ideal value when $V_{GS} = 3$ V?

14.2 An n-channel MOSFET has the following parameters:

$\mu_n = 400$ cm^2/V-s	$t_{ox} = 50$ nm
L = 2 microns	W = 20 microns
$V_T = +0.75$ V	

Assume the transistor is biased in the saturation region at $V_{GS} = 4$ V. (a) Calculate the ideal cutoff frequency. (b) Assume that the gate oxide overlaps both the source and drain contacts by 0.75 microns. If a load resistance of $R_L = 10$ kΩ is connected to the output, calculate the cutoff frequency. (Hints: the load resistance will essentially be the R_{ds} resistance for the transistor. The overlap of the gate with the drain creates the C_{gd} that goes into the calculation of the Miller capacitance. In saturation, C_{gs} is essentially just C_{ox}.)

14.3 A MOSFET has the following parameters: n^+ poly gate, $t_{ox} = 8$ nm, $N_D = 10^{17}$ cm^{-3}, and $Q'_{SS} = 5 \times 10^{10}$ cm^{-2}. (a) What is the threshold voltage of this MOSFET? Is the device enhancement or depletion mode? (b) What type of implant and dose are required such that $V_T = 0$?