ELEG 646; ELEG 446 - Nanoelectronic Device Principles – Spring 2005
Homework #10 (revision 3) - due noon Friday, 20 May 2005, in 140 Evans Hall

1. Using the surface field estimation, (a) calculate the intrinsic depth x_i at a temperature of 4K for n-channel Si MOSFET at the onset of strong inversion, assuming that the bulk Fermi potential ϕ_{pB} = - 0.3 V (even at 4K in this hypothetical case). (b) Briefly explain your numerical result for x_i. Discuss the significance of this number, and if it agree with quantum mechanics.

2. Consider the MOS capacitor (same as problem 5 of Homework 9) of area 1 cm^2 made on n-silicon with $N_D = 1.5 \times 10^{14}$ cm^{-3} and an Al gate. The SiO_2 layer is 200 nm thick. Assume that now the oxide contains 10^{12} mobile ions. Determine the flat-band and the threshold voltages when (a) all the ions are uniformly distributed in the oxide, (b) all the ions are at the Si- SiO_2 interface, and (c) all the ions are at the Al-SiO_2 interface.

3. (a) An Al gate enhancement-type n-channel Si MOSFET has a substrate concentration $N_a = 6 \times 10^{15}$ cm^{-3} and an oxide thickness of 0.1 μm. The SiO_2 has 10^{10} charges cm^{-2}. Determine the threshold voltage of the transistor. When the transistor is operated in the linear region with V_D= 0.5 V, calculate the gate voltage to obtain a drain current of 2 mA. Assume L = 10 μm, μ_n = 500 cm^2/V-sec, and Z = 100L. Calculate the g_m of the device and the cutoff frequency of operation f_T. (b) What changes will occur in the characteristics of the MOSFET when the gate metal is replaced by p-polysilicon doped with $N_a > 10^{19}cm^{-3}$ operated at the same current in the linear region with V_D= 0.5 V?

Homework assignments will appear on the web at:
http://www.ece.udel.edu/~kolodzey/courses/eleg646s05.html
Note: On each homework and report submission, you must please give your name, the due date, assignment number and the course number.