EECS 523 Exam #2

Name :

INSTRUCTIONS

Read all of the instructions before beginning the exam.

You have a total of 75 minutes to finish this exam.

This is an open-book, open-notes exam.

Unless otherwise noted on a particular problem, you must show your work (in the space provided plus the back of the pages) for all problems to receive full credit; simply providing answers will result in only partial credit, even if the answers are correct. If you require extra space beyond what is provided, be sure to turn in any material that is required to support your solutions.

Turn in the entire exam, including this cover sheet.

Put your name on any additional material that you submit.

No.	1	2	3	4	5	6	7
Grades	7	7	6	15	35	20	10

1- Name two methods to eliminate the Bird's beak problem in LOCOS process.

2- Name two Planarization methods that are used in Integrated Circuit technology.

3- If the DIBL effect on the threshold voltage is shown by this equation $V_T = V_{T0} - \eta Vds$, What do you expect η to be approximately proportional to:
   a) dox/ Xd
   b) dox/Leff
   c) Xd/dox
   d) Leff/dox

   (Xd = gate induced depletion width, Leff= effective channel length and dox= thin oxide thickness):

4- Using Qn, the mobile charge equation derived in the class; show that the diffusion current is much smaller than drift current when a MOSFET is biased in the strong inversion region. (Hint: in strong inversion $Vg- V_T -V(y)>>kT/q$).

5- A Boron implantation is performed through a sacrificial oxide layer in to the silicon in order to adjust the threshold voltage of the NMOS Transistor. The thickness of the oxide is equal to the range (Rp) of the implantation and $\Delta Rp = 0.03\ \mu m$ and the total implanted dose is $10^{12}\ cm^{-2}$. If the total thermal budget, including the implant itself, is $10^{-12}\ cm^2$, Nsub = $10^{15}\ cm^{-3}$, Ngate(N-Type) = $10^{20}\ cm^{-3}$, dox = 20nm :

   a) Find the threshold voltage V_T if a charge sheet model is used to represent the implanted Boron impurity.
   b) Find the threshold voltage V_T if a more complete model is used to represent the implanted Boron impurity.
   c) Specify the difference in the threshold voltage calculated above using the two different models.
   d) How much such a difference in V_T can change I_{off} of the device if we assume a constant subthreshold swing of 90 mV/decade .

6- Taking DIBL into account qualitatively draw log (Id) vs Vg in subthreshold region for the following cases (assume Vd = Vdd), show all the equations and reasoning you use to draw the curves:

a) $L = 4\ \mu m$, $Na = 10^{15}\ cm^{-3}$,
b) $L = 4\ \mu m$, $Na = 10^{17}\ cm^{-3}$,
c) $L = 0.22\ \mu m$, $Na = 10^{15}\ cm^{-3}$,
d) $L = 0.22\ \mu m$, $Na = 10^{17}\ cm^{-3}$,
e) What is the effect of Vd on these graphs If Vd is changed from Vdd to 0.1V? Just give a brief answer for the two channel lengths.

7- What is the minimum ψs (the surface potential) that cause GIDL in an ordinary NMOSFET? And how is this achieved?