High Speed Devices – Hand In 1.

You will model the electrostatics of an $In_{0.8}Ga_{0.2}As$ quantum well FET on a InP substrate, with $In_{0.48}Al_{0.52}As$ barriers, using a freeware Schrödinger-Possion solver, *1D Poisson* by Greg Snyder. You can get the program from the course page or from http://www3.nd.edu/~gsnider/ (for Mac or Linux versions). Make sure that you use the materials.txt file from the course page .zip.

_Use the included code to set up the geometry of the HEMT.

1) Calculate and plot the band profile at $V_{GS}=v_1$=0V, as well as the energy of the lowest bound state. Extract E_1-E_C as well as V_T.

2) Calculate and plot the band profile at $V_{GS}=v_1$=0.4 V, as well as the energy of the lowest bound state. Extract the sub band shift ΔE_1, and compare with the estimated value from the centroid capacitance from the lectures. You can get the sheet-charge n_s from the _status file.

3) Calculate and plot a CV curve (C=dQ/dV_{GS}) for the HEMT for -0.2 < V_{gs}<0.6 V. In the same plot, also include the calculated capacitance value from the lectures.

Optional:

4) V_T can be shifted by changing the doping. Set V_T=0V by increasing the doping level in the 10 nm thick InAlAs layer below the QW. What value of the doping is needed?

Email a pdf to abinaya.krishnaraja@eit.lth.se with the plots and answers to questions 1-3 (and 4). Deadline is 8/2 23.59. You can do the simulations in groups of two. If you have any questions about running the program you can ask Abinaya.

Quick instructions to 1D Possion: The program runs as a text based terminal window and is very user friendly. The program takes .txt files as input, and generates a .txt output file. The included file pndiode.txt for example simulates a simple pn-junction.

Some brief instructions: By changing the variable v1, a bias can be applied to the gate. To sweep the gate voltage, the syntax is `v1` v_{start} v_{stop} Δv. The `CV only` command produces a _CV output file, with total charge as well as capacitance as a function of v1. Removing the `only` flag produces a _out file for every bias.

```
#In0.8Ga0.2As Quantum well HEMT

surface schottky=.7 v1
InAlAs  t=40    Nd=1e12
```

```
InGaAs  t=70    Nd=1e12 x=0.8
InAlAs  t=100   Nd=1e12
InAlAs  t=1000  Nd=1e12
siinp   t=1000
substrate
fullyionized

v1 0.0
#v1 -0.2 0.6 0.05
#CV only

no holes
schrodingerstart=5
schrodingerstop=250
temp=300K
dy=2
```

Note – the layer thicknesses are in Ångströms and `dy` sets the grid spacing. You need some sort of graphing program (matlab, excel etc.) to plot the band profiles.