# High Speed Devices – Hand In 2.

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. (You need a new materials.txt file that also includes InAlAs). 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 $\Delta E_1$, 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 ($C$=d$Q$/d$V_{GS}$) 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 Aein.Shiribabadi@eit.lth.se with the plots and answers to questions 1-3 (and 4). Deadline is 14/2 23.59. You can do the simulations in a groups of two. If you have any questions about running the program you can ask Aein.

*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 vstart vstop 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
```