Nanoscale MOSFETs 2017 – Excercise 1

1. a) At which dimension does a square InAs nanowire obtain a separation between the first and second sub band of ΔE=100 meV?
   b) Assuming that the valence band quantization is negligible, what is the effective band gap?
   c) Calculate the electron velocity for an electron with an energy 50 meV above E_1.
   (E_g=0.36eV, m^*=0.023 m_0)

2. An InGaAs HEMT has an (infinite potential) quantum well thickness of W=10nm. Assuming T=0K, calculate the Fermi level if $n_s=10^{13}$ cm^{-2}. (m^*=0.053 m_0)

3. Work out the expressions for 1D and 3D strongly degenerate carriers similar to Eq. 1.28.

4. An extrinsic, diffusive semiconductor rod with length L, area A and doping N_D is kept at one end at T=T_1 and T=T_2 at the other end. At steady state, this leads to a linear temperature gradient over the rod. a) Calculate the open circuit voltage. b) Calculate the short circuit current.

5. For an InAs nanowire (E_g=0.36 eV, m^*=0.023m_0) with a width W=20 nm and thickness T=8 nm calculate the position of the lowest two subbands assuming:
   a. Parabolic Bands.
   b. Non parabolic bands. Use that k_x/k_y becomes quantized with $\frac{\pi L}{n}$
   c. Assuming non-parabolic bands, what is the effective mass around the Γ-point for the lowest subband?