Nanoscale MOSFETs 2014 – Excercise 5

1. An InGaAs MOSFET has μ_n=3000 cm^2/Vs, as measured from a long channel device. Calculate how close to the ballistic limit the FET is operating if L_g=50nm, both in the linear and saturated regime with V_{DS}=0.5V. (Assume that the device is operating in the MOS-limit).

2. Explain why the apparent field effect mobility, as extracted from $\mu_{eff} = \frac{L}{W}\frac{1}{V_{DS}}\frac{1}{C_G(V_{GS}-V_T)}$ is decreasing as L is reduced.

3. Estimate the mean free path for bulk InAs and GaAs at room temperature.

4. We have assumed that the mean free path is energy independent. However, most scattering processes are energy-dependent. For example, $\tau_m(E) = \tau_0\left(\frac{E}{kT_L}\right)^s$, where $-\frac{1}{2} \leq s \leq \frac{3}{2}$ for ionized impurity scattering with different degrees of screening. Derive an expression for the 2D current including energy dependent scattering.

5. R_{on} is measured for a 2D FET for different gate lengths. The FET has parasitic source/drain resistance R_{par}. Show that R_{on} increases linearly with L. Suggest a methodology for obtaining R_{par} and λ_0.