ECE 697MM HW#2

1) In a silicon MOSFET a roughly triangular quantum well is formed when an inversion layer is formed. The electrons in this well have an effective mass of $0.19\,m_0$ and exist in two degenerate bands (i.e. the two bands have the same energy minima → this gives a factor of two for the DOS).

a) Calculate the 2-D density of states in this QW (the spin degeneracy = 2)

b) For the rest of this problem, assume a low temperature (such as 4K) and that the 2DEG is degenerate. Measurements have determined that $n_s = 8\times10^{11}\ cm^{-2}$. Find the Fermi energy (above the minimum of the subband, i.e. E_0).

c) Find k_F, v_F and λ_F

d) If the mobility is measured to be $\mu = 10^4\ cm^2/Vs$, find τ_m and the mfp (L_m).

e) Find the resistance per square.

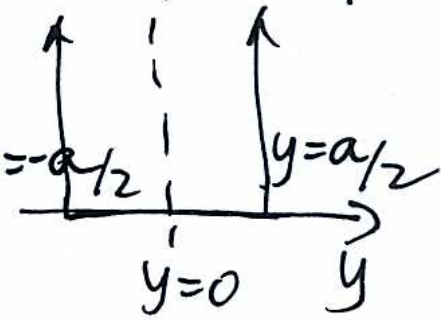
ECE 697 MM: HW # 2

2) A quantum waveguide is made from 2DEG in $Al_{0.3}Ga_{0.7}As/GaAs$. $n_s = 5\times10^{11}\ cm^{-2}$. (see Figure on page (26))

a) Use formulas on page (17) of the notes to find the two lowest states E_0 and E_1 in eV. $\hat{z}$ is perpendicular to the QW

b) The waveguide is formed by further confining the 2DEG in the $\hat{y}$-direction. This confinement acts as a "square" QW with infinitely steep walls: $\longrightarrow$ $a = 50\ nm$.

How many subbands due to the $\hat{y}$-confinement exist up to the Fermi energy?



Hint: First find the Fermi energy. The subbands look like Fig. 1.6.2 with the k-axis being the k_x-axis. You may need to look up the eigenvalues of E for a square well in a quantum mechanics book. Does the second level (E_1) contribute?

c) Sketch the 1D DOS in this electron waveguide, versus E, up to the Fermi energy.