11/15/2012 Intro. to condensed matter

Problem 1 Integer Quantum Hall effect(IQHE)

An electron is confined to a plane. Within the plane it moves freely, except the motion is restricted to an area of $A = L^2$. A magnetic field B is applied perpendicular to the plane.

(a) Calculate the energy levels.
(b) Calculate the degeneracy of each energy levels
(c) Assume that we have $N = nA$ electrons that the interaction between the electrons is neglected. Calculate and plot the magnetic field dependence of the chemical potential μ for termperatures $k_B T \ll \hbar\omega_c$, where $\omega_c = \frac{Be}{mc}$ is the cyclotron frequency. (The peculiar behavior of this system is related to the *integer quantum Hall effect*)
(d) Electrons of density $n' = 10^{18} cm^{-3}$ are confined into a 100Å-thick layer. What is the typical magnetic field required to see the effect discussed above? What temperatures are low enough at this field?

Problem 2 Saddle point in $E(\vec{k})$, DOS(E)

In a certain metal the electron energy has a saddle point at $\boldsymbol{k_0}$. In the neighborhood of $\boldsymbol{k_0}$ energy dispersion can be described by

$$E(\boldsymbol{k}) = E_0 + E^*(a^2k_x^2 - b^2k_y^2 + c^2k_z^2)$$

What is the contribution of this region to DOS? Make a drawing of $g(E)$?