PROBLEMS

Lecture 7

1. Estimate rate of intra-band transition in electric field. Estimate red shift of fundamental light adsorption edge in electric field (Franz-Keldysh effect).

2. Find rate of interband tunnelling in semiconductors in electric field.

3. It could happen that different sheets of the Fermi surface are coming close to each other. This happens, for instance, if the energy spectrum looks like

$$\epsilon(\mathbf{p}) = \sqrt{\frac{p_x^2}{2m_x} - \frac{p_y^2}{2m_y} - \frac{p_z^2}{2m_z} - \Delta^2}.$$

   Find probability of tunneling from one sheet to the other in external magnetic field B parallel to z-axis (magnetic breakdown).

4. Find the energy spectrum of electrons near to metal surface in magnetic field, parallel to the surface.

5. Consider the tight-binding model for electrons on square lattice in perpendicular magnetic field (Peierls-Harper problem). Show that Peierls substitution works well if the flux through elementary cell $\Phi = HS$ is much smaller than the flux quantum $\Phi_0 = 2\pi\hbar/ec$. Find electron spectrum for

$\Phi = \Phi_0/2$. Read Hoffstadter paper on numerics for $\epsilon(k)$ for different values of Φ (Hoffstadter batterfly).

6. Find resistance of a thin film of its thickness d? Consider boundary scattering as diffusive.

7. Show that de Haas-van Alfven Effect is sensitive to magnetic induction B (not H) and that it leads to diamagnetic instability and formation of diamagnetic domains.

8.

9. Find the condition and estimate the magnitude of Giant Quantum Oscillations of Sound Absorption in Metals.

10. How to determine Fermi momentum and shape of Fermi surface from experiments with slow positrons in metals?