Advanced Condensed Matter Physics/S. Basu/Assignment-8

Only correctness of the final answers will be checked. You may box the final answer.

1. Write down the relationship between resistance, $R$ and resistivity, $\rho$ involving geometrical parameters, such as dimension of the system, $L$. Verify the relation in 3 dimensions.

2. (a) Assume a $2 \times 2$ structure for the resistivity, $\rho$ and the conductivity, $\sigma$ matrices. Write expressions for $\sigma_{xx}$ (diagonal elements) and $\sigma_{xy}$ (off-diagonal elements) in terms of $\rho_{xx}$ and $\rho_{xy}$.
   
   (b) What does $\sigma_{xx} = 0$ signify in classical electrodynamics?
   
   (c) When $\sigma_{xx} = 0$, what are the corresponding values of $\rho_{xx}$ and $\sigma_{xy}$?

3. For a gauge transformation of the vector potential of the form:

   $$\tilde{A} \rightarrow \tilde{A} - \nabla \chi$$

   ($\chi$ being an arbitrary scalar), write down the transformation of the wavefunction, $\psi(r)$. Does $|\psi(r)|^2$ remain invariant under such transformation?

4. Write down the eigenfunction for a free particle of mass $m$ and charge, $q$ in a uniform magnetic field, $B$ applied in the $z$-direction. You may assume a Landau gauge of the form,

   $$\tilde{A} = (-By, 0, 0)$$

   What are the corresponding eigenvalues?

5. Compute the degeneracy of the Landau levels. What is the relationship between this degeneracy (per unit area of the sample) and the Hall quantization ($\nu$) in terms of the electron density, $n$?

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Your Submission:

Due Date Exceeded.
As per our records you have not submitted this assignment.