Quiz Answers: Week 10
ECE 656: Electronic Conduction In Semiconductors

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Lecture 23 Quiz :

1) The equation of motion for an electron in k-space is $\frac{d\left(\hbar\vec{k}\right)}{dt}=\vec{F}_e$. What assumptions are necessary for this equation to be valid?

a) Parabolic energy bands.
b) Non-degenerate conditions.
c) No quantum mechanical reflections.
d) No B-field.
e) No temperature gradients.

2) Under what conditions is this equation valid? $\frac{\partial f}{\partial t}+\vec{\upsilon}\bullet\nabla_r f+\vec{F}_e\bullet\nabla_p f=0$

a) No recombination-generation.
b) Equilibrium.
c) No scattering.
d) Position independent effective mass.
e) All of the above

3) What is the quantify, $\sum_{p'}S\left(\vec{p}'\rightarrow\vec{p}\right)f\left(\vec{p}'\right)\left[1-f\left(\vec{p}\right)\right]$?

a) The collision integral.
b) The in-scattering rate.
c) The out-scattering rate.
d) The relaxation time approximation.
e) The collision operator.

4) What is the quantity, $-\left(\frac{f\left(\vec{p}\right)-f_0\left(\vec{p}\right)}{\tau_m}\right)$?

a) The collision operator.
b) The collision operator in the relaxation time approximation.
c) The solution to the steady-state Boltzmann equation.
d) The in-scattering term of the collision operator.
e) The out-scattering terms of the collision operator.

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5) In the solution to the steady-state Boltzmann equation, $\delta f = \tau_m \left(-\frac{\partial f_0}{\partial E} \right) \vec{v} \bullet \vec{\mathcal{F}}$, what is the term $\vec{\mathcal{F}}$ called?

a) The electrochemical potential.
b) The chemical potential.
c) The statistical force.
d) The generalized force.
e) The electric field.

Lecture 24 Quiz:

1) What is the quantity. $\frac{1}{A}\sum_k \left(E - F_n\right)\vec{v}\left(\vec{k}\right) f\left(\vec{r},\vec{k}\right)$? ($E$ is the total energy.)

a) The energy density.
b) The energy flux.
c) The heat density.
d) The heat flux.
e) The kinetic energy flux.

2) In this equation, $\hat{C}f = -\left(\frac{f\left(\vec{p}\right) - f_S\left(\vec{p}\right)}{\tau_m} \right)$, what is $f_S\left(\vec{p}\right)$?

a) The distribution function.
b) The equilibrium distribution function.
c) A distribution with the shape of the equilibrium distribution function.
d) The Bose-Einstein distribution.
e) The anti-symmetric part of the distribution function.

3) How do we interpret the quantity, $\left(\vec{v}\,\vec{v}\right)$?

a) As a scalar.
b) As a vector.
c) As a second rank tensor.
d) As a third rank tensor.
e) None of the above.

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4) For spherical bands, how is the average scattering time, $\left\langle\left\langle \tau_m \right\rangle\right\rangle$ defined?

a) $\left\langle v_x^2 \tau_m \right\rangle / \left\langle v_x^2 \right\rangle$.

b) $\left\langle v^2 \tau_m \right\rangle / \left\langle v^2 \right\rangle$.

c) $\left\langle \left(E - E_C\right) \tau_m \right\rangle / \left\langle \left(E - E_C\right) \right\rangle$.

d) All of the above.

e) None of the above.

5) What is $\frac{1}{\mu_{tot}} = \frac{1}{\mu_1} + \frac{1}{\mu_2}$ called?

a) The Thompson relation.
b) The Kelvin relation.
c) The Wiedemann-Franz law.
d) The Lorenz number.
e) Mathiessen's rule.

Lecture 25 Quiz:

3) Why is the BTE harder to solve in the presence of a B-field?
   a) Because we are no longer near equilibrium.
   b) Because non-degenerate statistics must be used.
   c) Because the cross product makes the math more difficult.
   d) Because the gradient in momentum space can no longer be approximated by the gradient of f_S.
   e) Because the gradient in position space can no longer be approximated by the gradient of f_S.

4) In this equation, $\vec{J}_n = \sigma_S \vec{\mathcal{E}} - \sigma_S \mu_H \left(\vec{\mathcal{E}} \times \vec{B}\right)$, what is μ_H?
   a) The mobility.
   b) The effective mobility.
   c) The conductivity mobility.
   d) The chemical potential.
   e) The Hall mobility.

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3) What is the quantity, $\left\langle\left\langle \tau_m^2 \right\rangle\right\rangle \Big/ \left\langle\left\langle \tau_m \right\rangle\right\rangle^2$, called?

a) The Hall mobility.
b) The Hall coefficient.
c) The Hall factor.
d) The Hall concentration.
e) The Hall parameter.

4) What quantity does a Hall effect measurement find?

a) The Hall mobility.
b) The mobility.
c) The Hall concentration.
d) The carrier concentration.
e) The Hall resistivity.

6) What does the criterion $\omega_c \tau_m << 1$ imply?

a) Electrons scattering many times before completing a cyclotron orbit.
b) The magnetic field low.
c) Shubnikov-deHaas oscillations will not be observed.
d) All of the above.
e) None of the above.