**Lecture 26 Quiz :**

1) When we write the collision integral like this:

$$\hat{C}f\left(\vec{r},\vec{p},t\right)=\sum_{p'}S\left(\vec{p}'\rightarrow\vec{p}\right)f\left(\vec{p}'\right)-\sum_{p'}S\left(\vec{p}\rightarrow\vec{p}'\right)f\left(\vec{p}\right)$$

What assumption are we making?
   a)  That the initial state is empty.
   **b)  That the final state is empty.**
   c)  The relaxation time approximation.
   d)  That Fermi's Golden Rule is valid.
   e)  Equilibrium.

2) What does the condition, $\sum_{\vec{p}}\hat{C}f\left(\vec{r},\vec{p},t\right)=0$, imply?

   a)  The validity of the relaxation time approximation.
   b)  Non-degenerate conditions.
   **c)  That electrons are conserved.**
   d)  Steady-state conditions.
   e)  Equilibrium conditions.

3) When $S\left(\vec{p}\rightarrow\vec{p}'\right)=S\left(\vec{p}'\rightarrow\vec{p}\right)$, what type of scattering in involved?

   a)  Isotropic.
   b)  Inelastic phonon absorption
   c)  Inelastic phonon emission.
   **d)  Elastic.**
   e)  Electron-electron.

4) Why is electron-electron scattering often neglected?
   a)  Because the scattering rate is usually weak.
   **b)  Because the overall momentum, energy, and number is conserved, so there is little effect on macroscopic parameters**.
   c)  Because it is mathematically (and computationally) hard to treat..
   d)  All of the above.
   e)  None of the above.

5) Electron-electron scattering is often treated to first order by assuming an **equilibrium** (Maxwellian or Fermi-Dirac) distribution with one change. What is the change?

   **a) The Fermi level is replaced by the quasi-Fermi level.**
   b) The lattice temperature is replaced by the electron temperature.
   c) The magnitude of the distribution is re-normalized.
   d) The Fermi-function is replaced by the Bose-Einstein function.
   e) None of the above.

   (the assumption here is that we are still near equilibrium)

**Lecture 27 Quiz:**

1) When we write the collision integral in the Relaxation Time Approximation,
$$\hat{C}f\left(\vec{r},\vec{p},t\right)=-\frac{\left(f-f_{S}\right)}{\tau_{f}\left(\vec{r},\vec{p}\right)},$$
   what is the characteristic time, $\tau_{f}$ ?
   a) The scattering time.
   **b) The momentum relaxation time.**
   c) The energy relaxation time.
   d) All of the above.
   e) None of the above.

2) When we write the collision integral in the Relaxation Time Approximation,
$$\hat{C}f\left(\vec{r},\vec{p},t\right)=-\frac{\left(f-f_{S}\right)}{\tau_{f}\left(\vec{r},\vec{p}\right)},$$
   why do we use $f_{S}$ rather than the equilibrium, $f_{0}$ ?
   a) Because we are not exactly at equilibrium.
   **b) To be sure that the number of carriers is conserved.**
   c) To the sure that the momentum of the carriers is conserved..
   d) To the sure that the energy of the carriers is conserved..
   e) To the sure that the heat of the carriers is conserved..

3) Under what conditions is the Relaxation Time Approximation,

$$\hat{C}f\left(\vec{r},\vec{p},t\right)=-\left(f-f_{S}\right)/\tau_{f}\left(\vec{r},\vec{p}\right)$$

valid?
a) Near equilibrium
b) Near equilibrium with Maxwell-Boltzmann statistics with elastic scattering.
c) Near equilibrium with Maxwell-Boltzmann statistics with isotropic scattering
d) **Near equilibrium with elastic scattering or isotropic scattering with Maxwell Boltzmann statistics.**
e) Near equilibrium with isotropic scattering or inelastic scattering with Maxwell Boltzmann statistics.

4) Which of the following statements is true under near equilibrium conditions?
a) In general, the RTA accurately describes the in-scattering process.
b) In general, the RTA accurately describes the out-scattering process.
c) In general, the RTA accurately describes both the in- and out-scattering processes
d) **For specific conditions, the RTA accurately describes both in-scattering and out-scattering.**
e) None of the above.

(Not such a clear question. b) is also true for MB statistics.)

5) Consider the following two equations;

$$\sum_{p'}S\left(\vec{p}',\vec{p}\right)f\left(\vec{p}'\right)-\sum_{p'}S\left(\vec{p},\vec{p}'\right)f\left(\vec{p}\right)=0 \qquad \text{(i)}$$

$$S\left(\vec{p}',\vec{p}\right)f\left(\vec{p}'\right)-S\left(\vec{p},\vec{p}'\right)f\left(\vec{p}\right)=0 \qquad \text{(ii)}$$

What are these equations statement of ?

a) detailed balance
b) steady-state conditions.
c) (i) detailed balance and (ii) steady-state conditions.
d) (i) steady-state conditions and **(ii) detailed balance.**
e) none of the above

(This is a poor question. (ii) is detailed balance, but (1) is not steady-state.)

**Lecture 28 Quiz:**


1) Mathematically, what is the solution to the equilibrium BTE?
    a) The Fermi-function.
    **b) The Fermi function or the Bose-Einstein distribution.**
    c) Any function of kinetic energy.
    d) Any function of total energy.
    e) Any function of total momentum.

(The LHS is satisfied by any function of total energy, but the RHS needs a Fermi function to satisfy detailed balance.)


2) Which of the following statements is true in equilibrium?
    a) The electrostatic potential is constant with position.
    b) The chemical potential is constant with position.
    c) The carrier density potential is constant with position.
    d) The electrochemical potential is constant with position.
    **e) The electrochemical potential and temperature are constant with position.**


3) What are the proper boundary conditions for the 1D BTE?
    a) The carrier densities at the two contacts.
    b) The incident and emerging fluxes are the two contacts.
    c) The incident and emerging fluxes at one of the two contacts.
    **d) The incident fluxes at the two contacts.**
    e) The carrier densities at the two contacts.

(Will discuss more in Week 16).


4) In a ballistic device, the states in the devices fall into what two classes?
    a) Spin up and spin down states.
    b) Those fillable from contact one and those fillable from contact two.
    **c) Those fillable from contact one, those fillable from contact two, and those not fillable.**
    d) Conduction and valence band states.
    e) None of the above.


(Will discuss more in Week 16).

5) What is the quantity: $\dfrac{h}{2L}\sum_{k}|v_x|\delta(E-E_k)$?

    a) The transport distribution at energy, $E$.
    b) The mean-free-path at energy, $E$.
    c) The transmission at energy, $E$.
    d) The diffusion coefficient at energy, $E$.
    **e) The number of channels at energy, $E$.**