Quiz Week 12
ECE 656: Electronic Conduction In Semiconductors
Mark Lundstrom
Purdue University, Fall 2017

Answer the **multiple choice questions** below by choosing the **one, best answer**. Then **ask a question** about the lecture.

1) In class, we wrote the general balance equation for a quantity, n_ϕ, as $\frac{\partial n_\phi}{\partial t} = -\nabla \bullet \vec{F}_\phi + G_\phi - R_\phi$. What assumption is this equation based upon?
   a) That the semiconductor is non-degenerate.
   b) That the band structure is parabolic.
   c) That the temperature is uniform.
   d) That the electron temperature is equal to the phonon temperature.
   e) Only that the BTE is valid.

2) If $\phi(\vec{p}) = (E - F_n)\vec{\upsilon}$, where E is the total energy, then what is the associated flux in the balance equation?
   a) The kinetic energy flux.
   b) The total energy flux.
   c) The heat flux.
   d) The internal energy flux.
   e) The particle flux.

3) What is the quantity, $-q\mathcal{E}_i \left\{ \frac{1}{\Omega} \sum_{\vec{p}} \frac{\partial \phi}{\partial p_i} f \right\}$?
   a) The "physical quantity" term in the balance equation.
   b) The "associated flux" in the balance equation.
   c) The "generation term" in the balance equation.
   d) The "recombination" term in the balance equation.
   e) The drift term in the "associated flux".

4) When we write the recombination term as $R_\phi = (n_\phi - n_\phi^0) / \langle \tau_\phi \rangle$, what assumption are we making?
   a) Near equilibrium.
   b) The Relaxation Time Approximation.
   c) Non-degenerate carrier statistics.
   d) Steady-state conditions.
   e) Only that the BTE is valid.

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5) When we write the 1D current equation as $I_x = n_L q \mu_n \mathcal{E}_x + q D_n \, dn_L / dx$, what assumptions are we making?

a) Near-equilibrium conditions.
b) Time variations slow in comparison to the momentum relaxation time.
c) Uniform temperature.
d) All of the above.
e) b) and c) above.

6) When we write a balance equation for a quantity, n_ϕ, we always end up with an unknown, that we must write a new balance equation for. What is this unknown?

a) The associated flux for the quantity.
b) The generation term for the quantity.
c) The recombination term for the quantity.
d) The recombination time in the recombination term .
e) The electron temperature.

7) What does moment equation does $\phi(\vec{p}) = \upsilon_x \left(p^2 / 2m^* \right)$ give us?

a) The carrier continuity equation.
b) The carrier flux equation.
c) The carrier energy balance equation.
d) The carrier energy flux equation.
e) The carrier energy squared continuity equation.

8) What is the quantity, W_{xx} for parabolic energy bands?

a) The total energy density.
b) The kinetic energy density.
c) The kinetic energy density associated with one of the degrees of freedom.
d) The electron temperature.
e) The heat flux.

9) How is the hierarchy of balance equations terminated?

a) By assuming near-equilibrium conditions.
b) By assuming the Relaxation Time Approximation.
c) By invoking the Onsager Relations.
d) By expressing all of the quantities in the set of equations only in terms of quantities in same set of equations.
e) By using the NEGF equation.

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10) When we write the recombination term in the various balance equations as $R_\phi = \left(n_\phi - n_\phi^0\right) \Big/ \left\langle \tau_\phi \right\rangle$, sometimes a term corresponding to n_ϕ appears and a term corresponding to n_ϕ^0 **does not appear**. Why?

a) Under near-equilibrium conditions.
b) Under spatially uniform conditions.
c) When the balance equation corresponds to a moment higher than 2.
d) When the balance equation corresponds to a moment higher than 3.
e) When the quantity in the balance equation is a flux.

11) When we write a drift-diffusion equation in the form, $J_{nj} = nq\mu_n \mathcal{E}_j + \frac{2}{3}\mu_n \frac{\partial W}{\partial x_j}$, what assumption are we making?

a) Non-degenerate carrier statistics.
b) The temperature does not vary with position.
c) The electron temperature is equal to the lattice temperature.
d) The kinetic energy is equally distributed between the three degrees of freedom.
e) Only that the BTE is valid.