Week 7 Lecture 15 Quiz:
Near-Equilibrium Transport in the Bulk

ECE 656: Electronic Conduction In Semiconductors
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Purdue University, Fall 2013

Student's name: ________________________________

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

1) The electron current equation commonly used in semiconductor physics is written as $J_n = \sigma_n d(F_n/q)/dx$. To derive this from the Landauer approach, what assumptions are needed?

a) Near-equilibrium transport.
b) Constant temperature.
c) A conductor that is many mean-free-paths long.
d) Answers a) and c) above
e) Answers a) b), and c) above.

2) The drift-diffusion equation commonly used in semiconductor physics is written as $J_{nx} = nq\mu_n \mathcal{E}_x + qD_n dn/dx$. What assumption is **NOT needed** to derive this equation from the Landauer approach?

a) Near-equilibrium transport.
b) Constant temperature.
c) A conductor that is many mean-free-paths long.
d) Maxwell-Boltzmann statistics.
e) Steady-state conductions.

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3) Which of the following is correct about the conductivity of a 2D metal?

a) $\sigma_S = q^2 D_n(E_F) D_{2D}(E_F)$

b) $\sigma_S = q^2 D_{2D}(E_F) \dfrac{\upsilon^2(E_F)\tau(E_F)}{2}$

c) $\sigma_S = \dfrac{2q^2}{h} M_{2D}(E_F)\lambda(E_F)$

d) $\sigma_S = n_S q \left(\dfrac{q\tau(E_F)}{m^*} \right)$

e) All of the above are correct.

4) What is the quantity: $\dfrac{2q}{hn_S} \int \lambda(E) M_{2D}(E) \left(-\dfrac{\partial f_0}{\partial E} \right) dE$?

a) The conductivity of a 2D material.
b) The mobility of a 2D material.
c) The diffusion coefficient of a 2D material.
d) The average mean-free-path of a 2D material.
e) The resistivity of a 2D material.

5) How can we determine is a long resistor is operating in near-equilibrium conditions?
a) The voltage across the resistor must be less that $k_B T/q$.
b) The measured current is proportional to the applied voltage.
c) The magnitude of the electric field satisfies $\mathcal{E} << (k_B T/q)/\lambda_E$ where λ_E is the energy relaxation length.
d) a) and b) above.
e) a), b), and c) above.

6) What question do you have about this lecture?

Turn in to Prof. Lundstrom in class on Friday.