Quiz Answers Week 10
ECE 656: Electronic Conduction In Semiconductors

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1) What is the major problem with a 2-probe (as opposed to 4-probe) measurement of resistance (conductivity)?

   a) It includes the ballistic resistance.
   b) It includes the contact resistance.
   c) It generally requires specially designed test structures.
   d) It requires careful consideration of possible thermoelectric effects.
   e) It requires a high-impedance voltmeter.

2) What would be considered a low (but not unreasonably low) value of the interfacial contact resistivity?

   a) $\rho_C = 10^{-12}\ \Omega\text{-cm}^2$
   b) $\rho_C = 10^{-7}\ \Omega\text{-cm}^2$
   c) $\rho_C = 10^{-3}\ \Omega\text{-cm}^2$
   d) $\rho_C = 10^{1}\ \Omega\text{-cm}^2$.
   e) $\rho_C = 10^{3}\ \Omega\text{-cm}^2$

3) What is the transfer length, L_T?

   a) A parameter that describes the two-dimensional flow of current under a contact.
   b) A parameter that defines the effective width of a contact in lateral direction (along the direction of current flow in the resistor).
   c) A parameter related to the interfacial contact resistivity and resistivity of the semiconductor by $L_T = \sqrt{\rho_C / \rho_{SD}}$ cm.
   d) All of above.
   e) None of the above.

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4) Using a Hall bar geometry, what parameters can be measured?

   a) The contact resistance, carrier density, and mobility.
   b) The carrier density and mobility.
   c) **The resistivity and Hall concentration.**
   d) The transfer length, resistivity, and Hall concentration.
   e) The Hall concentration, the Hall mobility, and the interfacial contact resistivity.

5) What can we measure with a van der Pauw geometry that cannot be measured with a Hall bar geometry?

   a) The actual carrier concentration instead of the Hall concentration.
   b) The actual mobility instead of the Hall mobility.
   c) The Hall factor.
   d) The contact resistance.
   e) **Nothing – they are two different geometries for measuring the same quantities.**

6) The measured mobility vs. temperature characteristic typically displays a maximum at a certain temperature. Which of the following statements is true at the maximum?

   a) The semiconductor becomes degenerate.
   b) The semiconductor becomes nondegenerate.
   c) The free carriers freeze out.
   d) **Phonon scattering and ionized impurity scattering are equally important.**
   e) Phonon scattering is much more important that ionized impurity scattering.

7) Assume that $\vec{B} = B_z\hat{z}$ what is J_y according to $J_i = \sigma_S \mathcal{E}_i - \sigma_S \mu_H \varepsilon_{ijk} \mathcal{E}_j B_k$?

   a) $J_y = \sigma_S \mathcal{E}_y$
   b) $J_y = -\sigma_S \mu_H \mathcal{E}_x B_z$
   c) $J_y = +\sigma_S \mu_H \mathcal{E}_x B_z$
   d) $J_y = \sigma_S \mathcal{E}_y - \sigma_S \mu_H \mathcal{E}_x B_z$
   e) $J_y = \sigma_S \mathcal{E}_y + \sigma_S \mu_H \mathcal{E}_x B_z$

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8) We have seen that for parabolic bands in 2D with non-degenerate conditions, $\langle\langle\tau_m\rangle\rangle = \tau_0\,\Gamma(s+2)/\Gamma(2)$. What is the Hall coefficient, $r_H \equiv \langle\langle\tau_m^2\rangle\rangle / \langle\langle\tau_m\rangle\rangle^2$ is 2D?

a) $r_H = \Gamma(2s+2)/[\Gamma(2)]$.
b) $r_H = \Gamma(2s+2)\Gamma(2)/[\Gamma(s+2)]^2$
c) $r_H = \Gamma(2s+2)\Gamma(s+2)/[\Gamma(2)]^2$
d) $r_H = \Gamma(s+2)\Gamma(2)/[\Gamma(2s+2)]^2$
e) $r_H = \Gamma(3s+2)\Gamma(2)/[\Gamma(2s+2)]^2$.

9) Assume acoustic deformation potential (ADP) scattering (intravalley) dominates in a 2D semiconductor with parabolic energy bands. What is $\langle\langle\tau_m\rangle\rangle$?

a) $\langle\langle\tau_m\rangle\rangle = \tau_0$.
b) $\langle\langle\tau_m\rangle\rangle = \tau_0\,\Gamma(1/2)/\Gamma(2)$.
c) $\langle\langle\tau_m\rangle\rangle = \tau_0\,\Gamma(1)/\Gamma(2)$.
d) $\langle\langle\tau_m\rangle\rangle = \tau_0\,\Gamma(3/2)/\Gamma(2)$.
e) $\langle\langle\tau_m\rangle\rangle = \tau_0\,\Gamma(5/2)/\Gamma(2)$.

10) If the measured conductivity is independent of sheet carrier density in graphene, what is the dominant scattering mechanism likely to be?

a) Acoustic deformation potential scattering.
b) Optical deformation potential scattering.
c) Plasmon scattering.
d) Ionized impurity scattering.
e) Polar optical phonon scattering.