**Quiz Answers: Week 1**
**ECE 656: Electronic Conduction In Semiconductors**
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**Lecture 2 Quiz :**

1) Which bandstructure below best describes graphene?
   a) $E = E_C + \hbar^2 k^2 / \left(2m_n^*\right)$
   b) $E = E_V - \hbar^2 k^2 / \left(2m_p^*\right)$
   c) $E = \hbar \upsilon_F k$
   **d)** $E = \pm \hbar \upsilon_F k$
   e) $E = \pm \hbar \upsilon_F k^2$

2) What is the "crystal momentum" of an electron?
   a) $\vec{p} = m_0 \vec{\upsilon}$
   b) $\vec{p} = m_n^* \vec{\upsilon}$
   c) $\vec{p} = \left(m_n^* + m_p^*\right) \vec{\upsilon}$
   **d)** $\vec{p} = \hbar \vec{k}$
   e) $\vec{p} = \hbar^2 k^2 \vec{k}$

3) What is the quantity, $\psi\left(\vec{r}\right) = u\left(\vec{r}\right) e^{i\vec{k}\bullet\vec{r}}$, called?
   a) a plane wave electron wavefunction
   b) the envelope function
   c) an atomic orbital
   d) a Wannier function
   **e) a Bloch wave**

4) Consider a 2D semiconductor sheet in the x-y plane. The top surface is at $z = 0$ and the bottom at $z = t$. What is the wavefunction of the **second** subband? (Assume infinite confining potentials on the top and bottom).
   a) $\psi\left(\vec{r}\right) = \sin\left(\pi z / t\right) e^{i2k_x x} \times e^{i2k_y y}$
   b) $\psi\left(\vec{r}\right) = \cos\left(2\pi z / t\right) e^{ik_x x} \times e^{ik_y y}$
   **c)** $\psi\left(\vec{r}\right) = \sin\left(2\pi z / t\right) e^{ik_x x} \times e^{ik_y y}$
   d) $\psi\left(\vec{r}\right) = \cos\left(\pi z / t\right) e^{ik_x x} \times e^{ik_y y}$
   e) $\psi\left(\vec{r}\right) = \cos\left(2\pi z / t\right) e^{ik_x x} \times e^{ik_y y}$

5) What is a “quasi-electric field” for electrons?
   **a) A quantity that exerts a force on electrons due to variations in electron affinity**
   b) A quantity that exerts a force on electrons due to variations in bandgap
   c) A quantity that exerts a force on electrons due to variations in effective mass
   d) A quantity that exerts a force on electrons due to variations in the density of states
   e) A quantity that exerts a force on electrons and that is obtained by solving the Poisson equation.

**Lecture 3 Quiz:**

1) Which of the following is true about the density of states in *k*-space?
   a) It depends on the dimensionality of the semiconductor.
   b) States are spaced uniformly in k-space.
   c) It is independent of the semiconductor’s bandstructure.
   **d) All of the above.**
   e) None of the above.

2) Which of the following is true about the density of states in energy space?
   **a) It depends on the dimensionality of the semiconductor.**
   b) States are spaced uniformly in energy space.
   c) It is independent of the semiconductor’s bandstructure.
   d) All of the above.
   e) None of the above.

3) What is the quantity, $\dfrac{\sum_{k_x>0,k_y,k_z} \upsilon_x f_0\left(E_k\right)}{\sum_{k_x>0,k_y,k_z} f_0\left(E_k\right)}$ ?
   a) Zero.
   b) The average, thermal equilibrium electron velocity
   **c) The average, thermal equilibrium velocity of electrons with a +x-directed velocity**
   d) The rms thermal velocity
   e) The Richardson thermal velocity

4) What is the difference between a “script F” Fermi-Dirac integral, $\mathcal{F}_j(\eta_F)$ and a “roman F” Fermi-Dirac integral, $F_j(\eta_F)$?

a) There is no difference – they are the same quantity.

b) $\mathcal{F}_j(\eta_F) = dF_j/d\eta_F$

c) $F_j(\eta_F) = d\mathcal{F}_j/d\eta_F$

**d)** $F_j(\eta_F) = \Gamma(j+1)\mathcal{F}_j(\eta_F)$

e) $F_j(\eta_F) = \mathcal{F}_j(\eta_F)$ for $\eta_F << 0$

5) Which of the following is true when $\eta_F >> 0$?

a) $\mathcal{F}_j(\eta_F) \rightarrow \exp(\eta_F)$

b) $\mathcal{F}_j(\eta_F) > \exp(\eta_F)$

**c)** $\mathcal{F}_j(\eta_F) < \exp(\eta_F)$

d) $\mathcal{F}_j(\eta_F) \rightarrow \exp(\eta_F^j)$

e) $\mathcal{F}_j(\eta_F) \rightarrow 1$.