Week 1 Lecture 2 Quiz:
Bandstructure Review and Heterostructures

ECE 656: Electronic Conduction In Semiconductors

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

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

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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) $\psi(\vec{r}) = \sin(\pi z / t) e^{i2k_x x} \times e^{i2k_y y}$

b) $\psi(\vec{r}) = \cos(2\pi z / t) e^{ik_x x} \times e^{ik_y y}$

c) $\psi(\vec{r}) = \sin(2\pi z / t) e^{ik_x x} \times e^{ik_y y}$

d) $\psi(\vec{r}) = \cos(\pi z / t) e^{ik_x x} \times e^{ik_y y}$

e) $\psi(\vec{r}) = \cos(2\pi z / t) e^{ik_x x} \times e^{ik_y y}$

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.

6) What question do you have about this lecture?

Turn in to Prof. Lundstrom in class on Friday.