EE 505 – Nanostructures: Fundamentals and Applications

Fall 2013 **Prof. Carmen S. Menoni**
Homework #2 **Due Date: October 10, 2013**
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1. Explain which are characteristics of the electron wavefunction in a crystal. Provide a comparison for Schroedinger equation for a crystal compared with that for a hydrogen atom. Contrast also the eigenfunctions.
2. Explain band formation in a solid and provide main differences between a metal, insulator and semiconductor in terms of the band picture.
3. What is a hole?
4. Calculate the density of states in the conduction band of Ge for an excess energy ΔE=60 meV about the conduction band minimum. Calculate the total number of electrons at T=100K.
5. Explain how you would design a quantum well with a bandgap around 1.8 eV using III-V semiconductor materials. Assume a 50/50 conduction/valence band split. Calculate the number of confined eigenstates.
6. Explain the variation of the bandgap energy in a quantum dot material with dot size. Then explain main features of the figure in page 74 of the notes.
7. How is the interaction between an electron in a crystal and a photon modeled? How is Schroedinger equation modified?
8. Describe the differences between absorption and emission processes. What are conservation laws. Explain this in the context of the band diagram for a direct bandgap semiconductor material.
9. Exercise 3, Chapter 7. What is the physical meaning of the Fermi Energy?
10. Exercise 4, Chapter 7.
11. Exercise 8, Chapter 7.