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MID-SEMESTER EXAMINATION M.M. 30 DURATION: 2 HOURS
COURSE: INTRODUCTION TO NANOMATERIALS (PH 401) DATE: 17 – 09 – 2014
Attempt all Questions

Full Marks: 30

Time: 2hours

1. Fill in the blanks: **[0.5x5 = 2.5]**
   (i) Electrical conductivity in nanosize ceramics ..... compare to its bulk material.
   (ii) Magnetic coercivity of ferromagnetic material ..... upto a critical grain size (nanmeter range).
   (iii) Quantum efficiency of semiconductor crystals ..... with decrease in size in nanosize regime.
   (iv) Due to higher surface to volume ratio the catalytic efficiency of nanomaterial.....
   (v) Electrical conductivity for metals..... in nanomaterials compare to its bulk form.

2. Answer all the questions: **[1x8 = 8]**
   (i) Write the summery of Richard Feynaman talk" there is plenty of room at the bottom".
   (ii) What is the difference between conventional engineering and nanoengineering?
   (iii) Define nanoscience and nanotechnology.
   (iv) What characteristic of the butterfly morpho peleids limpida makes it beautiful colour? Explain.
   (v) Describe the hydrophobicity of leaves of trees and wings of bird and, explain how the concept has been used to develop technology?
   (vi) Define the 0, 1, 2 & 3 degree/s of confinement of material. Give one example from each category.
   (vii) What is the length scale order of strong confinement of electron inside the metal?
   (viii) Why the strength of the material increases with the decrease of grain size?

3. 300 nm thick (3.05 mm radius) disks with refractive index of 1.57 are floating on water (refractive index of water= 1.33). What will be the colour of sections, if we look it from the top? If somebody look at an angle of 60° to the surface of water, the colour of section will change or remain same? Justify your answer. **[3]**

4. Draw a graph between critical dimension (nm) and surface-to-volume ratio (nm^{-1}) for sphere, cylinder and cube. Discuss the significance of the curve in nano meter range. **[2]**

5. Define magic number in nanoscience. Write the structural magic numbers for cubo-octahedral FCC nanoparticle. **[4]**

6. Effective masses of electron and hole for InSb semiconductor are $0.014m_o$ and $0.4m_h$ respectively. Find the strong, intermediate and weak confinement region for the semiconductor. Sketch your result. [velocity of electron/hole is 10^5 m/s inside the semiconductor, Planck's constant= $6.62x10^{-34}$Js, $m_o=9.31x10^{-31}$kg]. **[3]**

7. Find out the melting point of spherical Gold nanoparticle of radius 80nm and 2nm. Plot the melting point versus radius of spherical gold nanoparticle. Melting point of Gold = 1336^0C, Boiling point of Gold = 2933^0C, Latent heat of Fusion of Gold = 15.4Cal/g, Latent heat of vaporization of Gold =377Cal/g and solid liquid interface surface energy for Gold = $132x10^{-3}Jm^{-2}$. **[2.5]**

8. What is the resolution of projection/ lithography system with a 100kV electron source. Assume n (refractive index) is 1.4 and projection angle $\theta=70°$. Use the equipment constant 0.75. **[2]**

9. Explain the photolithography with diagram. What is positive and negative resist in lithography? How photolithography differs from nanoimprint lithography? **[3]**

----------BEST OF LUCK----------