Indian Institute of Technology Patna

Bihta, Patna – 801106, India
DEPARTMENT OF PHYSICS

MID-SEMESTER EXAMINATION DATE: 25-09-2019

Time: 2hours **Full Marks: 30**

COURSE NO: PH401 COURSE TITLE: Introduction to Nanomaterials Attempt all Questions

(Note: No explanation during the examination)

1. Why not engineering possible beyond 10^{-10}m in length scale? [2]
2. Does molecular machine exist today? If yes, give an example. If not, Why? [2]
3. What was the gist of Feynman lecture "There's plenty of room at the bottom" at **Caltech** on 1959? [2]
4. Write degrees of confinement and degrees of freedom for bulk, quantum well, nanowire and quantum dot. [2]
5. Lenses are to be antireflected for ultraviolet electromagnetic radiation of wavelength 200nm. MgF_2 with n_f=1.40 is available with an engineer. What will be the thickness of quoting on the lens of refractive index n_{lense}=1.48 to protect UV-light of wavelength 200nm?

   Or

   Write a short note on top down method. [3]
6. Discuss the process of photolithography.

   Or

   Why is the electron lithography required for nanotechnology? What will be the resolution of electron lithography by using an electron of wavelength ($\lambda\sim$)2nm? Consider the best arrangement of the lithography set-up. Use the instrumental constant 0.6 and refractive index 1.5. [3]
7. Write a short note on ball mill method to produce nanomaterials. What is the ultimate size can be achieved in this method?

   Or

   Write a short note on pulse laser deposition. [3]
8. What is/are the difference/s between multicolours in butterfly morpho peleides limpida and Lycurgus cup, 4th century AD (Now at British museum, London)? What are the reasons for both multicolours? How are these causes used for modern technological development? Give two examples of commercial products from each category. [4]
9. What is the confinement in the semiconductor? Find out the confinement length for CdS semiconductor. The effective masses of hole and electron are $m_e \approx 0.2m_0$ and $m_a \approx 0.7\ m_0$ [m_0 is the rest mass of an electron]. Velocity of hole and electron are in the order of 10^5m/s. Sketch the different confinement lengths for the above semiconductor.[Rest mass of the electron = 9.1×10^{-31}kg and plank's constant= 6.63×10^{-34} m^2 kg/s] [4]
10. What is the magic number for the nanoparticles? Derive the expression to obtain the magic numbers for FCC structure. Sketch the surface to volume atom ratio versus particle size for this structure and discuss its importance for nanoscience. [5]

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