



Indian Institute of Technology Patna
End Semester Examination (End-Sem) (Aug-Nov-2013)

COURSE NO: PH401

COURSE TITLE: Introduction to Nanomaterials

Duration: 3 hours

Full Marks: 50

1. Answer All the questions:

[7x2=14]

- (i) What is principle of optical recording devices? How nanotechnology helps on optical memory devices?
- (ii) How magnetic cooling differs from conventional refrigeration?
- (iii) How defects in nanosize controls the strength of the material?
- (iv) Why specific heat of nanomaterials is higher than that of its bulk materials?
- (v) Write the properties (at least 4) of carbon nanotube.
- (vi) Plot the energy versus DOS (Density of States) for (a) (9,9) metallic conducting CNT (Carbon Nanotubes) and (b) (7,11) semiconducting CNT.
- (vii) Why the strength of nanocomposite is more than the bulk materials?

2. Answer All the questions:

[5x3=15]

- (i) What are the concepts (mode of operation) of catilevers as sensor? Describe the concepts.
- (ii) What are the materials used for MEMS and NEMS device? Give two examples from each category of metallic, semiconductor and oxides.
- (iii) Give an account of different class of materials.
- (iv) What is meaning of magnetic domain wall? What type/s of domain wall present in case of thin films. Pictorially demonstrate the different magnetic domain wall in thin film.
- (v) Define Zig-zag, armchair and helical nanotube. Illustrate the chiral vectors of these three nanotubes.

3. How can MEMS cantilever beams being used as nanomechanical resonator, pressure sensor, thermopneumatic valve, thermal data storage device and biosensors? Can one MEMS device integrate all the above sensors? If yes, draw the block diagram for it. If no, give the reason, why not? [5]

4. What are the primary types of magnetic recording media? What is GMR? How GMR phenomena can be used to develop a magnetic recording media? Give two examples of memory devices developed by GMR concept. [4]

5. What is the tensile strength (σ_s) of C-C (bond order = 1, Bond length = 0.154 and bond dissociation energy = 348 kJ.mol⁻¹) and C≡C (bond order = 1.33, Bond length = 0.142 and bond dissociation energy = 480 kJ.mol⁻¹)? How much mass under earth's gravitational pull are these bonds able to hold without braking? [4]

6. Determine the diameter for the following nanotubes: (6,6), (8,8) (42,55) and (13,72). Identify the electrical nature of nanotubes. [4]

7. Write a short note on coulomb blockade. How it is applied to nanotransistors i.e. single electron transistor? Plot the V-I characteristic of nanoconductors. Two Cu nanoparticles of diameter 1 nm each combined and make a bigger nanoparticle. What is the net resistance of bigger Cu nanoparticle if the individual Cu nanoparticle (1 nm) resistance is 12 mΩ. [4]

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