

Seat No. : \_\_\_\_\_

# MF-121

March-2019

B.Sc., Sem.-V

## CC-305A : Physics + Electronics (Nanoscience & Nanotechnology)

Time : 2:30 Hours]

[Max. Marks : 70

- Instructions :**
- (1) All the questions are compulsory.
  - (2) The symbols have their usual meanings.
  - (3) The figures to the right inside bracket indicate full marks.

1. (A) (i) What are Nano materials ? Give the detailed classification of nano materials. Discuss the comparison between two types of excitons. 7
- (ii) Discuss the structural properties of nanomaterials by considering the illustrations of ZnS and CdSe nanoparticles. 7

**OR**

- (i) Define the mechanical properties :
- (1) Young modulus
  - (2) Plastic deformation
  - (3) Hardness
- Discuss the quantum size effects for these properties in nanomaterials.
- (ii) What are ferromagnetic materials ? Name the different magnetic nano materials. Describe the important magnetic behaviour of magnetic particles at nanometer scale.
- (B) Answer the following questions in short (Any **Four**) : 4
- (i) What is a quantum dot ?
  - (ii) Define Vicker Hardness (VHN) scale to measure the hardness of the material.
  - (iii) On which electroluminescence principle does the light emitting diode (LED) work ?
  - (iv) What is a spin valve ?
  - (v) What will be the quantum size effect on the optical property of CdSe nanoparticles when their size is reduced from 5 nm to 2 nm ?
  - (vi) Why has the nano crystalline material has more electrical resistance compared to the polycrystalline material ?

2. (A) (i) Show a chart representing different methods for the synthesis of nanomaterials. What are top-down and bottom-up approaches for the synthesis of nanomaterials ? Classify the different syntheses methods listed in above shown chart into top-down and bottom-up approaches. 7

(ii) What are colloids ? Give the illustrations of different colloids. Describe a method to synthesize gold nanoparticles through the colloidal route. 7

**OR**

(i) In context to chemical method for the synthesis of nanomaterials, answer the following questions :

(a) What are sols and gels ?

(b) What is the sol-gel method ?

(c) Write the importance and advantages of sol-gel method.

(d) Show the sol-gel options to synthesize aerogels and ceramic fibers with a neat schematic diagram.

(ii) State the important properties of carbon nano tubes (CNTs). Using a neat sketch showing different folding axis on a graphene-sheet of carbon nano tube, describe the terms chiral vector, chiral tube, diameter and angle of folding for carbon nano tube. Represent the table illustrating different type of carbon nano tubes.

(B) Answer the following questions in short (Any **Four**) : 4

(i) What is an Ostwald ripening ?

(ii) Name the illustration of two important biocolloids.

(iii) What is an Elay-Riedel mechanism for the growth of nanomaterials ?

(iv) What is a graphene ?

(v) What is meant for chemical capping used in the synthesis of semiconductor nanoparticles ?

(vi) Why is the silica gel considered as an ideal gel to synthesize nanomaterials ?

3. (a) (i) What is meant for the characterization of nano materials ? Describe the different type of characterization methods and their importance in characterizing materials in detail. 7

(ii) What is an X-ray diffraction ? Derive Scherrer equation to determine the size of nano particles based on diffraction phenomenon. What would be the broadening of diffraction peak caused by ZnS nano particle of 15 nm size when the monochromatic X-rays of 1.542 Å wavelength are scattered at the Bragg angle of 14.5° ? 7

**OR**

- (i) Discuss the analogy between electron and optical microscopy. With the help of a neat sketch, describe the interaction of high energy electrons with solid sample producing different electromagnetic radiations.
- (ii) For the nano technological applications,
  - (a) What is the use of aerogels in space and defense ?
  - (b) How can the nanotechnology fulfill the power requirements in satellite and spaceship ?
  - (c) How can the biological labelling be achieved with nanotechnology ?

(B) Answer the following questions in short : (Any **Three**)

**3**

- (i) What is an electrocryomicroscope ?
- (ii) What do you mean by a technique called EDAX ?
- (iii) What is the spintronics ?
- (iv) Write the principle of a confocal electron microscope.
- (v) What will be the wavelength of an electron beam excited with 50 kV electric potential ? (Planck's constant =  $6.62 \times 10^{-34}$  J s, electron charge =  $1.6 \times 10^{-19}$  C and electron mass =  $9.1 \times 10^{-31}$  kg)

4. (A) (i) What is the luminescence in the semi-conducting materials ? Name the different principles involved in the luminescence property of material and describe the thermoluminescence phenomenon in detail. 7

(ii) Name the different physical methods used in the synthesis of nano materials. Using a neat schematic diagram, explain Physics Vapour Deposition (PVD) technique to synthesize nano materials. 7

**OR**

(i) List the carbeneous nanomaterials of different dimensions. Discuss the important features of  $C_{60}$  fullerene. What are endohedral and exohedral fullerenes ?

(ii) Explain the concepts of atomic scattering factor and crystal structure factor. The unit cell of sodium chloride (NaCl) having F.C.C. structure has four  $Na^+$  and four  $Cl^-$  ions located at  $(0, 0, 0)$ ,  $(0, 1/2, 1/2)$ ,  $(1/2, 1/2, 0)$ ,  $(1/2, 0, 1/2)$  and  $(1/2, 0, 0)$ ,  $(0, 1/2, 0)$ ,  $(0, 0, 1/2)$ ,  $(1/2, 1/2, 1/2)$  respectively. If the atomic scattering factor for  $Na^+$  and  $Cl^-$  ions are  $f_1$  and  $f_2$  respectively, then using the structure factor formula show that the intensity of X-rays scattered from  $[1\ 0\ 0]$  plane of the NaCl crystal is zero.

(B) Answer the following questions in short : (Any **three**)

**3**

- (i) Which is the characterization technique used to study the electronic structure of nanomaterials ?
  - (ii) Why is the vacuum required for imaging in scanning electron microscope (SEM) and the transmission electron microscope (TEM) ?
  - (iii) How will you increase the conductivity of C<sub>60</sub> fullerene ?
  - (iv) What are super paramagnetic particles ?
  - (v) Which type of carbon nano tubes exhibits metallic behaviour ?
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