

Seat No. : _____

ML-110

May-2022

B.Sc., Sem.-V

SE-305 (A) : Physics (Nanoscience and Nanotechnology)

Time : 2 Hours]

[Max. Marks : 50

- Instructions :**
- (1) All questions in Section-I carry equal marks.
 - (2) Attempt any **three** questions in Section-I.
 - (3) Question **9** in Section-II is **COMPULSORY**.

SECTION-I

1. (A) Describe the development of various nano sized materials from early human civilization to presently developed nano structures. How can Mollusk and Flagella play the useful role as natural nano materials ? 7
- (B) Discuss the size dependent properties of semiconducting nano particles at the size of an exciton. Illustrate the size dependent properties of Cd_3P_2 and CdS semiconducting materials at nanometer dimension. 7
2. (A) Define the phenomenon of luminescence in the semiconducting nanomaterials. Name the different principles involved in the luminescence property of material and describe any one of them in detail. 7
- (B) In context to mechanical properties of materials, define :
 - (i) Young modulus
 - (ii) Plastic deformation and
 - (iii) Hardness

Discuss the effect of reducing the size from bulk to nanometer on the young modulus and hardness of material. 7

3. (A) Define an electrical conductivity of a material. How will you measure an electrical conductivity of metal cluster of nanometer dimension ? With the necessary diagram explain the terms Coulomb blockade and Coulomb staircase. 7
- (B) Name the different magnetic nano materials. Describe magnetic multilayers in detail. Give the schematic representation of magnetic multilayers showing ferromagnetic and antiferromagnetic coupling. 7
4. (A) Show a chart representing different methods for the synthesis of nanomaterials. Describe the top-down and bottom-up approaches for the synthesis of nanomaterials. Give the three illustrations of method involving top-down and bottom-up approaches each. 7
- (B) Draw the labelled diagram of Physical Vapour Deposition (PVD) method and answer the following questions in brief : 7
- (i) What is the use of a cold finger and scraper in the equipment ?
- (ii) Why is the distance between a source and cold finger an important factor ?
- (iii) Why is the inert gas required in the experiment ?
- (iv) What is used to cool the cold finger in the deposition chamber ?
5. (A) What are colloids ? Give the illustrations of different colloids. Explain the growth mechanism of nano particles using La-Mer diagram. 7
- (B) What is a planetary ball mill ? Describe the high energy ball milling process to obtain the nano material of desired dimension. 7
6. (A) Draw a neat sketch showing different folding axis on a graphene-sheet of carbon nano tube. Describe the terms chiral vector, achiral tube, diameter and angle of folding for carbon nano tube. A chiral vector in carbon nano tube is represented as $\vec{R} = 4\hat{x} + 3\hat{y}$. If the distance between any two nearest carbon atoms is 1.2 \AA , calculate the diameter and folding angle of such carbon nano tube. 7
- (B) Give-the properties of carbon nano tubes. Show the experimental set up of electric arc discharge method and give its general specifications. Describe how this method helps to produce Multi Walled Carbon Nano Tubes (MWCNTs) 7

7. (A) What is meant for the characterization of nano materials ? Name the main characterization methods to analyze the materials. Discuss the analogy between electron and optical microscopy. What will be the wavelength of an electron beam excited with 40 kV electrical potential ?
(Given $h = 6.62 \times 10^{-34}$ J s, $e = 1.6 \times 10^{-19}$ C and $m = 9.1 \times 10^{-31}$ Kg). 7
- (B) Derive Scherrer equation to determine the size of nano particles using X-ray diffraction. The broadening of diffraction peak caused by ZnS nano particle is of 0.5° when the monochromatic X-rays of 1.542 \AA wavelength are scattered at the Bragg angle of 15° . Calculate the size of the nano particle in nanometer. 7
8. (A) In context to nano technological applications, 7
- (i) Describe the role of titania (TiO_2) nano particles in automobile.
- (ii) Why are the nanomaterials important in the textile and cosmetics ?
- (B) For the nano technological applications, 7
- (i) How can the biological labelling be achieved with nano technology ?
- (ii) How is the spintronics useful in the development of nanotechnology ?

SECTION-II

9. Attempt any **EIGHT** : 8
- (1) Which is the type of electron microscope used to investigate the morphology of synthesized nano solids ?
- (2) What are ferrimagnetic materials ?
- (3) Which is the type of excitons result in the CdSe quantum dots ?
- (4) The structural transformation for the bulk crystalline Cadmium selenide (CdSe) material for hexagonal to octahedral requires 2 GPa (Giga Pascal) pressure to be applied on it. How much should be the pressure required to get similar structural transformation for nano crystalline CdSe nano particles of 1.2 nm size ?
- (5) Define Surface Plasmon Resonance in metallic nano particles.

- (6) In which range of electromagnetic radiation does the surface plasmon resonance (SPR) appear for gold and silver nano particles ?
- (7) A Chiral vector in a Carbon Nano Tube (CNT) is represented as $\vec{R} = 3\hat{x} + 3\hat{y}$.
What will be the type of such CNT and the folding angle for the same ?
- (8) What is the Langmuir-Hinshelwood mechanism for the growth of nanomaterials ?
- (9) Name the colloidal route through which gold nano particles are synthesized.
- (10) Which is the characterization technique used to determine electronic structure of nano materials ?
- (11) How can the resolution of image be tuned to large value in an electron microscope ?
- (12) When all the atoms of the same plane receiving X-rays at the same incident angle, what will be the result on the scattered X-rays ?
- (13) Show the intensity distribution of X-rays diffracted from nano crystalline solid.
- (14) Determine the atomic scattering factor for carbon atom when the X-rays of 0.7173 \AA are scattered at half angle of 30° by it.
- (15) What do you mean by the diffraction techniques called SAXS and SANS ?
- (16) What is the difference between aerogels and zeolites ?
