B.Sc. 5th Semester (Honours) Examination, 2022 (CBCS)

Subject : Physics

Course : DSE-2(3)

(Nano Materials and Applications)

Time: 2 Hours   **Full Marks: 40**

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Symbols and abbreviations have their usual meanings.

1. Answer *any five* of the following questions: 2×5=10

   (a) What are the induced effects due to increase in surface area of nanoparticles?

   (b) Write down the advantages of bottom-up synthesis methods of nanomaterial.

   (c) Define quantum dot. In which way is it different from an atom?

   (d) Compare between the traditional optical microscope and electron microscope.

   (e) An electron beam can undergo diffraction by a crystal. Through what potential should a beam of electron be accelerated so that its wavelength becomes equal to 1.54Å?

   (f) What is Quasi-particle? How does it differ from real particles?

   (g) State the main differences between edge dislocation and screw dislocation.

   (h) What are the advantages of nanowire solar cell compared to their bulk counterpart?

2. Answer *any two* of the following questions: 5×2=10

   (a) Briefly explain the meaning of quantum confinement. An electron of energy E is incident on a step potential of height $V_O = 10\ eV$. Find the transmission coefficient T and reflection coefficient R in the following cases:

      (i) $E = 7\ eV$

      (ii) $E = 20\ eV$ 2+3=5

   (b) What is electrodeposition process for thin film fabrication? What are advantages of this synthesis process? State some applications of electrodeposition method.   1+2+2=5

   (c) What is the difference between electrical band gap and optical band gap? How are these band gaps measured experimentally? Will they be same for ZnO material?   2+2+1=5

   (d) Draw the schematic diagram depicting the working principle of any one of the following:

      (i) Scanning Electron Microscope

      (ii) Atomic Force Microscope   5

3. Answer *any two* of the following questions: 10×2=20

  (a) Describe Ball milling process for synthesis of nanoparticles with a neat sketch. List the factors influencing the size of the products in ball mill.   7+3=10

  (b) (i) Explain briefly the method of determining crystallite size from XRD spectrum using Scherrer's formula. Calculate crystallite size of nanoparticle with FWHM – 0.14 deg, $\lambda = 0.154$ nm and $\theta = 45$ deg.

     (ii) Derive necessary formula for indexing X-ray diffraction patterns obtained from materials with a cubic structure.   (4+2)+4=10

  (c) (i) What is meant by hopping conduction? Explain why the hopping process is variable.

     (ii) State Mott's law of variable range hopping conduction. What are the important assumptions in deriving Mott's law? Under what conditions, Mott's law is valid?   3+7=10

  (d) Discuss briefly the major applications of quantum dots (QDs) in LED. Outline the applications of QDs in bioimaging. Why are QDs beneficial for photovoltaic devices?   4+4+2=10

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