2024

(May)

PHYSICS

Discipline Specific Elective

(*Mano Materials and Applications*)

Course Code : **PHY-DS-T4-602**

Credit : **4**

Total Marks : 56 Time : $2^1/_2$ Hours

The figures in the margin indicate full marks for the questions

1. (*a*) The branch of Physics where the length scale of the phenomena can be described in terms of the De-Broglie wavelength is - 1

(*i*) Classical mechanics (*ii*) Quantum mechanics

(*iii*) Relativity (*iv*) High energy

(***Choose the correct answer***)

(*b*) In a 3D object, the confinement of charge carriers occurs in – 1

(*i*) 1 dimension (*ii*) 2 dimension

(*iii*) 3 dimension (*iv*) None of the above

(***Choose the correct answer***)

Contd 2

(c) Find the expression for the density of states for a particle of mass m^* with energy lying between E and $E+dE$. 8

Or

Find the expression for the density of state for 2D, 1D nanoparticles. 6+2=8

2. (a) Which of the following is a mechanical method for nano-material synthesis ? 1

(i) Ball milling (ii) Laser ablation

(iii) Spray pyrolysis (iv) Sol-gel-method

(***Choose the correct answer***)

(b) What are the two main functions of the carrier gas in CVD technique of synthesis of nanoparticles ? 2

(c) Describe briefly e-beam evaporation or the pulsed laser deposition method for synthesis of nanoparticles. 5

3. (a) Back scattered electrons and secondary electrons from the sample are essential for imaging in – 1

(i) AFM (ii) SEM

(iii) TEM (iv) STM

(***Choose the correct answer***)

Contd 3

(*b*) Mention two parameters that can be calculated from XRD pattern. Mention one advantage and one disadvantage of XRD method of characterization of sample. $^1/_2+^1/_2+1+1=3$

(*c*) Discuss the principles of a Scanning Electron Microscopy (STM). Mention two applications of STM. 3+1=4

Or

Discuss the principles of Transmission Electron Microscopy (TEM). Mention two advantages of TEM over Scanning Electron Microscopy (SEM). 3+1=4

4. (*a*) In case of photoluminescence, the external stimulus is – 1

(*i*) Electric field (*ii*) Photon

(*iii*) Heat

(***Choose the correct answer***)

(*b*) What are excitons ? Discuss how it is formed in direct and indirect band gap semiconductor ? 1+4=5

(*c*) Find the expression for the Coulomb force of interaction between a dielectric and a point charge. 6

5. (*a*) When a pair of cation and anion pair is missing from the lattice site, the defect is known as – 1

(*i*) Line imperfection (*ii*) Frenkel defect

(*iii*) Schottky defect (*iv*) Dislocation

(***Choose the correct answer***)

(*b*) Explain the Coulomb blocked effect. Name a device that is constructed on the basis of this phenomenon. 4+1=5

6. (*a*) Mention two properties of Carbon nanotubes. 2

(*b*) Write short note on (***any two***) : 5×2=10

(*i*) Nanoparticles for optical switching

(*ii*) MEMS and NEMS

(*iii*) Magnetic data storage

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