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6 SEM TDC DSE PHY (CBCS) 2 (H)

2024

(May)

PHYSICS

(Discipline Specific Elective)

(For Honours)

Paper : DSE–2

(Nanomaterials and Applications)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option of the following : 1×5=5

(a) STM can only scan

(i) insulating surfaces

(ii) conducting surfaces

(iii) polymer materials

(iv) None of the above

(b) The resolving power of TEM is derived from

(i) electrons

(ii) specimens

(iii) voltage applied

(iv) pressure

(c) X-ray crystallography is a form of

(i) Raman scattering

(ii) Inelastic scattering

(iii) Elastic scattering

(iv) None of the above

(d) The main consequence of disorder in the electronic structures of the material is the appearance of

(i) localized states

(ii) valence band

(iii) conduction band

(iv) None of the above

(e) The phenomenon used by single-electron devices for their operations is

(i) optical storage

(ii) tunneling effect

(iii) Coulomb blockage

(iv) None of the above

2. (a) What is quantum confinement? 2

(b) Briefly explain top-down and bottom-up approaches with examples. 2+2=4

(c) What is excitonic Bohr radius? How is dielectric constant affect the excitonic Bohr radius of a semiconductor material? 1+1=2

(d) Calculate the ground state exciton binding energy for GaAs. Given, $m_e^* = 0 \cdot 067\, m_e$, $m_h^* = 0 \cdot 5\, m_e$. Where m_e is free electron mass and the dielectric constant of GaAs is 12·93. 3

3. (a) Define density of states. Derive an expression for density of states for two dimensional materials and plot it as a function of energy. 1+3+1=5

(b) Explain quantum wires and quantum dots on the basis of their dimensions. 1½+1½=3

(c) Discuss the working of quantum dot heterostructures (QDHS) laser. 3

4. (a) What is a ball mill? Describe its working and state the various key factors responsible for selecting a grinding media in a ball mill. 1+4=5

(b) Distinguish between Mott-Wannier and Frenkel excitons. 2

5. (a) What is Coulomb blockage effect? Why is Coulomb blockage observed usually at low temperature? 2+2=4

(b) Explain the use of nanowires in making solar cells. 3

6. Discuss the working principle of an atomic force microscope (AFM). What are the different modes of operations of AFM? 4+2=6

Or

Explain the construction and working principle of scanning electron microscopy (SEM). 6

7. Write short notes on any *two* of the following : 3×2=6

(a) Carbon nanotubes based transistors

(b) NEMS

(c) Optical properties of nanostructures

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