Total No. of Printed Pages—4

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

2023

(May/June)

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 from the following : 1×5=5

(a) The density of states for a zero-dimensional system shows the variation like that of a

(i) δ-function

(ii) exponential function

(iii) step-like behaviour

(iv) None of the above

(b) Which of the following is an example of a top-down approach?
(i) Molecular beam epitaxy
(ii) Mechanical grinding
(iii) Gas phase condensation
(iv) Molecular self-assembly

(c) Mott-Wannier exciton cannot be formed in which of the following materials?
(i) CdTe
(ii) CdSe
(iii) Si
(iv) NaCl

(d) Coulomb interaction happens in
(i) insulators
(ii) metals
(iii) semiconductors
(iv) All of the above

(e) The charging effect which blocks the injection of single charge into or from the quantum dot is
(i) tunneling effect
(ii) hopping effect
(iii) Coulomb blockage
(iv) None of the above

(Continued)

2. (a) Write down the basic difference between PVD and CVD techniques. 2

(b) Discuss the steps involved for synthesis of nanostructure materials by Sol-Gel method or spray pyrolysis method. 4

(c) Write the various factors that affect the resolving power of an optical instrument. 2

(d) Explain the different modes of operation of STM. 3

Or

Explain direct and indirect semi-conductors with schematic diagram. 3

3. (a) Give the schematic diagram and discuss the working principle of a transmission electron microscope. 4

(b) What is meant by optical storage? Describe briefly about various optical storage devices. 1+3=4

(c) Define density of states of materials at nanoregime. Derive the expression for density of states (DoS) of a three-dimensional bulk system. 1+3=4

4. (a) For an electron in a 1-D box of length 2 nm, calculate the energy separation between the levels for $n = 7$ and $n = 3$. 2

(Turn Over)

(b) How can the lowering of size affect band gap? 2

5. (a) What are excitons? Explain the different types of excitons. 1+2=3

(b) Calculate the exciton Bohr radius for CdSe. Given $m_e^* = 0 \cdot 13 m_e$, $m_h^* = 0 \cdot 4 m m_e$, where m_e is free electron mass and dielectric constant $\varepsilon = 9 \cdot 4$. 3

6. (a) How can thin films be used for making LEDs and solar cells? 3

(b) Write briefly about the charging effect in quantum dot. 3

(c) What is hopping conductivity? Mention different types of hopping conduction. 1+2=3

Or

What do you mean by surface defects and deep-level defects? 1½+1½=3

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

(a) Single-electron transistor

(b) Quantum dots in LED

(c) MEMS

★★★

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