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

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(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

(2)

- (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

(3)

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

- (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 $m_e^* = 0.13 m_e$, $m_h^* = 0.4 m m_e$, where m_e is free electron mass and dielectric constant $\epsilon = 9.4$. 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? $1\frac{1}{2}+1\frac{1}{2}=3$

7. Write short notes on any two of the following : $3 \times 2 = 6$
- (a) Single-electron transistor
- (b) Quantum dots in LED
- (c) MEMS
