No. of Printed Pages : 5

MPHE–027

M. SC. (PHYSICS)

(MSCPH)

Term-End Examination

June, 2025

MPHE–027 : NANOSCIENCE

Time : 2 Hours *Maximum Marks : 50*

***Note** : (i) Attempt any **five** questions.*

(ii) Use of calculator is allowed.

(iii) Symbols have their usual meanings.

(iv) The marks for each question are indicated against it.

1. (a) Explain any *five* uses of nanotechnology in the Prehistoric and Ancient Era. 5

   (b) Draw La Mer diagram and explain the growth mechanism in its *three* regions. 5

2. Explain with the help of proper diagrams the *four* significant modes of solid layer (thin film) growth. 10

3. (a) Explain the principle used in the sonochemical method of synthesizing nanoparticles. 5

   (b) What are the importance components used for green synthesis of nanoparticles ? What is meant by bio-template ? How is it useful in nanostructure synthesis ? 2+1+2

4. (a) Describe the first system used by Rice University group for the synthesis of fullerenes. How was the presence of cage molecules of carbon first discovered ? 4+1

   (b) What are Janus Particles ? Which methods can be used for preparing Janus particles ? 3+2

5. (a) Explain the origin of *two* absorption peaks in the absorption spectra for nano-rod structures of metals like gold. 5

   (b) Explain with band diagram the structure of Type I and reverse (inverted) Type I semiconductor core-shell particles. State *one* example of each. 5

6. What are composite materials ? What are nanocomposites ? Describe the *three* main types of nanocomposites. 2+2+6

7. (a) Explain the ballistic transport of electrons. 3

   (b) Derive the expression for quantum conductance of a nanowire connected to two reservoirs of electrons with chemical potentials μ_1 and μ_2 with $\mu_1 > \mu_2$. 5

   (c) Write the Landauer's formula for the conductance and explain the various terms. 2

8. (a) What are photonic crystals ? Draw labelled schematic representation of a 1-D photonic crystal and explain how the dimensionality of the crystal is decided. 4

(b) What are quantum materials ? 2

(c) Explain how a topological insulator is different from a conventional insulator. Give *one* example of a topological insulator. 4

Physical constants :

$h = 6.62 \times 10^{-34}$ J-s

$k_B = 1.38 \times 10^{-23}$ JK^{-1}

$c = 3 \times 10^{8}$ ms^{-1}

$\in_o = 8.854 \times 10^{-12}$ Fm^{-1}

$m_e = 9.1 \times 10^{-31}$ kg

$N_A = 6.022 \times 10^{26}$ kmol^{-1}

× × × × ×