D 121316 **(Pages : 2)** **Name.....**

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (CBCSS) [REGULAR / SUPPLEMENTARY] EXAMINATION, APRIL 2025

Physics

PHY 4E 16—SYNTHESIS, CHARACTERIZATION TECHNIQUES AND APPLICATIONS OF NANOMATERIALS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Section A

(8 Short questions, each answerable within 7½ minutes)
Answer **all** *questions.*
Each question carries a weightage of 1.

1. Explain the significance of the target material in the laser ablation method.
2. Briefly explain the two distinct stages in the formation of nanoparticles from a solution.
3. How can PL spectroscopy help in studying defects in semiconductors ?
4. What is the basic principle of atomic force microscopy ?
5. How does superconductivity enable SQUID to detect very weak magnetic fields ?
6. Explain the mechanism behind self-cleaning surfaces using nanomaterials.
7. What kind of samples are suitable for four probe resistivity measurements ?
8. Explain how NEMS differ from MEMS in terms of scale and functionality.

(8 × 1 = 8 weightage)

Section B

(4 Essay questions, Each answerable within 30 *minutes)*
Answer any **two** *questions.*
Each question carries a weightage of 5.

9. Discuss the physical methods for the synthesis of nanomaterials.
10. Describe scanning probe techniques such as AFM and STM, highlighting their working principles and applications in nanoscale imaging.
11. Discuss the impact of nanomaterials in biomedical fields.
12. Explain the concept, fabrication, and applications of nanodevices and nanomachines.

(2 × 5 = 10 weightage)

Turn over

Section C

(7 Problem questions, Each answerable within 15 *minutes)*

Answer any **four** *questions.*

Each question carries a weightage of 3.

13. Outline the steps involved in synthesizing nanoparticles using the microemulsion technique.

14. Explain how the sol-gel process allows control over particle size and porosity.

15. Calculate the Bragg diffraction angles for

    (a) first-order

    (b) second-order reflections,

    when X-rays of wavelength 1.20 Å are incident on a crystal with an interplanar spacing of 2.50 Å.

16. (a) Describe the principle of UV-Visible spectroscopy in the analysis of nanomaterials. How can it be used to distinguish between different types of nanomaterials ?

    (b) A sample solution in a cuvette with a path length of 2.5 cm transmits 25% of the incident light. Determine the concentration of the solution if the molar absorptivity is 3500 $dm^3mol^{-1}cm^{-1}$.

17. What is the Hall effect ? Describe a basic experimental setup for Hall effect measurement and list three key parameters of a semiconductor material that can be derived from these measurements.

18. Describe the principle behind superhydrophobic self-cleaning surfaces, often inspired by the "lotus effect". How do nanostructures on a surface contribute to achieving this extreme water repellency and self-cleaning ability ?

19. Explain the importance of supramolecular chemistry and non-covalent interactions in the design and bottom-up assembly of functional nanodevices or molecular machines.

(4 × 3 = 12 weightage)