

R4577

Sub. Code

25MNS2C1

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Nanoscience and Technology

SYNTHESIS OF NANOMATERIALS

(CBCS – 2025 onwards)

Time : 3 Hours

Maximum : 75 Marks

Part A

(10 × 1 = 10)

Answer **all** the following objective questions by choosing the correct option.

1. In inert gas condensation, the role of inert gas is to
(CO1, K1)
 - (a) Oxidize nanoparticles
 - (b) Enhance plasma density
 - (c) Control cooling and nucleation
 - (d) Increase evaporation rate
2. RF magnetron sputtering is preferred over DC sputtering for
(CO1, K1)
 - (a) Metallic targets only
 - (b) Insulating targets
 - (c) High vacuum systems
 - (d) Low deposition rates

3. Grain size control in sol—gel synthesis is mainly influenced by (CO2, K1)
- (a) Stirring speed
 - (b) pH and aging time
 - (c) Shape of container
 - (d) Type of solvent only
4. Sonochemical synthesis primarily utilizes (CO2, K1)
- (a) Thermal decomposition
 - (b) Cavitation effects
 - (c) Electrolysis
 - (d) Photoreduction
5. Hydrothermal synthesis is typically carried out under (CO3, K1)
- (a) Room temperature and pressure
 - (b) Low temperature vacuum
 - (c) High temperature and autogenous pressure
 - (d) Cryogenic conditions
6. Formation of nanoflowers is mainly governed by (CO3, K2)
- (a) Milling speed
 - (b) Supersaturation and growth kinetics
 - (c) Laser wavelength
 - (d) Type of substrate

7. Tungsten carbide balls are preferred in ball milling because of (CO4, K1)
- (a) Low density
 - (b) Chemical inertness and hardness
 - (c) Low cost
 - (d) Flexibility
8. Equal Channel Angular Pressing (ECAP) mainly induces (CO4, K2)
- (a) Grain growth
 - (b) Severe plastic deformation
 - (c) Oxidation
 - (d) Phase separation
9. Phycosynthesis refers to nanoparticle synthesis using (CO5, K1)
- (a) Bacteria
 - (b) Viruses
 - (c) Algae
 - (d) Proteins
10. DNA-templated nanostructures rely on (CO5, K1)
- (a) Magnetic interactions
 - (b) Base-pair recognition
 - (c) Thermal evaporation
 - (d) Electrochemical reduction

Part B

(5 × 5 = 25)

Answer **all** the questions not more than 500 words each.

11. (a) Explain the working principle of arc discharge method for nanoparticle synthesis. (CO1, K4)

Or

- (b) Discuss the advantages of pulsed laser deposition (PLD) over thermal evaporation. (CO1, K2)

12. (a) Describe the sol—gel process with emphasis on parameters controlling grain size. (CO2, K2)

Or

- (b) Explain the role of templates in microemulsion-based synthesis. (CO2, K2)

13. (a) Outline the principle of hydrothermal synthesis with suitable examples. (CO3, K5)

Or

- (b) Describe the growth mechanism of one-dimensional nanostructures under hydrothermal conditions. (CO3, K2)

14. (a) Explain the importance of material-to-ball ratio in ball milling. (CO4, K4)

Or

- (b) Compare wet milling and dry milling techniques. (CO4, K4)

15. (a) Describe microbial-mediated synthesis of nanoparticles. (CO5, K2)

Or

- (b) Explain protein-based bioproduct mediated nanoparticle synthesis. (CO5, K4)

Part C

(5 × 8 = 40)

Answer **all** the questions not more than 1000 words each.

16. (a) Discuss inert gas condensation and laser ablation techniques with schematic illustrations and applications. (CO1, K2)

Or

- (b) Explain RF and DC magnetron sputtering, highlighting their differences and applications. (CO1, K2)

17. (a) Describe solvothermal and photochemical synthesis methods and compare their advantages. (CO2, K2)

Or

- (b) Explain electrospinning technique for nanomaterial synthesis with process parameters. (CO2, K4)

18. (a) Discuss hydrothermal synthesis conditions required for controlled morphology of 3D nanostructures. (CO3, K4)

Or

- (b) Explain the synthesis and growth of carbon nanotubes using hydrothermal routes. (CO3, K4)

19. (a) Discuss severe plastic deformation techniques with emphasis on ECAP and HPT. (CO4, K2)

Or

- (b) Explain melt quenching and annealing processes for amorphous-to-crystalline transformations. (CO4, K4)

20. (a) Discuss photosynthesis and phycoynthesis methods for nanoparticle synthesis. (CO5, K2)

Or

- (b) Explain DNA-templated nanostructure formation and its significance in nanotechnology. (CO5, K4)
-

R4578

Sub. Code

25MNS2C2

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Nanoscience & Technology

MATERIALS CHARACTERIZATION TECHNIQUES

(CBCS – 2025 onwards)

Time : 3 Hours

Maximum : 75 Marks

Part A

(10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. Which technique is most suitable for measuring the hardness and elastic modulus of nanomaterials at the sub-micron scale? (CO1, K1)
 - (a) Rockwell Hardness Test
 - (b) Nanoindentation
 - (c) Brinell Test
 - (d) Tensile Testing
2. The ability of certain nanoceramics to undergo significant plastic deformation without failure is known as (CO1, K2)
 - (a) Elasticity
 - (b) Fatigue
 - (c) Super-plasticity
 - (d) Abrasion
3. In electrical characterization, the Hall Effect is primarily used to determine which of the following? (CO2, K1)
 - (a) Magnetic permeability
 - (b) Type of charge carriers and carrier density
 - (c) Dielectric constant
 - (d) Dipole relaxation time

4. The phenomenon where the magnetic moments of a material exhibit a lag behind the applied magnetic field is represented by a (CO2, K1)
- (a) Relaxation curve
 - (b) Hysteresis loop
 - (c) Impedance spectrum
 - (d) Activation energy plot
5. Which spectroscopic technique is based on the inelastic scattering of monochromatic light, usually from a laser? (CO3, K1)
- (a) UV-Visible Spectroscopy
 - (b) FTIR
 - (c) Raman Spectroscopy
 - (d) XPS
6. X-ray Diffraction (XRD) is primarily used in materials characterization to determine (CO3, K2)
- (a) Chemical oxidation states
 - (b) Crystal structure and phase identification
 - (c) Surface morphology
 - (d) Elemental composition of liquids.
7. Which microscopy technique utilizes a sharp probe that “scans” the surface to provide atomic-level 3D topographical images? (CO4, K2)
- (a) SEM
 - (b) TEM
 - (c) AFM (Atomic Force Microscopy)
 - (d) HRTEM

8. In Scanning Electron Microscopy (SEM), which signals are primarily responsible for providing morphological information about the sample surface? (CO4, K1)
- (a) Transmitted electrons
 - (b) Secondary electrons
 - (c) X-rays
 - (d) Auger electrons
9. The Butler-Volmer equation describes the relationship between electrical current and (CO5, K2)
- (a) Solution viscosity
 - (b) Overpotential at an electrode interface
 - (c) Particle size
 - (d) Magnetic coercivity
10. Which electrochemical technique involves sweeping the electrode potential linearly with time and measuring the resulting current? (CO5, K2)
- (a) Chronoamperometry
 - (b) Cyclic Voltammetry
 - (c) Galvanostatic charge-discharge
 - (d) Potentiometer

Part B

(5 × 5 = 25)

Answer **all** questions not more than 500 words each.

11. (a) Explain the principle of Nanoindentation. How is it used to determine the elastic modulus of a nanomaterial? (CO1, K3)

Or

- (b) (i) Define super-plasticity in nanoceramics.
- (ii) Discuss the factors that influence the wear resistance of nanoparticles. (CO1, K4)

12. (a) Describe the working principle of Vibrating Sample Magnetometer (VSM) for magnetic measurements. (CO2, K3)

Or

- (b) Explain the concept of Impedance Spectroscopy. How does it help in distinguishing between bulk and grain boundary capacitances? (CO2, K4)

13. (a) Compare and contrast UV-Visible spectroscopy and Photoluminescence (PL) spectroscopy in terms of their application in analyzing electronic properties. (CO3, K4)

Or

- (b) (i) State the principle of FTIR spectroscopy.
(ii) Explain how Raman spectroscopy is used as a non-destructive tool for structural characterization. (CO3, K3)

14. (a) Analyze the importance of Selected Area Electron Diffraction (SAED) in a TEM for identifying the crystal structure of a specific nanoparticle. (CO4, K4)

Or

- (b) Explain the mechanism of image formation in Scanning Tunneling Microscopy (STM). Mention its primary limitations. (CO4, K4)

15. (a) Derive the Stokes-Einstein equation and explain its significance in the context of ion interaction in electrochemical cells. (CO5, K3)

Or

- (b) Distinguish between Cyclic Voltammetry and Chronoamperometry. How are they used to study the kinetics of electrode reactions? (CO5, K4)

Part C

(5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Evaluate the mechanical behaviour of nanomembranes. Discuss how interconnected pores affect the plastic deformation of nanomaterials. (CO1, K5)

Or

- (b) (i) Elaborate on the failure stress and strain toughness of thin films.
(ii) Discuss the adhesion and friction properties of nanoparticles in NEMS applications. (CO1, K5)
17. (a) “The magnetic properties of materials change significantly when the grain size is reduced to the nanoscale.” Justify this statement with respect to coercivity and the hysteresis loop. (CO2, K5)

Or

- (b) Provide a comprehensive report on the principles, experimental techniques, and applications of ESR Spectroscopy in characterizing paramagnetic species. (CO2, K6)
18. (a) Design a characterization protocol using X-ray Photoelectron Spectroscopy (XPS) and ICP-OES to determine both the elemental composition and the oxidation state of a newly synthesized metal oxide nanocomposite. (CO3, K6)

Or

- (b) Explain the theory of X-ray Diffraction (XRD). How can Scherrer’s formula be applied to calculate the average crystallite size from an XRD pattern? (CO3, K5)

19. (a) Compare the imaging capabilities of Scanning Electron Microscopy (SEM) and High-Resolution Transmission Electron Microscopy (HRTEM). Which technique would you choose for atomic-level structural insights and why? (CO4, K5)

Or

- (b) (i) Describe the operational modes of Atomic Force Microscopy (AFM).
(ii) Explain how STEM provides better contrast for heavy atoms compared to conventional TEM. (CO4, K4)
20. (a) Formulate a detailed study on the Butler-Volmer equation. How does it describe the transition from reversible to irreversible electrochemical behaviour? (CO5, K6)

Or

- (b) Discuss the recent advances in electrochemical impedance spectroscopy (EIS) and its application in evaluating the galvanostatic charge-discharge cycles of nano-battery materials. (CO5, K5)
-

R4579

Sub. Code

25MNS2C3

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Nanoscience and Technology

NANOELECTRONICS AND NANODEVICES

(CBCS – 2025 onwards)

Time : 3 Hours

Maximum : 75 Marks

Part A

(10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. The fundamental limit where classical physics fails and quantum effects dominate in electronic devices is known as (CO1, K1)
 - (a) Moore's Law
 - (b) Quantum Confinement
 - (c) Thermal Limit
 - (d) Ohmic Regime
2. Which type of memory uses the polarization of dielectric materials to store information? (CO2, K2)
 - (a) SRAM
 - (b) FeRAM
 - (c) Flash
 - (d) DRAM
3. The Giant Magnetoresistance (GMR) effect is primarily used in (CO3, K2)
 - (a) Solar cells
 - (b) Hard disk drive sensors
 - (c) LEDs
 - (d) Capacitors

4. A “Single Electron Transistor” operates based on the principle of (CO4, K2)
- (a) Thermionic emission
 - (b) Coulomb Blockade
 - (c) Avionic drift
 - (d) Photoelectric effect
5. Which of these is a 1D nanostructure? (CO4, K1)
- (a) Quantum Well
 - (b) Quantum Dot
 - (c) Nanowire
 - (d) Bulk Silicon
6. In spintronics, information is processed using the of an electron (CO3, K1)
- (a) Charge
 - (b) Mass
 - (c) Spin
 - (d) Velocity
7. Which lithographic technique is most suitable for creating patterns at the atomic scale? (CO1, K2)
- (a) Photolithography
 - (b) Electron Beam Lithography
 - (c) X-ray lithography
 - (d) Nanoimprint
8. Quantum Cascade Lasers (QCLs) operate based on transitions within (CO5, K2)
- (a) Valence bands
 - (b) Conduction sub-bands
 - (c) P-N junctions
 - (d) Atomic nuclei
9. The primary advantage of OLEDs over traditional LCDs is (CO5, K2)
- (a) Higher power consumption
 - (b) Self-emission of light
 - (c) Slower response time
 - (d) Need for backlight

10. Carbon-based nanomaterials like Nanotubes are categorized as (CO5, K1)
- (a) Organic nanomaterials
 - (b) Inorganic nanomaterials
 - (c) Polymers
 - (d) Metallic alloys

Part B

(5 × 5 = 25)

Answer **all** questions not more than 500 words each.

11. (a) Explain the basic concept of Moore's Law and its limitations in nanoelectronics. (CO1, K2)

Or

- (b) Describe the lithographic techniques used for nanofabrication. (CO1, K2)

12. (a) Discuss the classification of semiconductor memory devices. (CO2, K2)

Or

- (b) Explain the working principle of a calorimetric sensor. (CO2, K4)

13. (a) Define the GMR effect and its significance in spintronics. (CO3, K2)

Or

- (b) What is spin-dependent tunneling? Explain briefly. (CO3, K2)

14. (a) Write a note on the architecture of a Single Electron Transistor (SET). (CO4, K3)

Or

- (b) Discuss the role of simulation in designing semiconductor nanodevices. (CO4, K3)

15. (a) Explain the preparation and properties of Quantum Dots. (CO5, K4)

Or

- (b) Describe the working of a Quantum Wire Laser. (CO5, K4)

Part C

(5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Elaborate on the physical fundamentals and tools required for micro and nano fabrication. (CO1, K2)

Or

- (b) Justify how quantum confinement changes the electronic properties of materials. (CO1, K5)
17. (a) Provide a detailed account of Ferroelectric Random Access Memory (FeRAM) circuit design. (CO2, K2)

Or

- (b) Illustrate the different types of sensors used for identifying hazardous gases in nano-scale environments. (CO2, K2)
18. (a) Derive and discuss the Landau-Lifshitz-Gilbert equation in the context of spin dynamics. (CO3, K2)

Or

- (b) Compare and contrast Ballistic Spin Transport with Diffusive Spin Transport. (CO3, K5)
19. (a) Evaluate the performance and challenges of nano-scale MOSFETs compared to bulk MOSFETs. (CO4, K5)

Or

- (b) Explain the concept and applications of Nanorobotics and Nanomanipulation. (CO4, K4)
20. (a) Discuss the evolution and working mechanism of Organic Light Emitting Diodes (OLEDs). (CO5, K4)

Or

- (b) Analyze the electronic and photonic properties of carbon-based nanomaterials. (CO5, K4)

R4580

Sub. Code

25MNS2C4

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Nanoscience and Technology

**NANOMATERIALS FOR BIOLOGICAL AND
ENVIRONMENTAL SENSORS**

(CBCS – 2025 onwards)

Time : 3 Hours

Maximum : 75 Marks

Part A

(10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. The biological element responsible for analyte recognition in a biosensor is called (CO1, K1)
 - (a) Transducer
 - (b) Bioreceptor
 - (c) Amplifier
 - (d) Signal processor
2. Which biosensor operates based on current measurement? (CO1, K2)
 - (a) Potentiometric
 - (b) Conductometric
 - (c) Amperometric
 - (d) Optical

3. Carbon nanotubes are mainly used in biosensors due to their (CO2, K2)
- (a) Optical transparency
 - (b) High electrical conductivity
 - (c) Low density
 - (d) Magnetic behavior
4. Which fabrication technique is MOST suitable for mass production of disposable biosensors? (CO2, K3)
- (a) Electron beam lithography
 - (b) Photolithography
 - (c) Screen printing
 - (d) Atomic layer deposition
5. Heavy metal pollutants become more hazardous in aquatic systems primarily because of (CO3, K4)
- (a) Rapid evaporation
 - (b) Biomagnification through food chains
 - (c) Photodegradation
 - (d) Chemical neutralization
6. Heavy metals are categorized as (CO3, K1)
- (a) Organic pollutants
 - (b) Biological pollutants
 - (c) Inorganic pollutants
 - (d) Radioactive pollutants

7. The sensing mechanism of SnO₂-based gas sensors is governed by (CO4, K4)
- (a) Proton conduction
 - (b) Surface adsorption and charge depletion
 - (c) Piezoelectric polarization
 - (d) Optical absorption coefficient
8. Metal oxide gas sensors mainly work on the principle of (CO4, K2)
- (a) Optical absorption
 - (b) Electrochemical reduction
 - (c) Oxidizing and reducing reactions
 - (d) Piezoelectricity
9. Surface plasmon resonance biosensors are extremely sensitive to changes occurring at (CO5, K4)
- (a) Bulk solution phase
 - (b) Metal—dielectric interface
 - (c) Entire optical path
 - (d) Detector surface only
10. Wearable biosensors require flexible substrates mainly to (CO5, K3)
- (a) Increase optical transparency
 - (b) Reduce signal noise
 - (c) Improve user comfort and conformability
 - (d) Enhance enzymatic activity

Part B

(5 × 5 = 25)

Answer **all** questions not more than 500 words each.

11. (a) Explain the components and working principle of an electrochemical biosensor. (CO1, K2)

Or

- (b) Describe label-free biosensing techniques. (CO1, K2)

12. (a) Discuss the role of carbon-based nanomaterials in biosensor performance. (CO2, K3)

Or

- (b) Explain screen printing and photolithography techniques in biosensor fabrication. (CO2, K3)

13. (a) Describe different types of environmental pollutants and their sources. (CO3, K3)

Or

- (b) Explain the working of water quality sensors. (CO3, K3)

14. (a) Discuss nanomaterials used in metal oxide gas sensors. (CO4, K4)

Or

- (b) Explain the fabrication techniques of gas sensors. (CO4, K4)

15. (a) Write an account on non-invasive biosensors. (CO5, K5)

Or

- (b) Explain the applications of SPR-based biosensors in disease diagnosis. (CO5, K5)

Part C

(5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Describe in detail the classification and working principles of biosensors. (CO1, K2)

Or

- (b) Explain quantum dots and FRET-based biosensing techniques. (CO1, K2)

17. (a) Analyze the impact of nanomaterials on biosensor sensitivity and selectivity. (CO2, K4)

Or

- (b) Discuss microfluidics and lab-on-a-chip integration in biosensors. (CO2, K4)

18. (a) Describe environmental monitoring sensors for air and soil quality. (CO3, K3)

Or

- (b) Explain light and pressure sensors used in environmental monitoring. (CO3, K3)

19. (a) Discuss gas sensing mechanisms with suitable diagrams. (CO4, K5)

Or

- (b) Evaluate real-world applications of nanomaterial-based gas sensors. (CO4, K5)

20. (a) Describe advanced biosensors used in point-of-care diagnostics. (CO5, K5)

Or

(b) Discuss wearable biosensors for healthcare management. (CO5, K5)

R4581

Sub. Code

25MNS2E1

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

NanoScience and Technology

**Elective : NANOMATERIALS FOR INFORMATION
STORAGE AND SEMICONDUCTOR DEVICES**

(CBCS – 2025 onwards)

Time : 3 Hours

Maximum : 75 Marks

Part A

(10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. Which type of data storage remains intact even when the power supply is disconnected? (CO1, K1)
 - (a) Volatile Memory
 - (b) Non-volatile Memory
 - (c) Dynamic Memory
 - (d) Cache Memory
2. In optical storage, the “Pit” and “Land” structure is read using which technology? (CO2, K1)
 - (a) Magnetic Induction
 - (b) Laser Reflection
 - (c) Electrical Resistance
 - (d) Thermal Expansion

3. Which solid-state memory type uses a “floating gate” transistor to store charge? (CO3, K1)
- (a) SRAM
 - (b) DRAM
 - (c) Flash Memory
 - (d) MRAM
4. The phenomenon where resistance changes based on the alignment of magnetic layers is called: (CO4, K1)
- (a) Hall Effect
 - (b) Giant Magneto resistance (GMR)
 - (c) Photoelectric Effect
 - (d) Seebeck Effect
5. What does “MEMS” stand for in semiconductor manufacturing? (CO5, K1)
- (a) Micro-Electromechanical Systems
 - (b) Macro-Electronic Mini Systems
 - (c) Magnetic-Electric Memory Storage
 - (d) Modern Electronic Manufacturing Standards
6. Which optical disc format offers the highest storage capacity? (CO2, K2)
- (a) CD-ROM
 - (b) DVD-RW
 - (c) Blu-ray
 - (d) VCD

7. Phase-change memory (PRAM) relies on the transition between which two states? (CO3, K1)
- (a) Liquid and Solid
 - (b) Amorphous and Crystalline
 - (c) Paramagnetic and Ferromagnetic
 - (d) Gas and Plasma
8. In magnetic recording, what does “PMR” stand for? (CO4, K1)
- (a) Primary Magnetic Resolution
 - (b) Perpendicular Magnetic Recording
 - (c) Photo-Magnetic Resistance
 - (d) Phase-modulated Recording
9. Which cleanroom classification is considered “cleaner” (fewer particles)? (CO5, K2)
- (a) Class 10
 - (b) Class 100
 - (c) Class 1000
 - (d) Class 10,000
10. The “superparamagnetic limit” is a primary challenge in which industry? (CO4, K2)
- (a) Solar Cell Fabrication
 - (b) Textile Engineering
 - (c) Magnetic Data Storage
 - (d) Bio-imaging

Part B

(5 × 5 = 25)

Answer **all** questions not more than 500 words each.

11. (a) Outline the fundamental hierarchy of data storage from primary to tertiary levels. (CO1, K2)

Or

- (b) Explain the role of nanotechnology in increasing the density of modern data storage. (CO1, K2)

12. (a) Describe the working principles of Magneto-optical disks. (CO2, K2)

Or

- (b) Compare the read/write mechanisms of standard DVDs versus Blu-ray technology. (CO2, K4)

13. (a) Explain the functioning of Spin-transfer torque RAM (STT-MRAM). (CO3, K2)

Or

- (b) Contrast the performance characteristics of DRAM versus SRAM. (CO3, K4)

14. (a) Discuss the importance of Giant Magnetoresistance in hard disk drive heads. (CO4, K2)

Or

- (b) Analyze the advantages of Perpendicular Magnetic Recording over Longitudinal Recording. (CO4, K4)

15. (a) Summarize the fabrication steps involved in creating Thin Film transistors. (CO5, K2)

Or

- (b) Examine the environmental requirements and protocols of a semiconductor cleanroom. (CO5, K4)

Part C

(5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Illustrate the evolution of information storage and the critical role played by nanomaterials in this transition. (CO1, K3)

Or

- (b) Evaluate the future of DNA-based and molecular data storage as alternatives to silicon. (CO1, K5)

17. (a) Demonstrate how Holographic Data Storage achieves high-volume 3D data recording. (CO2, K3)

Or

- (b) Formulate a technical report on the limitations of near-field optical storage. (CO2, K6)

18. (a) Categorize different next-generation non-volatile memories (RRAM, FeRAM, and CRAM) based on their switching mechanisms. (CO3, K4)

Or

- (b) Design a comparison matrix for neuromorphic memory devices versus traditional Von Neumann architectures. (CO3, K6)

19. (a) Apply the principles of Magnetic Tunnelling Junctions to explain the sensitivity of modern magnetic sensors. (CO4, K3)

Or

- (b) Assess the impact of the superparamagnetic limit on the scaling of magnetic recording media. (CO4, K5)

20. (a) Execute a detailed study on the integration of Photonic Integrated Circuits in modern telecommunications. (CO5, K4)

Or

- (b) Develop a strategy for sustainable semiconductor manufacturing using NEMS and green fabrication techniques. (CO5, K6)
-

R4582

Sub. Code

25MNS2S1

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

NanoScience and Technology

**ANALYSIS AND INTERPRETATION OF
NANOMATERIALS**

(CBCS – 2025 onwards)

Time : 3 Hours

Maximum : 75 Marks

Part A

(10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. Which equation is primarily used to calculate the crystallite size from XRD peak broadening? (CO1, K1)
 - (a) Bragg's Law
 - (b) Scherrer Equation
 - (c) Tauc's Equation
 - (d) Kubelka-Munk Function
2. In Miller indices, the notation (hkl) represents: (CO1, K1)
 - (a) The lattice constant
 - (b) A specific set of parallel planes
 - (c) The grain boundary
 - (d) The dislocation density

3. In a TEM image, the scale bar primarily helps to interpret: (CO2, K2)
- (a) The chemical composition
 - (b) The actual size of the nanostructure
 - (c) The atomic weight
 - (d) The magnetic property
4. A “spotty” ring pattern in SAED (Selected Area Electron Diffraction) indicates that the material is: (CO2, K2)
- (a) Amorphous
 - (b) Single Crystalline
 - (c) Polycrystalline
 - (d) Liquid
5. Tauc’s plot is drawn between photon energy on the x-axis and _____ on the y-axis. (CO3, K3)
- (a) $(\alpha h \nu)^2$
 - (b) Absorbance
 - (c) Transmittance
 - (d) Wavelength
6. The Kubelka-Munk function is specifically applied to calculate band gap energy from: (CO3, K3)
- (a) Transmittance data
 - (b) Diffuse Reflectance Spectra
 - (c) Emission spectra
 - (d) X-ray diffraction data

7. In Raman spectroscopy, Gaussian peak fitting is primarily used to: (CO4, K4)
- (a) Remove noise from the signal
 - (b) Deconvolute overlapping peaks and find intensity
 - (c) Calculate the crystallite size
 - (d) Measure the sample weight
8. Analyzing the “G-band” and “D-band” ratio in Raman spectra helps to determine: (CO4, K4)
- (a) The defect density in carbon nanomaterials
 - (b) The band gap energy
 - (c) The magnetic saturation
 - (d) The specific capacitance
9. Cyclic Voltammetry (CV) curves for an ideal Double Layer Capacitor (EDLC) typically look like a: (CO5, K5)
- (a) Perfect circle
 - (b) Rectangular shape
 - (c) Sharp triangular peak
 - (d) Exponential decay curve
10. To estimate specific capacitance from a CV curve, which parameter is integrated? (CO5, K5)
- (a) The area under the current-voltage curve
 - (b) The peak height only
 - (c) The scan rate squared
 - (d) The resistance value

Part B

(5 × 5 = 25)

Answer **all** questions not more than 500 words each.

11. (a) Define Lattice constant and recall the formula to calculate micro-strain in a crystal lattice. (CO1, K1)

Or

- (b) List the steps involved in indexing XRD peaks with Miller indices (hkl). (CO1, K1)

12. (a) Explain how to interpret the scale bar data in SEM studies to estimate particle size. (CO2, K2)

Or

- (b) Distinguish between Single Crystalline and Polycrystalline patterns in SAED analysis. (CO2, K2)

13. (a) Calculate the direct band gap energy if the Tauc's plot intercept on the x-axis is 3.2 eV. Show the relation used. (CO3, K3)

Or

- (b) Apply the Kubelka-Munk function to determine band gap energy from optical spectra data. (CO3, K3)

14. (a) Analyze the significance of intensity calculation in Gaussian fit functions for Raman spectra data. (CO4, K4)

Or

- (b) Differentiate between single peak fitting and multiple peak fitting in Raman analysis. (CO4, K4)

15. (a) Plan a general procedure to estimate specific capacitance from Cyclic Voltammetry (CV) data. (CO5, K5)

Or

- (b) Formulate the steps required for Rietveld refinement to determine band structure. (CO5, K5)

Part C

(5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Describe the detailed procedure for calculating grain size and d-spacing using XRD data analysis. (CO1, K1)

Or

- (b) Reproduce the standard JCPDS card matching process for identifying an unknown nanomaterial. (CO1, K1)

17. (a) Interpret the nano-morphological differences between SEM and TEM images with suitable examples. (CO2, K2)

Or

- (b) Discuss the estimation of d-spacing and hkl values from an SAED pattern interpretation. (CO2, K2)

18. (a) Demonstrate the finding of direct and indirect band gap energy using Tauc's plot with a schematic diagram. (CO3, K3)

Or

- (b) Solve for the band gap energy of a semiconductor using the optical absorption spectrum and appropriate mathematical functions. (CO3, K3)

19. (a) Examine the nature of a nanomaterial by analyzing its Raman spectra through multiple peak fitting techniques. (CO4, K4)

Or

- (b) Analyze the Gaussian peaks in a complex Raman spectrum to predict the material's structural quality. (CO4, K4)

20. (a) Design a comprehensive method to analyze electrochemical data for supercapacitor Device Applications using CV curves. (CO5, K5)

Or

- (b) Construct an electron density map interpretation based on Rietveld refinement data for different nanomaterials. (CO5, K5)
-

R4995

Sub. Code

533401

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Fourth Semester

Nanoscience and Technology

NANOTOXICOLOGY

(CBCS – 2022 onwards)

Time : 3 Hours

Maximum : 75 Marks

Part A

(10 × 1 = 10)

Answer **all** the following objective type questions by choosing the correct option.

1. Which of the following is defined as a natural source of nanopollution? (CO1, K1)
 - (a) Diesel exhaust
 - (b) Volcanic ash
 - (c) Carbon nanotubes
 - (d) Industrial effluents
2. Identify the primary entry route of aerosols into the human body. (CO1, K1)
 - (a) Dermal absorption
 - (b) Inhalation via respiratory tract
 - (c) Intravenous injection
 - (d) Ingestion

3. Oxidative stress in cells is primarily caused by the generation of: (CO2, K2)
- (a) ATP
 - (b) DNA ligase
 - (c) Reactive Oxygen Species (ROS)
 - (d) Ribosomes
4. Which mechanism explains the internalization of nanoparticles by a cell? (CO2, K2)
- (a) Exocytosis
 - (b) Endocytosis
 - (c) Plasmolysis
 - (d) Glycolysis
5. Applying the concept of translocation, where would inhaled ultra-fine particles most likely accumulate after leaving the lungs? (CO3, K3)
- (a) Hair follicles
 - (b) Circulatory system and liver
 - (c) Fingernails
 - (d) Tooth enamel
6. If a nanoparticle enters via the GI tract, which barrier must it cross to enter the bloodstream? (CO3, K3)
- (a) Blood-brain barrier
 - (b) Intestinal epithelial lining
 - (c) Alveolar membrane
 - (d) Dermal layer

7. Analysis of a Comet Assay result showing a long “tail” indicates: (CO4, K4)
- (a) High cell viability
 - (b) Severe DNA damage
 - (c) Intact cell membrane
 - (d) Increased mitochondrial activity
8. Differentiate between Acute and Subacute toxicity studies. (CO4, K4)
- (a) Acute is long-term; Subacute is short-term
 - (b) Acute involves single exposure; Subacute involves repeated exposure
 - (c) Acute uses zebra fish; Subacute uses humans
 - (d) There is no difference
9. To formulate a new regulation for engineered nanomaterials, which factor is most critical to address first? (CO5, K5)
- (a) Color of the packaging
 - (b) Risk assessment and dosimetry data
 - (c) Marketing strategy
 - (d) Patent expiration date
10. Design a safety protocol for handling dry nanopowders. Which measure is essential? (CO5, K5)
- (a) Working in an open room with a fan
 - (b) Using a HEPA-filtered fume hood
 - (c) Wearing cotton gloves only
 - (d) Storing them in direct sunlight

Part B

(5 × 5 = 25)

Answer **all** questions not more than 500 words each.

11. (a) List the various physicochemical characteristics of nanomaterials that influence their toxicity. (CO1, K1)

Or

- (b) Define nanopollution and list three anthropogenic sources. (CO1, K1)

12. (a) Explain the mechanism of Reactive Oxygen Species (ROS) mediated toxicity in cells. (CO2, K2)

Or

- (b) Summarize the process of cellular uptake of nanoparticles. (CO2, K2)

13. (a) Illustrate the translocation pathway of nanoparticles from the respiratory tract to the central nervous system. (CO3, K3)

Or

- (b) Apply your knowledge of dermal exposure to predict how damaged skin might affect nanoparticle absorption compared to healthy skin. (CO3, K3)

14. (a) Analyze the advantages and limitations of using Zebra fish as a model system for nanotoxicity testing. (CO4, K4)

Or

- (b) Compare the MTT assay and comet assay. (CO4, K4)

15. (a) Compose a set of ethical guidelines that should be followed during the research and development of nanomedicine. (CO5, K5)

Or

- (b) Propose a risk assessment framework for a new industrial nanomaterial being released into the market. (CO5, K5)

Part C

(5 × 8 = 40)

Answer **all** questions not more than 1000 words each.

16. (a) Describe in detail of the nanoparticles their entry routes into the human body. (CO1, K2)

Or

- (b) Recall and describe the effect of size, shape and surface charge on the toxicity of nanoparticles. (CO1, K1)

17. (a) Discuss the inflammatory response and immunotoxicity caused by the interaction of nanoparticles with cells. (CO2, K2)

Or

- (b) Explain elaborately the mechanisms of genotoxicity and hemolytic activity induced by nanomaterials. (CO2, K2)

18. (a) Demonstrate how nanoparticles interact with biological membranes and trace their disposition in the liver, spleen and kidney. (CO3, K3)

Or

- (b) Apply the concepts of biodistribution to explain the potential toxicity of nanoparticles in the eye and respiratory tract. (CO3, K3)

19. (a) Analyze the methodology and significance of *in vivo* toxicity testing using Mice/Rat models. (CO4, K4)

Or

- (b) Examine the role of Ecotoxicological studies in nanotoxicology. (CO4, K4)
20. (a) Formulate a comprehensive strategy for the regulation of Engineered Nanomaterials, considering legal and social implications. (CO5, K5)

Or

- (b) Design a patent proposal for a novel nanomedicine, highlighting the ethical agenda and execution challenges involved. (CO5, K5)
-