R4604

Sub. Code
25MMS2C1

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Materials Science

MATERIALS CHEMISTRY

(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 bonding is dominant in noble gas solids like Ne and Ar ? (CO1, K2)

   (a) Ionic

   (b) Covalent

   (c) Metallic

   (d) Van der Waals

2. Hydrogen bonding is strongest when hydrogen is bonded to: (CO1, K1)

   (a) Carbon

   (b) Nitrogen

   (c) Sulfur

   (d) Phosphorus

3. Electrical conductivity of a semiconductor increases with temperature because: (CO2, K4)

(a) Mobility increases

(b) Band gap increases

(c) Carrier concentration increases

(d) Lattice vibrations decrease

4. Which defect acts as a recombination center in semiconductors? (CO2, K2)

(a) Donor impurity

(b) Acceptor impurity

(c) Vacancy

(d) Frenkel defect

5. Which polymer structure shows the highest tensile Strength? (CO3, K1)

(a) Linear polymer

(b) Branched polymer

(c) Cross-linked polymer

(d) Amorphous polymer

6. Glass transition temperature (Tg) is associated with: (CO3, K1)

(a) Motion of polymer chains in amorphous regions

(b) Melting of crystalline regions

(c) Chemical degradation

(d) Crosslinking reaction

7. Which surface Property determines electron emission from a material? (CO4, K2)

(a) Band gap

(b) Work function

(c) Surface roughness

(d) Surface phonons

8. Thermionic emission occurs due to: (CO4, K1)

(a) High electric field

(b) Photon absorption

(c) Thermal energy

(d) Mechanical stress

9. Which process is most suitable for producing ultra-fine ceramic powders? (CO5, K2)

(a) Solid-state reaction

(b) Mechanical alloying

(c) Sol-gel method

(d) Melt quenching

10. Which step in Sol-gel Processing leads to network formation? (CO5, K2)

(a) Hydrolysis

(b) Condensation

(c) Drying

(d) Sintering

Part B (5 × 5 = 25)

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

11. (a) Explain bonding in elemental solids with examples. (CO1, K2)

Or

(b) What is ionicity? How 1s it related to electronegativity? (CO1, K1)

12. (a) Explain energy band structure of semiconductors. (CO2, K4)

Or

(b) What is doping? Explain n-type and p-type semiconductors. (CO2, K1)

13. (a) Explain the structure and geometry of polymers. (CO3, K2)

Or

(b) Describe polymer crystallinity and polymer crystals. (CO3, K2)

14. (a) Distinguish between ideal and real surfaces. (CO4, K2)

Or

(b) What are surface defects? Give examples. (CO4, K5)

15. (a) Explain the issues involved in materials synthesis and processing. (CO5, K4)

Or

(b) Explain powder synthesis and its importance. (CO5, K4)

Part C (5 × 8 = 40)

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

16. (a) Explain different types of bonding in solids and their influence on material properties. (CO1, K4)

Or

(b) Discuss mixed ionic-covalent bonding and the concept of ionicity. (CO1, K2)

17. (a) Discuss the microscopic and macroscopic properties of semiconductors. (CO2, K2)

Or

(b) Explain the effect of doping and defects on semiconductor properties. (CO2, K4)

18. (a) Discuss structure-property relationships in polymers. (CO3, K2)

Or

(b) Explain mechanical properties of polymers and viscoelastic behavior. (CO3, K4)

19. (a) Discuss electronic properties of surfaces with reference to electron emission phenomena. (CO4, K5)

Or

(b) Explain surface defects and their role in modifying material properties. (CO4, K4)

20. (a) Explain synthesis and processing of ceramics and glasses. (CO5, K4)

Or

(b) Explain polymerization mechanisms and their role in tailoring polymer properties. (CO5, K4)

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R4605

Sub. Code
25MMS2C2

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Materials Science

MATERIALS CHARACTERISATION

(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. DMA measures (CO1, K4)

   (a) Optical density

   (b) Viscoelastic properties

   (c) Magnetic moment

   (d) Conductivity

2. Endothermic peaks are typically associated with (CO1, K3)

   (a) Heat absorption

   (b) Heat release

   (c) Weight gain

   (d) Oxidation state change

3. Dislocation density is inversely proportional to: (CO2, K4)

(a) Hardness

(b) Crystallite size squared

(c) Wavelength

(d) Intensity

4. If wavelength (λ) increases in Bragg's Law, diffraction angle (θ) will generally: (CO2, K4)

(a) Decrease

(b) Increase

(c) Remain constant

(d) Become zero

5. When nanoparticle size becomes very small, band gap usually: (CO3, K4)

(a) Increases

(b) Decreases

(c) Becomes zero

(d) Does not change

6. Fluorescence differs from phosphorescence mainly by: (CO3, K5)

(a) Color

(b) Density

(c) Temperature

(d) Emission lifetime

7. Tapping mode AFM is preferred because it: (CO4, K4)

(a) Increase surface damages

(b) Reduces surface damage

(c) Increases voltage

(d) Changes phase

8. HRTEM is preferred over SEM when studying: (CO4, K5)

(a) Surface roughness only

(b) Particle color

(c) Atomic lattice fringes

(d) Sample weight

9. A straight-line I–V graph usually shows: (CO5, K5)

(a) Broken material

(b) Magnetic effect

(c) Capacitor effect

(d) Ohmic / normal conductor behaviour

10. Why is four-probe better than two-probe for thin films? (CO5, K4)

(a) Uses more wires

(b) It avoids error from contact resistance

(c) It is faster

(d) It changes voltage

Part B (5 × 5 = 25)

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

11. (a) Distinguish between Differential Scanning Calorimetry (DSC) and Differential Thermal Analysis (DTA). (CO1, K4)

Or

(b) Explain the importance of inert atmosphere in thermal analysis. (CO1, K3)

12. (a) Derive Bragg's law. Give its Significance in study crystal structure (CO2, K4)

Or

(b) Judge the reliability of XRD for amorphous materials and support your reasoning. (CO2, K5)

13. (a) Evaluate the reliability of Beer-Lambert law at high concentrations. (CO3, K5)

Or

(b) Analyze quenching mechanisms in fluorescence spectra. (CO3, K4)

14. (a) Examine the limitations of EDAX in detecting light elements. (CO4, K5)

Or

(b) Analyse how particle size distribution histograms indicate agglomeration. (CO4, K4)

15. (a) Compare CV and IV characteristics. (CO5, K4)

Or

(b) Distinguish between four probes and two probes methods. (CO5, K4)

Part C (5 × 8 = 40)

Answer all the questions not more than 1000 words each.

16. (a) Analyse phase transitions (melting, crystallization, Tg) using DSC curves. (CO1, K4)

Or

(b) Distinguish between Thermal Gravimetric Analysis and Thermal Mechanical Analysis. (CO1, K4)

17. (a) Explain the Powder (Debye Scherer) method of X-Ray diffraction. How is it useful to study the lattice parameter of a crystal? (CO2, K5)

Or

(b) Examine the role of instrumental broadening in microstructure calculations. (CO2, K4)

18. (a) Examine how conjugation influences IR absorption frequency. (CO3, K5)

Or

(b) Analyze the effect of solvent polarity on UV-Vis absorption maxima. (CO3, K4)

19. (a) Evaluate the construction and working of TEM. (CO4, K5)

Or

(b) Evaluate the advantages, disadvantages and basic principles of XPS. (CO4, K5)

20. (a) Analyse the hall probe and measurement technique. (CO5, K5)

Or

(b) Compare temperature-dependent I-V characteristics in intrinsic and extrinsic Semiconductors. (CO5, K4)

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R4606	Sub. Code
	25MMS2C3

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Materials Science

THIN FILMS SCIENCE AND TECHNOLOGY

(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. Thin film are generally defined as materials with thickness (CO1, K1)

   (a) > 1mm (b) $1\,\mu m - 1mm$

   (c) 1nm – $1\mu m$ (d) > 1 cm

2. Tribological coatings mainly improve (CO1, K1)

   (a) Electrical conductivity

   (b) Optical transparency

   (c) Wear and friction resistance

   (d) Thermal insulation

3. Multiple beam interface is mainly used to measure (CO2, K2)

(a) Electrical conductivity

(b) Film thickness

(c) Hardness

(d) Adhesion

4. Electron microscopy provides information about (CO2, K2)

(a) Optical properties

(b) Microstructure and morphology

(c) Film thickness only

(d) Stress only

5. Sputtering is based on (CO3, K3)

(a) Thermal evaporation

(b) Momentum transfer by ion bombardment

(c) Chemical reaction

(d) Optical excitation

6. Laser ablation uses (CO3, K3)

(a) Thermal heaters

(b) Ion beams

(c) High - energy laser pulses

(d) Chemical etching

7. The thickness of a single - layer anti - reflection coating is (CO4, K2)

(a) λ (b) $\lambda/2$

(c) $\lambda/4$ (d) $\lambda/8$

8. SQUID is used to measure (CO4, K2)

(a) Temperature

(b) Electric field

(c) Extremely small magnetic fields

(d) Pressure

9. Thermochromic windows respond to (CO5, K3)

(a) Electric field

(b) Light

(c) Temperature changes

(d) Magnetic field

10. Nanotechnology improves smart windows by (CO5, K3)

(a) Increasing thickness

(b) Enhancing optical and thermal performance

(c) Reducing transparency

(d) Making them heavier

Part B (5 × 5 = 25)

Answer all the questions not more than 500 words each

11. (a) What are thin films? Mention any four applications. (CO1, K1)

Or

(b) What are tribological coatings? (CO1, K1)

12. (a) Describe the quartz crystal thickness monitoring technique. (CO2, K2)

Or

(b) What information does X - ray diffraction provide for thin films? (CO2, K1)

13. (a) Describe Chemical Vapour Deposition (CVD)? (CO3, K3)

Or

(b) Explain laser ablation technique. (CO3, K4)

14. (a) Write a note on electrophotography. (CO4, K5)

Or

(b) Explain thin film diode. (CO3, K4)

15. (a) What are smart materials? Give examples. (CO5, K3)

Or

(b) List testing methods for smart windows. (CO5, K2)

Part C (5 × 8 = 40)

Answer all the questions not more than 1000 words

16. (a) Explain general features and applications of thin film. (CO1, K4)

Or

(b) Discuss thin film structures and structural defects. (CO1, K2)

17. (a) Describe ellipsometric and styles techniques in detail (CO2, K2)

Or

(b) Discuss electron microscopy techniques used for thin films. (CO2, K2)

18. (a) Describe CVD and MOCVD techniques with advantages and applications. (CO3, K3)

Or

(b) Describe chemical solution deposition techniques with spray pyrolysis. (CO3, K2)

19. (a) Discuss electrical and dielectric behaviour of thin films. (CO4, K5)

Or

(b) Explain thin films components: diode, transistor, strain gauge, and gas sensor. (CO4, K4)

20. (a) Describe different types of smart windows and their working principles. (CO5, K3)

Or

(b) Explain applications of smart windows and their sustainability aspects. (CO5, K4)

R4607

Sub. Code
25MMS2C4

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Materials Science

CRYSTAL GROWTH

(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. Nucleation is the process of (CO1,K1)

   (a) Growth of crystals

   (b) Formation of a stable nucleus of a new phase

   (c) Coalescence of grains

   (d) Melting of solids

2. In heterogeneous nucleation, the shape of the nucleus is usually (CO1,K1)

   (a) Perfect sphere (b) Hemisphere

   (c) Cubical (d) Irregular

3. In 2-D nucleation, the critical nucleus (CO2, K2)

   (a) Spherical (b) Cubical

   (c) Disc – shaped (d) Cylindrical

4. Spiral growth occurs due to the presence of (CO2, K2)

(a) Vacancies

(b) Impurities

(c) Screw dislocations

(d) Edge dislocation

5. A conservative process in crystal growth means (CO3, K1)

(a) No heat loss

(b) No mass loss

(c) No impurities

(d) No temperature gradient

6. Zone melting is mainly used for (CO3, K1)

(a) Crystal shaping

(b) Doping

(c) Purification of materials

(d) Surface polishing

7. Accelerated Crucible Rotation Technique (ACRT) is (CO4, K2)

(a) Increase evaporation

(b) Enhance mixing in melt

(c) Reduce impurities

(d) Control fluid flow and corporation

8. Sol - Gel method involves transformation of (CO4, K4)

(a) Solid to liquid (b) Gas to liquid

(c) Sol to gel (d) Melt to solid

9. A photonic band gap is analogous to (CO5, K2)

(a) Thermal gap

(b) Electronic band gap

(c) Magnetic gap

(d) Optical absorption edge

10. LEDs and laser diodes are commonly fabricated using (CO5, K2)

(a) Amorphous materials

(b) Polycrystalline metals

(c) Single crystalline semiconductors

(d) Glass

Part B (5 × 5 = 25)

Answer **all** the question not more than 500 words each

11. (a) Explain homogeneous nucleation. (CO1, K1)

Or

(b) Explain heterogeneous nucleation. (CO1, K4)

12. (a) Explain Temkin ' s model of crystal growth. (CO2, K2)

Or

(b) What is atmospheric nucleation? (CO2, K1)

13. (a) Differentiate between conservative and non - conservative process. (CO3, K4)

Or

(b) Explain Zone melting. (CO3, K4)

14. (a) Explain low temperature solution growth. (CO4,K4)

Or

(b) Explain crystal growth in gel. (CO4, K4)

15. (a) Explain the importance of crystal growth in electronic semiconductors. (CO5, K2)

Or

(b) What the photonic crystals? (CO5, K1)

Part C (5 × 8 = 40)

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

16. (a) Explain classical theory of nucleation. (CO1,K2)

Or

(b) Write a detailed note on nucleation rate and induction period. (CO1, K1)

17. (a) Explain two – dimensional nucleation theory with energy considerations. (CO2, K2)

Or

(b) Explain BCF surface diffusion theory of crystal growth. (CO2, K4)

18. (a) Explain temperature measurement and control techniques used in crystal growth. (CO3, K4)

Or

(b) Explain Bridgman and Czochralski methods with comparison. (CO3, K4)

19. (a) Explain electro-crystallization technique. (CO4, K4)

Or

(b) Explain Sol - Gel growth technique. (CO4, K4)

20. (a) Discuss the importance of crystal growth in electronic and optical devices. (CO5, K2)

Or

(b) Explain biomedical applications of crystal growth. (CO5, K2)

R4608

Sub. Code
25MMS2E1

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Materials Science

Elective – MOLECULAR SPECTROSCOPY

(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 condition is necessary for atomic orbitals to combine to form molecular orbitals? (CO1, K1)
   (a) Same energy only
   (b) Same shape only
   (c) Comparable energy and proper symmetry
   (d) Same principal quantum number

2. *sp* hybridization results in (CO1, K2)
   (a) Tetrahedral geometry
   (b) Linear geometry
   (c) Trigonal planar geometry
   (d) Octahedral geometry

3. The selection rule for pure rotational microwave spectra is: (CO2, K2)
   (a) $\Delta J = \pm 1$ (b) $\Delta J = 0$
   (c) $\Delta J = \pm 2$ (d) $\Delta \upsilon = \pm 1$

4. Stark effect in rotational spectroscopy arises due to interaction with: (CO2, K3)

(a) Magnetic field (b) Electric field

(c) Radiation field (d) Gravitational field

5. A vibration is IR active only if: (CO3, K3)

(a) Polarizability changes

(b) Dipole moment changes

(c) Molecular mass changes

(d) Bond length remains constant

6. The number of normal modes of vibration for a non-linear molecule containing N atoms is : (CO3, K4)

(a) 3N (b) 3N – 5

(c) N – 1 (d) 3N – 6

7. Raman scattering occurs due to change in: (CO4, K4)

(a) Dipole moment (b) Polarizability

(c) Magnetic moment (d) Nuclear spin

8. Which molecule is Raman active but IR inactive? (CO4, K5)

(a) CO (b) HCl

(c) N_2 (d) H_2O

9. Nuclear magnetic resonance occurs due to interaction between: (CO5, K5)

(a) Electric dipole and electric field

(b) Nuclear spin and magnetic field

(c) Electron spin and electric field

(d) Orbital motion and radiation

10. Chemical shift is usually expressed in: (CO5, K4)

(a) ppm (b) Hz

(c) Tesla (d) Joule

Part B (5 × 5 = 25)

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

11. (a) Explain the symmetry aspects of molecular orbitals. (CO1, K2)

Or

(b) Define molecular orbital and explain bonding and antibonding orbitals. (CO1, K1)

12. (a) What is isotopic Substitution? Explain its spectroscopic importance. (CO2, K3)

Or

(b) What is quadrupole hyperfine interaction? (CO2, K2)

13. (a) Derive the vibrational energy levels of a diatomic molecule. (CO3, K4)

Or

(b) Explain asymmetry of rotation—vibration bands. (CO3, K3)

14. (a) Explain rotational Raman spectra of diatomic molecules. (CO4, K4)

Or

(b) State and explain the mutual exclusion principle. (CO4, K5)

15. (a) What is nuclear resonance? State the condition for resonance. (CO5, K4)

Or

(b) State Bloch equations and their significance. (CO5, K5)

Part C (5 × 8 = 40)

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

16. (a) Explain Heitler–London theory of hydrogen molecule in detail. (CO1, K1)

Or

(b) Describe Molecular Orbital Theory of diatomic. (CO1, K2)

17. (a) Discuss isotopic substitution and its role in determining molecular structure. (CO2, K2)

Or

(b) Discuss symmetric top molecules and their rotational spectra. (CO2, K3)

18. (a) Explain vibrational spectra of diatomic molecules including anharmonicity. (CO3, K4)

Or

(b) Explain vibrational spectra of polyatomic molecules. (CO3, K4)

19. (a) Explain Raman scattering theory and its significance in molecular spectroscopy. (CO4, K4)

Or

(b) Explain mutual exclusion principle with suitable examples. (CO4, K5)

20. (a) Explain nuclear magnetic resonance in detail with energy level splitting. (CO5, K4)

Or

(b) Describe NQR spectroscopy and its applications. (CO5, K5)

R4609

Sub. Code
25MMS2S1

M.Sc. DEGREE EXAMINATION, APRIL – 2026

Second Semester

Materials Science

CHEMICAL 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. A chemical sensor is best defined as a device that: (CO1, K1)

   (a) Detects only biological molecules

   (b) Converts chemical information into an analytically useful signal

   (c) Stores chemical data permanently

   (d) Measures only concentration by optical methods

2. Which transducer converts chemical interaction into a change in resistance? (CO1, K2)

   (a) Optical transducer

   (b) Thermal transducer

   (c) Conductometric transducer

   (d) Piezoelectric transducer

3. A major limitation of thermal sensors is: (CO2, K1)

(a) Poor sensitivity

(b) Conductometric transducer

(c) Poor reproducibility

(d) Large response time

4. ISFET stands for: (CO2, K1)

(a) Ion-Sensitive Field-Effect Transistor

(b) Integrated Sensor Field-Effect Transistor

(c) Ion-Selective Frequency Transistor

(d) Integrated Semiconductor FET

5. The main role of enzymes in biosensors is to: (CO3, K1)

(a) Act as signal amplifiers

(b) Protect the electrode

(c) Improve conductivity

(d) Provide selective biorecognition

6. An ideal biosensor material should be: (CO3, K2)

(a) Chemically inert only

(b) Biocompatible and stable

(c) Highly toxic

(d) Optically opaque

7. The primary role of Self-Assembled Monolayers (SAMs) in sensor fabrication is to: (CO4, K1)

(a) Increase bulk conductivity

(b) Provide controlled surface functionalization

(c) Act as transducers

(d) Replace electrodes

8. Photolithography is primarily used to: (CO4, K5)

(a) Print thick films

(b) Deposit polymers

(c) Pattern micro- and nano-scale features

(d) Assemble biomolecules

9. Which material is widely used in flexible and wearable sensors? (CO5, K2)

(a) Graphene and conducting polymers

(b) Silicon wafer

(c) Quartz crystal

(d) Alumina ceramics

10. Electrochemical sensors in forensic analysis are valued for: (CO5, K1)

(a) Low sensitivity

(b) Portability and rapid detection

(c) High operating temperature

(d) Long calibration time

Part B (5 × 5 = 25)

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

11. (a) Describe about chemical sensor and explain its basic components and working principle. (CO1, K2)

Or

(b) Distinguish between Physico-chemical and biological transducers. (CO1, K3)

12. (a) Explain the working principle of thermal chemical sensors. (CO2, K4)

Or

(b) What are ISFET sensors? Mention their advantages. (CO2, K1)

13. (a) Describe DNA-based biosensors and their working principle. (CO3, K2)

Or

(b) Explain mono-enzyme and bi-enzyme biosensors. (CO3, K2)

14. (a) Summarize the principle and role of self-assembled monolayers (SAMs) in sensor fabrication. (CO4, K5)

Or

(b) What engineering factors are important for mass production of sensors? (CO4, K5)

15. (a) Describe sensor applications in technological process control. (CO5, K2)

Or

(b) Describe the role of sensors in clinical chemistry. (CO5, K5)

Part C (5 × 8 = 40)

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

16. (a) Describe various signal transduction mechanisms used in chemical sensors. (CO1, K2)

Or

(b) Define and discuss sensor performance parameters such as sensitivity, selectivity, LOD, response time, and reproducibility. (CO1, K3)

17. (a) Describe semiconductor transducers (ISFET and ENFET) with fabrication materials and applications. (CO2, K4)

Or

(b) Discuss recent trends in Physico-chemical sensors and the challenges to be addressed. (CO2, K3)

18. (a) Elaborate about affinity-based and inhibition-based biosensors with principles and applications. (CO3, K5)

Or

(b) Summarize the material selection criteria and challenges in developing bio-electronic devices. (CO3, K5)

19. (a) Explain MEMS-based sensor fabrication and its importance in large-scale manufacturing. (CO4, K4)

Or

(b) Compare top-down and bottom-up fabrication approaches in sensor engineering. (CO4, K4)

20. (a) Discuss the application of sensors in healthcare monitoring, emphasizing materials used. (CO5, K2)

Or

(b) Explain forensic applications of sensors and their advantages over traditional methods. (CO5, K4)

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