

B.Sc. (Honours) Material science
(w.e.f 2023-24)

COURSE 1:

SEMESTER – 1

ESSENTIALS AND APPLICATIONS OF MATHEMATICAL, PHYSICAL AND CHEMICAL SCIENCES

UNIT I: ESSENTIALS OF MATHEMATICS:

Complex Numbers: Introduction of the new symbol i – General form of a complex number – Modulus-Amplitude form and conversions

Trigonometric Ratios: Trigonometric Ratios and their relations – Problems on calculation of angles

Vectors: Definition of vector addition – Cartesian form – Scalar and vector product and problems

Statistical Measures: Mean, Median, Mode of a data and problems

UNIT II: ESSENTIALS OF PHYSICS:

Definition and Scope of Physics- Measurements and Units - Motion of objects: Newtonian Mechanics and relativistic mechanics perspective - Laws of Thermodynamics and Significance- Acoustic waves and electromagnetic waves- Electric and Magnetic fields and their interactions- Behavior of atomic and nuclear particles- Wave-particle duality, the uncertainty principle- Theories and understanding of universe

UNIT III: ESSENTIALS OF CHEMISTRY::

Definition and Scope of Chemistry- Importance of Chemistry in daily life -Branches of chemistry and significance- Periodic Table- Electronic Configuration, chemical changes, classification of matter, Biomolecules- carbohydrates, proteins, fats and vitamins.

UNIT IV: APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY:

Applications of Mathematics in Physics & Chemistry: Calculus, Differential Equations & Complex Analysis

Application of Physics in Industry and Technology: Electronics and Semiconductor Industry, Robotics and Automation, Automotive and Aerospace Industries, Quality Control and Instrumentation, Environmental Monitoring and Sustainable Technologies.

Application of Chemistry in Industry and Technology: Chemical Manufacturing, Pharmaceuticals and Drug Discovery, Materials Science, Food and Beverage Industry.

UNIT V: ESSENTIALS OF COMPUTER SCIENCE:

Milestones of computer evolution - Internet, history, Internet Service Providers, Types of Networks, IP, Domain Name Services, applications.

Ethical and social implications: Network and security concepts- Information Assurance Fundamentals, Cryptography-Symmetric and Asymmetric, Malware, Firewalls, Fraud Techniques- Privacy and Data Protection

Recommended books:

1. Functions of one complex variable by John.B.Conway, Springer- Verlag.
2. Elementary Trigonometry by H.S.Hall and S.R.Knight
3. Vector Algebra by A.R.Vasishtha, Krishna Prakashan Media(P)Ltd. 4.Basic Statistics by B.L.Agarwal, New age international Publishers
5. University Physics with Modern Physics by Hugh D. Young and Roger A. Freedman
6. Fundamentals of Physics by David Halliday, Robert Resnick, and Jearl Walker
7. Physics for Scientists and Engineers with Modern Physics" by Raymond A. Serway and John W. Jewett Jr.
8. Physics for Technology and Engineering" by John Bird
9. Chemistry in daily life by Kirpal Singh
10. Chemistry of bio molecules byS. P. Bhutan
11. Fundamentals of Computers by V. RajaRaman
12. Cyber Security Essentials by James Graham, Richard Howard, Ryan Olson

ADVANCES OF MATHEMATICAL, PHYSICAL AND CHEMICAL SCIENCES

UNIT I: ADVANCES IN BASICS MATHEMATICS

Straight Lines: Different forms – Reduction of general equation into various forms – Point of intersection of two straight lines

Limits and Differentiation: Standard limits – Derivative of a function – Problems on product rule and quotient rule

Integration: Integration as a reverse process of differentiation – Basic methods of integration

Matrices: Types of matrices – Scalar multiple of a matrix – Multiplication of matrices –

Transpose of a matrix and determinants

UNIT II: ADVANCES IN PHYSICS:

Renewable energy: Generation, energy storage, and energy-efficient materials and devices.

Recent advances in the field of nanotechnology: Quantum dots, Quantum Communication- recent advances in biophysics- recent advances in medical physics- Shape Memory Materials.

UNIT III: ADVANCES IN CHEMISTRY:

Computer aided drug design and delivery, nano sensors, Chemical Biology, impact of chemical pollutants on ecosystems and human health, Dye removal - Catalysis method

UNIT IV: ADVANCED APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY

- Mathematical Modelling applications in physics and chemistry
- Application of Renewable energy: Grid Integration and Smart Grids,
- Application of nanotechnology: Nanomedicine,
- Application of biophysics: Biophysical Imaging, Biomechanics, Neurophysics,
- Application of medical physics: Radiation Therapy, Nuclear medicine

Solid waste management, Environmental remediation- Green Technology, Water treatment.

UNIT V: Advanced Applications of computer Science

Number System-Binary, Octal, decimal, and Hexadecimal, Signals-Analog, Digital, Modem, Codec, Multiplexing, Transmission media, error detection and correction- Parity check and CRC, Networking devices- Repeater, hub, bridge, switch, router, gateway.

Recommended books:

1. Coordinate Geometry by S.L.Lony, Arihant Publications
2. Calculus by Thomas and Finny, Pearson Publications
3. Matrices by A.R.Vasishtha and A.K.Vasishtha, Krishna Prakashan Media(P)Ltd.
4. "Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle
5. "Energy Storage: A Nontechnical Guide" by Richard Baxter
6. "Nanotechnology: Principles and Applications" by Sulabha K. Kulkarni and Raghvendra A. Bohara

7. "Biophysics: An Introduction" by Rodney Cotterill
8. "Medical Physics: Imaging" by James G. Webster
9. "Shape Memory Alloys: Properties and Applications" by Dimitris C. Lagoudas
10. Nano materials and applications by M.N.Borah
11. Environmental Chemistry by Anil.K.D.E.
12. Digital Logic Design by Morris Mano
13. Data Communication & Networking by Bahrouz Forouzan.

Semester II (Major 1)

Syllabus - Concepts in Materials Science

UNIT –I (9 Hrs)

Crystal Bonding: Crystal bonding, ionic crystal, potential and lattice energy of ionic crystals, Madelung constant, covalent bonding, Vander wall bonding, hydrogen bond and metallic bond, formation of energy bands in solids - distinction between metals, insulators and semiconductors.

Activity Proposed: Case study on types of bonds

Evaluation Method: Assignment

UNIT –II (9 Hrs)

Translational vectors; Lattice and Basis; Unit cell; Bravais lattices; Lattice constants, Crystal planes; Miller indices; Symmetric operations; Point groups; Packing fraction; Simple cubic structures; Body centered cubic structure, Face centered cubic structure; Hexagonal close packed structure; NaCl, CsCl, Diamond and ZnS structures

Activity Proposed: Development of model crystal structures

Evaluation Method: Demonstration and

Unit-III (9 hrs)

Point defects: Impurities; Vacancies - Frenkel and Schottky intrinsic vacancies; Equilibrium concentration of defects; Ionic conductivity in alkali halides; Color centers: Classification- F, F', V centers-Production of color centers

Line defects: Edge and Screw dislocations; Burger vector;

Plane defects: Stacking faults; Grain boundaries – Low angle grain boundaries

Activity Proposed: Presentation on various defects

Evaluation Method: Content, Way of explanation, body language

Unit IV (9 hrs)

Formation of Crystals: Crystal growth – Velocity of growth, Theories of growth, Mechanism of growth, Twinning – Growth twins, Deformation twins, Transformation twins, Growth in the solid state – Recrystallization, Martensite transformation.

Activity Proposed: Student mini projects

Evaluation Method: Viva

Unit V (9 hrs)

Structure analysis and Transformations in crystals: Atomic scattering factor. Laue conditions for diffraction and Bragg's law - Geometrical structure factor – Laue method, Powder XRD Method, Applications of XRD.

Activity Proposed: Student mini projects

Evaluation Method: Viva

Text Books:

1. R. L. Singhal, Solid State Physics, Kedarnath Ramnath - Publisher
2. S.O. Pillai, Solid State Physics, Wiley Easter Ltd.(1994)
3. Gupta, Kumar, Sharma, Solid State Physics
4. Stephen Elliott and S.R. Elliot, The Physics and Chemistry of Solids, Wiley, 1st Edn (1998)
5. Malik Wahid U. Et. Al, Selected topics in inorganic chemistry, S. Chand & Co., Ltd. (2009)

Semester II (Major 2)

Course Code	Title of the Course	L	T	P	C
	SCIENCE OF MATERIALS IN DAILY LIFE	3	0	0	3
Prerequisites	Classification of materials				

Syllabus - SCIENCE OF MATERIALS IN DAILY LIFE

UNIT -I (10 hrs)

Conductors: Metals, Alloys, Semiconductors- Definition, elementary ideas of electrical properties, optical properties, mechanical properties, thermal properties. Specific examples of metals- Copper, Aluminium, Iron, Gold, Silver. Uses of metals. Drawbacks of metals. Alloys- advantages of alloying. Examples-Brass, Bronze, Steel, Stainless steel, Gold alloys, silver alloys and their uses. Semiconductors: Elemental semiconductors- Silicon, Germanium. Doping- n-type and p-type semiconductors, p-n junctions

Activity Proposed: Classification of metals and alloys

Evaluation Method: Study report

UNIT –II (10 hrs)

Polymers and composites: Plastics- Introduction, Types of plastics, Rubber- Types of rubber, Vulcanization of rubber. Fibers- Different types of natural and synthetic fibers. Resins, Adhesives and polymer coatings. Physical, chemical, mechanical properties and applications of polymers. Recycling of polymers. Composites- Introduction, types, Wood, Concrete, FRP and some advanced composites. Properties and applications.

Activity Proposed: Preparation of polymers

Evaluation Method: Lab report

Unit-III: (9 hrs)

Ceramics: Ceramics- Introduction, classification, raw materials, fabrication methods, properties and applications, Types of ceramics- oxide and non-oxide ceramics, Allotropes of carbon- graphite, diamond and fullerene, Primary refractory materials.

Activity Proposed: preparation of models

Evaluation Method: Demonstration

Unit IV: (7 hrs)

Glasses: Introduction, raw materials, manufacture of glass, properties and applications, Types of glasses, properties and Applications, Photochromic and photosensitive glasses.

Activity Proposed: Preparation of Glasses

Evaluation Method: Lab report

Unit V: (9 hrs)

Nanomaterials: Origin of nanotechnology, Properties of nano-materials, Quantum confinement, Surface to Volume ratio, Top down and Bottom-up methods, Methods of preparation - Ball milling, Sol-Gel, PVD, CVD, Characterization – XRD, SEM, TEM.

Activity Proposed: Presentation on synthesis of nano materials

Evaluation Method: Content, Demonstration

Text Books:

1. Materials Science and Engineering – V Raghavan (Prentice Hall India, 1993)
2. Introduction to Solids – A J Dekker (McMillan India, 1981)
3. Plastics-How Structure determines properties- G Gruenwald (Hanser)
4. Materials Science- Nagpal (Khanna, Delhi)
5. Polymer Science –V R Gowariker, N V Viswanath, Jayadev Sridhar (Wiley Eastern, 1987)
6. Composite Materials-Engineering & Science – F L Mathews & R D Rawlings (Chapman & Hall, 1990)
7. Introduction to Ceramics – W D Kingery, H K Bower and U R Uhlman (John Wiley, 1960)
8. Glasses and vitreous state – J Zarzycki (Cambridge University Press, 1982)
9. Nanoscale Materials – (Ed) L.M. Liz-Marzan and P.V.Kamat, (Kluwer, 2003)

Minimum of 6 experiments has to be done out of 8

List of Experiments/Syllabus

1. Electrical Resistivity of conducting wires
2. Preparation of Urea formaldehyde resin
3. Preparation of Phenol formaldehyde resin
4. Preparation of Borate based glasses
5. Preparation of Silicate based glasses
6. To determine the Viscosity and molecular weight of the polymer using viscometer
7. Preparation of Zinc Oxide nano material by precipitation method
8. Energy band gap of semiconductors