

Course Structure

YEAR-1

Semester-I

S.No.	Subject Code	Name of the subject	No. of Credits
01	ENGH-101	General English-I	04
02	PHYH-102	Physics-I (Mechanics and Properties of Matter)	04
03	CHEH-103	Chemistry-I	04
04	MATH-104	Mathematics-I	04

Semester-II

S.No.	Subject Code	Name of the subject	No. of Credits
01	ENGH-201	General English-II	04
02	PHYH-202	Physics-II (Oscillation of Waves)	04
03	CHEH-203	Chemistry-II	04
04	MATH-204	Mathematics-II	04

Physics-I (Mechanics and Properties of Matter)

Semester-I
Code: PHYH-102
External: 80

Max. Marks: 100
Internal: 20;

Min. Pass Marks: 40

Unit-I

Forces in inertial systems; Fictitious forces, acceleration due to uniformly rotating frame; Foucault's pendulum; Galilean transformation, conservation of momentum, inelastic collisions of equal masses, Velocity and acceleration in rotating coordinate systems; Applications. Conservation of energy, free fall; potential energy, linear restoring forces. Transformations between kinetic and potential energy; conservative forces, escape velocity from the earth and from solar system; Gravitational potential near the surface of earth. Projectile motion.

Unit-II

Centre of mass; collision of particles; transverse momentum components, collision of particles with internal excitations; general elastic collisions of particles; systems with variable mass; conservation of angular momentum; torque due to internal and external forces (examples). The equation of motion of a rigid body, Moment of inertia (with examples), Time dependence of motion (with examples), rolling without slipping, torque about center of mass with examples, rotation about fixed axis; moment and products of inertia; Euler equation with applications.

Unit-III

Inverse square law force, Potential energy and force between a point mass and spherical shell, solid sphere, Gravitational self energy, Orbits: equations and Kepler's Laws; two body problem, reduced mass; Vibration of diatomic molecule. Newtonian Relativity; Michelson-Morley Experiment, Special theory of relativity, Lorentz transformations and their consequences (Simultaneity, time dilation and length contraction), Addition of velocities, Variation of mass with velocity, mass energy relation; space-time four-dimensional continuum; four vectors.

Unit-IV

Elasticity : Elastic moduli and their interrelations, torsion of a cylinder, bending moment, cantilever, simply supported beam with concentrated load at the centre, strain energy. Viscosity : Streamline and turbulent motion, Poiseuille's formula, critical velocity, Reynolds number, Bernoulli's theorem, Stokes' law. Molecular Theory of Surface tension, elevation and depression of liquid columns in a capillary tube, excess pressure in a spherical bubble and spherical drop.

Text Books:

1. *Mechanics* Berkeley physics course, v.1: By Charles Kittel, Walter Knight, Malvin Ruderman, Carl Helmholtz, Burton Moyer, (Tata McGraw-Hill, 2007)
2. *Mechanics* by D S Mathur (S. Chand & Company Limited, 2000)

References:

1. *An introduction to mechanics* by Daniel Kleppner, Robert J. Kolenkow (McGraw-Hill, 1973).
2. *Fundamentals of Physics* by Halliday, Resnick and Walker (John Wiley)

Chemistry-I

Semester-I

Code: CHEH-103

Max. Marks: 100

Min. Pass Marks: 32

Internal: 20; External: 80

Unit-I

Covalent Bonding : Qualitative approach to Valence Bond Theory and its Limitations. Hybridization, Equivalent and Non-equivalent Hybrid Orbitals, Bent's Rule and Applications.

Symmetry and Overlap. Molecular Orbital Diagrams of diatomic and simple polyatomic systems (O_2 , C_2 , B_3 , CO , NO and their ions; HCl , BeF_2 , CH_4 , Bcl_3) (Idea of Sp^3 Mixing and Orbital Interaction to be given).

Unit-II

Packing in Crystals : Close Packed Structures. (1) Spinal, (2) Ilmenite and (3) Perovskite Structures of Mixed Metal Oxides. Size Effects, Radius, Ratio Rules and their Limitations. Lattice Energy : Born Equation (Calculations of Energy in Ion Pair and Ion-pairs Square Formation), Madelung Constant. Kapustinskii Equation and its Applications. Born-Haber Cycle and its Applications. Weak Chemical Forces : Van-der-Waals Forces, Hydrogen Bonding. Effects of Chemical Forces on M.P., B.P., and Solubility. Energetics of Dissolution Process.

Unit-III

Crystal Field Theory : Measurement of $10 Dq$ CFSE in Weak and Strong Fields. Pairing Energies. Factors affecting the Magnitude of $10 Dq$. Octahedral vs. Tetrahedral Coordination. Tetragonal Distortions from Octahedral Symmetry. The Jahn – Teller Theorem. Square – Planar Coordination. Ligand Field and Molecular Orbital Theories.

Unit-IV

The Trans Effect. Mechanism of the Trans Effect. Kinetics of Square Planar Substitution Reactions. Thermodynamic and Kinetic Stability. Labile and Inert Complexes. Kinetics of Octahedral Substitution Reaction. Mechanism of Substitution in Octahedral Complexes. Mechanism of Electron Transfer Reactions (Inner and Outer Sphere Mechanism).

Text Books:

1. P. S Sindhu, Modern Chemistry, S. Chand & Sons.
2. J. D. Lee, A New Concise Inorganic Chemistry, E.L.B.S.

MATHEMATICS-I

Semester-I
Code: MATH-104

Max. Marks: 100
Min. Pass Marks: 32
Internal: 20; External: 80

Unit I

Review of limit and continuity, properties of continuous functions on closed intervals, Rolle's theorem, Mean value theorems (Lagrange's and Cauchy), Taylor's and Maclaurin's theorem with applications. Indeterminate forms, L'Hospital's rule (with proof), Successive differentiation, Leibnitz theorem, Darboux intermediate value theorem for the derivative.

Unit II

Tangents and normals (polar co-ordinates only). Pedal equations, length of arcs. Partial

differentiation of functions of two and three variables. Euler's theorem on homogeneous functions. Curvature, radius of curvature for Cartesian and polar coordinates, double points, Asymptotes, Cartesian and polar coordinates, envelopes, involutes and evolutes, tracing of curves (Cartesian coordinates only).

Unit III

Parabola: Equation of tangent and normal, pole and polar, pair of tangents from a point, equation of a chord of a parabola in terms of its middle point, parametric equations of a parabola. Ellipse; Tangents and Normals, pole and polar, parametric equations of ellipse, Diameters, conjugate diameters and their properties. Hyperbola: Equations of tangents and normals, equation of hyperbola referred to asymptotes as axes, Rectangular and conjugate diameters and their properties. Tracing of conics (Cartesian co-ordinates only).

Unit IV

Sphere: condition for two spheres to be orthogonal. Radical plane. Coaxial system. Simplified form of the equation of two spheres. Cone: Vertex, guiding curve, generator, equation of cone with vertex as origin or a given vertex and guiding curve, condition that the general equation of the second degree should represent a cone. Angle between generators of section of a cone and plane through vertex. Necessary and sufficient conditions for a cone to have three mutually perpendicular generators. Cylinder: equation of the cylinder whose generators intersect a given conic and are parallel to given line, enveloping cylinder of a sphere.

Text Books :

- 1.S.D. Chopra and M.L. Kochar and A.Aziz-ul-Auzeem,- Differential Calculus (Thoroughly revised and enlarged new edition- 2004).
2. S.Pirzada and T.A.Chisti, Geometry, Universities Press, Oreint Blackswan, 2007.

References:

1. T.M.Apostol,- Calculus I
2. Shanti Narayan- Differential Calculus.
3. P. Balasubrahmanyam,- K.G. Subramanian and G.R.Venkataraman, Coordinate Geometry of two and three Dimensions,
4. R.J.T.Bell- A Text Book of Solid Geometry.

Physics-II (Oscillations and Waves)

Semester-II
Code: PHYH-202

Max. Marks: 100
Min. Pass Marks: 40
Internal: 20; External: 80

Unit-I

Simple Harmonic Oscillations. Differential Equation of SHM and its Solution. Amplitude, Frequency, Time Period and Phase. Velocity and Acceleration. Kinetic, Potential and Total Energy and their Time Average Values. Reference Circle. Rotating Vector Representation of SHM. Mass-Spring system, Simple Pendulum, Torsional Pendulum, Oscillations in a U-Tube. Compound pendulum: Centres of Percussion and Oscillation, and Bar Pendulum.

Unit-II

Superposition of Two Collinear Harmonic Oscillations :- Linearity and Superposition Principle. Oscillations having Equal/Unequal Frequencies Beats. Superposition of N Collinear Harmonic Oscillations with Equal Phase Differences and Equal Frequency Differences. Superposition of

Two Mutually Perpendicular Simple Harmonic Motions with Frequency Ratios 1:1 and 1:2 using Graphical and Analytical Methods. Lissajous Figures and their Uses.

Unit-III

System with Two Degrees of Freedom : Coupled Oscillators. Normal Coordinates and Normal Modes. Energy Relation and Energy Transfer. Normal Modes of N Coupled Oscillators. Free Oscillations. Damped Oscillations : Damping Coefficient, Log Decrement. Forced Oscillations : Transient and Steady States, Amplitude, Phase, Resonance, Sharpness of Resonance, Power Dissipation and Quality Factor. Helmholtz Resonator

Unit-IV

Wave Motion and wave equation.:- Plane and Spherical Waves. Longitudinal and Transverse Waves. Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. Standing (Stationary) Waves in a String : Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes wrt Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Open and Closed Pipes. Superposition of N Harmonic Waves.

Text Books:

1. H. J. Pain: The Physics of Vibrations and Waves, 6th edition (John Wiley and Sons).

References:

1. A. P. French: Vibrations and Waves, M.I.T introductory course.
2. Waves: BERKELEY PHYSICS COURSE by Franks Crawford (Tata McGrawHill, 2007).
3. Fundamentals of Waves & Oscillations By K. Uno Ingard (Cambridge University Press, 1988)

Chemistry-II

Semester-I

Code: CHEH-203

Max. Marks: 100

Min. Pass Marks: 40

Internal: 20; External: 80

Unit-I

Bonding in Organic Molecules and its effects on Shape Chirality and RS Nomenclature as applied to Chiral Centers. Treatment of Chirality upto three chiral centers. Conformation of Acyclic and Cyclic Systems, Conformational Analysis of Di-substituted Cyclohexanes. Geometrical Isomerism and E-2 Nomenclature.

Unit-II

Electronic Displacements in Organic Molecules. Aromaticity. Reactivity of Organic Molecules. Heterolytic and Homolytic Fission. Nucleophiles, Electrophiles, Acids and Bases and their Relative Strengths (including Carbon Acids). Addition, Elimination and Substitution Reactions (including Electrophilic, Nucleophilic and Aromatic Types). Arynes and Carbenes as Reaction Intermediates.

Unit-III

Functional Group. Orientation Effect in Aromatic Substitution. Groups. (1) Hydroxyl Group, (2) Phenol, (3) Carbonyl Group, (4) Carboxylic Acid Group and its Derivatives : Esters and Amides, (5) Cyano Group, (6) Nitro Group, and (7) Amino Group. Organic Reactions : (1) Aldol Condensation, (2) Cannizzaro Reaction, (3) Claisen Condensation, (4) Darzen Reaction, (5) Dickermann Reaction, (6) Grignard Synthesis, (7) Mannich Reaction, (8) Michael Reaction, and (9) Perkin Reaction,

Unit-IV

Types of Polymerization. Forms of Polymers. (1) Condensation Polymerization, (2) Ring Opening Polymerization, (3) Addition Polymerization, and (4) Ziegler-Natta Polymerization. Natural and Synthetic Rubbers.

Books

1. I.L. Finar, Organic Chemistry, (Vol. I & II), E.L.B.S.
2. R.T. Morrison & R.N. Boyd, Organic Chemistry, Prentice Hall.
3. Arun Bahl and B.S. Bahl, Advanced Organic Chemistry, S. Chand.
4. T.W. Graham Solomons, Organic Chemistry, John Wiley and Sons.

Mathematics-II

Semester-II
Code: MATH-204

Max. Marks: 100
Min. Pass Marks: 40
Internal: 20; External: 80

Unit-I

Integration (indefinite and definite), Reduction formulae, differential equations, Bernoulli's equation, and sufficient condition for exactness, symbolic operators, Homogeneous and nonhomogeneous linear differential equations with constant coefficients and those reducible to such equations.

UNIT-II

Miscellaneous forms of differential equations. First order higher degree equations solvable for x, y, z, p . Equations from which one variable is explicitly absent, Clairut's equation and equations reducible to Clairut's form.

Some Special Integrals Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral)

UNIT-III

Vector Differentiation :- Scalar and Vector Fields. Ordinary and Partial Derivative of a Vector w.r.t. Coordinates. Space Curves. Unit Tangent Vector and Unit Normal Vector. Directional Derivatives and Normal Derivative. Gradient of a Scalar Field and its Geometrical Interpretation. Divergence and Curl of a Vector Field. Laplacian. Vector Identities. Ordinary Integral of Vectors. Line, Surface and Volume Integrals. Flux of a Vector Field. Gauss' Divergence Theorem,

Green's Theorem and Stokes Theorem.

Unit-IV

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. Double and Triple Integrals : Change of Order of Integration. Change of Variables and Jacobian. Applications of Multiple Integrals to surfaces and volumes.

Text Books:

1. **Integral Calculus:** S.D. Chopra and M.L. Kochar
2. **Schaum's Outline of Vector Analysis**, 2nd Edn. By Murray Spiegel and Seymour Lipschutz (TatMcGraw-Hill, 2009)

References:

1. K. A. Ross, **Elementary analysis: the theory of calculus**, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
2. Arfken, Weber and Harris, **Mathematical Methods for Physicists**, 7th Edition (Academic Press).