B.Sc. (Maths)

Combination of Physics-Chemistry-Mathematics

- **Subject-1 Physics**
- **Subject-2 Chemistry**
- **Subject-3 Mathematics**

B.Sc. Physics

DISTRIBUTION OF DIFFERENT COURSES AND CREDITS IN VARIOUS SEMESTERS

Offered By:

Department of Physics
Faculty of Science
Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur

Course Code : PHY 101

Course Title : Basics of Physics(Elementary appreciation of Physics)

Credits : 2+0

Unit – I

Physical quantities, important units, dimensional analysis, error analysis. Mechanics: concepts of velocity, acceleration, momentum, force and energy. Gravity: Projectiles and satellites, orbits of planets, eclipses, solar system, stars and galaxies. Elementary idea of origin of the universe. Sound: oscillations, waves, concept of musical notes.

Indian Science organization and Premier Institutes.

Unit – II

Heat: Conservation of Energy, Temperature, heat capacities, thermal expansion and conductivity. Light: Mirrors, prism, lenses, human eye, microscope and telescope. Electromagnetic spectrum, Hydrogen spectral lines, Solar Fraunhofer lines. Electricity: Current, Potential, Resistance, Capacitance and Inductance. Household appliances. Conductors, Insulators and Semi-conductors.

Course Code : PHY 102

Course Title : Mathematical Physics & Newtonian Mechanics

Credits : 4+0

Part A

Unit 1 Vector Algebra

Coordinate rotation, reflection and inversion as the basis for defining scalars, vectors, pseudo-scalars and pseudo-vectors (include physical examples). Component form in 2D and 3D.Geometrical and physical interpretation of addition, subtraction, dot product, wedge product,crossproduct and triple product of vectors. Position, separation and displacement vectors.

Unit 2 Vector Calculus

Geometrical and physical interpretation of vector differentiation, Gradient, Divergence and Curland their significance. Vector integration, Line, Surface (flux) and Volume integrals of vectorfields. Gradient theorem, Gauss-divergence theorem, Stoke-curl theorem, Greens theorem andHelmholtz theorem (statement only). Introduction to Dirac delta function.

Unit 3 Coordinate Systems

2D & 3D Cartesian, Spherical and Cylindrical coordinate systems, basis vectors, transformationequations. Expressions for displacement vector, arc length, area element, volume element, gradient,divergence and curl in different coordinate systems. Components of velocity and acceleration indifferent coordinate systems. Examples of non-inertial coordinate system and pseudo-acceleration.

Unit 4 Introduction to Tensors

Principle of invariance of physical laws w.r.t. different coordinate systems as the basis fordefiningtensors. Coordinate transformations for general spaces of nD, contravariant, covariant & mixedtensors and their ranks, 4-vectors. Index notation and summation convention.Symmetric and skew-symmetric tensors. Invariant tensors, Kronecker delta and Epsilon (LeviCivita) tensors. Examplesof tensors in physics.

Part B

Unit 1 Dynamics of a System of Particles

Review of historical development of mechanics up to Newton. Background, statement and criticalanalysis of Newton’s axioms of motion. Dynamics of a system of particles, centre of mass motion,and conservation laws & their deductions. Rotating frames of reference, general derivation of originof pseudo forces (Euler, Coriolis & centrifugal) in rotating frame, and effects of Coriolis force.

Unit 2 Dynamics of a Rigid Body

Angular momentum, Torque, Rotational energy and the inertia tensor. Rotational inertia for simplebodies (ring, disk, rod, solid and hollow sphere, solid and hollow cylinder, rectangular lamina). Thecombined translational and rotational motion of a rigid body on horizontal and inclined planes.Elasticity, relations between elastic constants, bending of beam and torsion of cylinder.

Unit 3 Motion of Planets & Satellites

Two particle central force problem, reduced mass, relative and centre of mass motion. Newton's

law of gravitation, gravitational field and gravitational potential. Kepler's laws of planetary motionand their deductions. Motions of geo-synchronous & geo-stationary satellites and basic idea ofGlobal Positioning System (GPS).

Unit 4 Wave Motion

Differential equation of simple harmonic motion and its solution, use of complex notation, dampedand forced oscillations, Quality factor. Composition of simple harmonic motion, Lissajous figures.Differential equation of wave motion. Plane progressive waves in fluid media, reflection of wavesand phase change, pressure and energy distribution. Principle of superposition of waves, stationarywaves, phase and group velocity.

Course Code : PHY 103

Course Title : Practical (Mechanical Properties of Matter)

Credits : 0+2

List of Experiments

Course Code : PHY 104

Course Title : Thermal Physics & Semiconductor Devices

Credits : 4+0

PART A

Unit 1 Zeroth&First Law of Thermodynamics

State functions and terminology of thermodynamics. Zeroth law and temperature. First law, internal energy, heat and work done. Work done in various thermodynamical processes. Enthalpy, relation between C P and C V . Carnot's engine, efficiency and Carnot's theorem. Efficiency of internal combustion engines (Otto and diesel).

Unit 2 Second&Third Law of Thermodynamics

Different statements of second law, Clausius inequality, entropy and its physical significance. Entropy changes in various thermodynamical processes. Third law of thermodynamics and unattainability of absolute zero. Thermodynamical potentials, Maxwell's relations, conditions for feasibility of a process and equilibrium of a system. Clausius- Clapeyron equation, Joule-Thompson effect.

Unit 3 Kinetic Theory of Gases

Kinetic model and deduction of gas laws. Derivation of Maxwell's law of distribution of velocities and its experimental verification. Degrees of freedom, law of equipartition of energy (no derivation) and its application to specific heat of gases (mono, di and poly atomic).

Unit 4 Theory of Radiation

Blackbody radiation, spectral distribution, concept of energy density and pressure of radiation. Derivation of Planck's law, deduction of Wien's distribution law, Rayleigh-Jeans law, Stefan- Boltzmann law and Wien's displacement law from Planck's law.

PART B

Unit 1 DC & AC Circuits

Growth and decay of currents in RL circuit. Charging and discharging of capacitor in RC, LC and V RCL circuits. Network Analysis - Superposition, Reciprocity, Thevenin's and Norton's theorems. AC Bridges - measurement of inductance (Maxwell's, Owen's and Anderson's bridges) and measurement of capacitance (Schering's, Wein's and de Sauty's bridges).

Unit 2 Semiconductors & Diodes

P and N type semiconductors, qualitative idea of Fermi level. Formation of depletion layer in PN junction diode, field & potential at the depletion layer. Qualitative idea of current flow mechanism in forward & reverse biased diode. Diode fabrication. PN junction diode and its

characteristics, static and dynamic resistance. Principle, structure, characteristics and applications of Zener, Tunnel, Light Emitting, Point Contact and Photo diodes. Half and Full wave rectifiers, calculation of ripple factor, rectification efficiency and voltage regulation. Basic idea about filter circuits and voltage regulated power supply.

Unit 3 Transistors

Bipolar Junction PNP and NPN transistors. Study of CB, CE & CC configurations w.r.t. active, cutoff& saturation regions; characteristics; current, voltage & power gains; transistor currents & relations between them. Idea of base width modulation, base spreading resistance & transition time. DC Load Line analysis and Q-point stabilisation. Voltage Divider Bias circuit for CE amplifier. Qualitative discussion of RC coupled amplifier (frequency response not included).

Unit 4 Electronic Instrumentation

Multimeter: Principles of measurement of dc voltage, dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, electron gun, electrostatic focusing and acceleration (no mathematical treatment). Front panel controls, special features of dual trace CRO, specifications of a CRO and their significance. Applications of CRO to study the waveform and measurement of voltage, current, frequency & phase difference.

Course Code : PHY 105

Course Title : Practical (Thermal Properties of Matter & Electronic Circuits)

Credits : 0+2

List of Experiments

Course Code : PHY 201

Course Title : Electromagnetic Theory & Optics

Credits : 4+0

PART A

Unit 1 Electrostatics

Electric charge & charge densities, electric force between two charges. General expression for Electric field in terms of volume charge density (divergence & curl of Electric field), general expression for Electric potential in terms of volume charge density and Gauss law (applications included). Study of electric dipole. Electric fields in matter, polarization, auxiliary field D (Electric displacement), electric susceptibility and permittivity.

Unit 2 Magnetostatics

Electric current & current densities, magnetic force between two current elements. General expression for Magnetic field in terms of volume current density (divergence and curl of Magnetic field), General expression for Magnetic potential in terms of volume current density and Ampere's circuital law (applications included). Study of magnetic dipole (Gilbert & Ampere model). Magnetic fields in matter, magnetisation, auxiliary field H, magnetic susceptibility and permeability.

Unit 3 Time Varying Electromagnetic Fields

Faraday's laws of electromagnetic induction and Lenz's law. Displacement current, equation of continuity and Maxwell-Ampere's circuital law. Self and mutual induction (applications included). Derivation and physical significance of Maxwell's equations. Theory and working of moving coil ballistic galvanometer (applications included).

Unit 4 Electromagnetic Waves

Electromagnetic energy density and Poynting vector. Plane electromagnetic waves in linear infinite dielectrics, homogeneous & inhomogeneous plane waves and dispersive & non-dispersive media. Reflection and refraction of homogeneous plane electromagnetic waves, law of reflection, Snell's law, Fresnel's formulae (only for normal incidence & optical frequencies) and Stoke's law.

PART B

Unit 1 Interference

Conditions for interference and spatial & temporal coherence. Division of Wavefront - Fresnel's Biprism and Lloyd's Mirror. Division of Amplitude - Parallel thin film, wedge shaped film and Newton's Ring experiment. Interferometer - Michelson and Fabry-Perot.

Unit 2 Diffraction

Distinction between interference and diffraction. Fresnel's and Fraunhofer's class of diffraction. Fresnel's Half Period Zones and Zone plate. Fraunhofer diffraction at a single slit, n slits and Diffracting Grating. Resolving Power of Optical Instruments - Rayleigh's criterion and resolving power of telescope, microscope & grating.

Unit 3 Polarisation

Polarisation by dichronic crystals, birefringence, Nicol prism, retardation plates and Babinet's compensator. Analysis of polarized light. Optical Rotation - Fresnel's explanation of optical rotation and Half Shade & Biquartz polarimeters.

Unit 4 Lasers

Characteristics and uses of Lasers. Quantitative analysis of Spatial and Temporal coherence. Conditions for Laser action and Einstein's coefficients. Three and four level laser systems (qualitative discussion).

Course Code : PHY 202

Course Title : Practical (Demonstrative Aspects of Electricity & Magnetism)

Credits : 0+2

List of Experiments

Course Code : PHY 203

Course Title : Modern Physics & Electronics

Credits : 4+0

PART A

Unit 1 Relativity-Experimental Background

Structure of space & time in Newtonian mechanics and inertial & non-inertial frames. Galilean transformations. Newtonian relativity. Galilean transformation and Electromagnetism. Attempts to locate the Absolute Frame: Michelson-Morley experiment and significance of the null result. Einstein's postulates of special theory of relativity.

Unit 2 Relativity-Relativistic Kinematics

Structure of space & time in Relativistic mechanics and derivation of Lorentz transformation equations (4-vector formulation included). Consequences of Lorentz Transformation Equations (derivations & examples included): Transformation of Simultaneity (Relativity of simultaneity); Transformation of Length (Length contraction); Transformation of Time (Time dilation); Transformation of Velocity (Relativistic velocity addition); Transformation of Acceleration; Transformation of Mass (Variation of mass with velocity). Relation between Energy & Mass (Einstein's mass & energy relation) and Energy & Momentum.

Unit 3 Inadequacies of Classical Mechanics

Particle Properties of Waves: Spectrum of Black Body radiation, Photoelectric effect, Compton effect and their explanations based on Max Planck's Quantum hypothesis. Wave Properties of Particles: Louis de Broglie's hypothesis of matter waves and their experimental verification by Davisson-Germer's experiment and Thomson's experiment.

Unit 4 Introduction to Quantum Mechanics

Matter Waves: Mathematical representation, Wavelength, Concept of Wave group, Group (particle) velocity, Phase (wave) velocity and relation between Group & Phase velocities. Wave Function: Functional form, Normalisation of wave function, Orthogonal & Orthonormal wave functions and Probabilistic interpretation of wave function based on Born Rule.

PART B

Unit 1 Transistor Biasing

Faithful amplification & need for biasing. Stability Factors and its calculation for transistor biasing V circuits for CE configuration: Fixed Bias (Base Resistor Method), Emitter Bias

(Fixed Bias with Emitter Resistor), Collector to Base Bias (Base Bias with Collector Feedback) &, Voltage Divider Bias. Discussion of Emitter-Follower configuration.

Unit 2 Amplifiers

Classification of amplifiers based on Mode of operation (Class A, B, AB, C & D), Stages (single & multi stage, cascade &cascode connections), Coupling methods (RC, Transformer, Direct & LC couplings), Nature of amplification (Voltage & Power amplification) and Frequency capabilities (AF, IF, RF & VF).Theory & working of RC coupled voltage amplifier (Uses of various resistors & capacitors, andFrequency response) and Transformer coupled power amplifier (calculation of Power, Effect oftemperature, Use of heat sink & Power dissipation).Calculation of Amplifier Efficiency (power efficiency) for Class A Series-Fed, Class ATransformer Coupled, Class B Series-Fed and Class B Transformer Coupled amplifiers.

Unit 3 Feedback & Oscillator Circuits

Feedback Circuits: Effects of positive and negative feedback. Voltage Series, Voltage Shunt, Current Series and Current Shunt feedback connection types and their uses for specific amplifiers. Estimation of Input Impedance, Output Impedance, Gain, Stability, Distortion, Noise and Band Width for Voltage Series negative feedback and their comparison between different negative feedback connection types. Oscillator Circuits: Use of positive feedback for oscillator operation. Barkhausen criterion for self-sustained oscillations. Feedback factor and frequency of oscillation for RC Phase Shift oscillator and Wein Bridge oscillator. Qualitative discussion of Reactive Network feedback oscillators (Tuned oscillator circuits): Hartley &Colpitt oscillators.

Unit 4 Introduction to Fiber Optics

Basics of Fiber Optics, step index fiber, graded index fiber, light propagation through an optical fiber, acceptance angle & numerical aperture, qualitative discussion of fiber losses and applications of optical fibers.

Course Code : PHY 204

Course Title : Practical (Basic Electronics Instrumentation)

Credits : 0+2

List of Experiments

Course Code : PHY 301

Course Title : Classical Mechanics and Statistical Mechanics

Credits : 4+0

PART A

Unit 1 Constrained Motion

Constraints - Definition, Classification and Examples. Degrees of Freedom and Configuration space. Constrained system, Forces of constraint and Constrained motion. Generalised coordinates, Transformation equations and Generalised notations & relations. Principle of Virtual work and D'Alembert's principle.

Unit 2 Lagrangian Formalism

Lagrangian for conservative & non-conservative systems, Lagrange's equation of motion (no derivation), Comparison of Newtonian &Lagrangian formulations, Cyclic coordinates, and Conservation laws (with proofs and properties of kinetic energy function included). Simple examples based on Lagrangian formulation.

Unit 3 Hamiltonian Formalism

Phase space, Hamiltonian for conservative & non-conservative systems, Physical significance of Hamiltonian, Hamilton's equation of motion (no derivation), Comparison of Lagrangian& Hamiltonian formulations, Cyclic coordinates, and Construction of Hamiltonian from Lagrangian. Simple examples based on Hamiltonian formulation.

Unit 4 Central Force

Definition and properties (with prove) of central force. Equation of motion and differential equation of orbit. Bound & unbound orbits, stable & non-stable orbits, closed & open orbits and Bertrand's theorem. Motion under inverse square law of force and derivation of Kepler's laws. Laplace-Runge- Lenz vector (Runge-Lenz vector) and its applications.

PART B

Unit 1 Macrostate& Microstate

Macrostate, Microstate, Number of accessible microstates and Postulate of equal a priori. Phase space, Phase trajectory, Volume element in phase space, Quantisation of phase space and number of accessible microstates for free particle in 1D, free particle in 3D & harmonic oscillator in 1D.

Unit 2 Concept of Ensemble

Problem with time average, concept of ensemble, postulate of ensemble average and Liouville's

theorem (proof included). Micro Canonical, Canonical & Grand Canonical ensembles. Thermodynamic Probability, Postulate of Equilibrium and Boltzmann Entropy relation.

Unit 3 Distribution Laws

Statistical Distribution Laws: Expressions for number of accessible microstates, probability & number of particles in ith state at equilibrium for Maxwell-Boltzmann, Bose-Einstein & Fermi-Dirac statistics. Comparison of statistical distribution laws and their physical significance. Canonical Distribution Law: Boltzmann's Canonical Distribution Law, Boltzmann's Partition Function, Proof of Equipartition Theorem (Law of Equipartition of energy) and relation between Partition function and Thermodynamic potentials.

Unit 4 Applications of Statistical Distribution Laws

Application of Bose-Einstein Distribution Law: Photons in a black body cavity and derivation of Planck's Distribution Law. Application of Fermi-Dirac Distribution Law: Free electrons in a metal, Definition of Fermi energy, Determination of Fermi energy at absolute zero, Kinetic energy of Fermi gas at absolute zero and concept of Density of States (Density of Orbitals).

Course Code : PHY 302

Course Title : Quantum Mechanics & Spectroscopy

Credits : 4+0

PART A

Unit 1 Operator Formalism

Operators: Review of matrix algebra, definition of an operator, special operators, operator algebra and operators corresponding to various physical-dynamical variables. Commutators: Definition, commutator algebra and commutation relations among position, linear momentum & angular momentum and energy & time. Simple problems based on commutation relations.

Unit 2 Eigen & Expectation Values

Eigen & Expectation Values: Eigen equation for an operator, eigen state (value) and eigen functions. Linear superposition of eigen functions and Non-degenerate & Degenerate eigen states. Expectation value pertaining to an operator and its physical interpretation. Hermitian Operators: Definition, properties and applications. Prove of the hermitian nature of various physical-dynamical operators.

Unit 3 Uncertainty Principle & Schrodinger Equation

Uncertainty Principle: Commutativity & simultaneity (theorems with proofs). Non commutativity of operators as the basis for uncertainty principle and derivation of general form of uncertainty principle through Schwarz inequality. Uncertainty principle for various conjugate pairs of physical- dynamical parameters and its applications.

Schrodinger Equation: Derivation of time independent & time dependent forms, Schrodinger equation as an eigen equation, Deviation & interpretation of equation of continuity in Schrodinger representation, and Equation of motion of an operator in Schrodinger representation.

Unit 4 Applications of Schrodinger Equation

Application to 1D Problems: Infinite Square well potential (Particle in 1D box), Finite Square well potential, Potential step, Rectangular potential barrier and 1D Harmonic oscillator. Application to 3D Problems: Infinite Square well potential (Particle in a 3D box) and the Hydrogen atom (radial distribution function and radial probability included).(Direct solutions of Hermite, Associated Legendre and Associated Laguerre differential equationsto be substituted).

PART B

Unit 1 Vector Atomic Model

Inadequacies of Bohr and Bohr-Sommerfeld atomic models w.r.t. spectrum of Hydrogen atom (fine structure of H-alpha line). Modification due to finite mass of nucleus and Deuteron spectrum. Vector atomic model (Stern-Gerlach experiment included) and physical & geometrical interpretations of various quantum numbers for single & many valence electron systems. LS &jj couplings, spectroscopic notation for energy states, selection rules for transition of electrons and intensity rules for spectral lines. Fine structure of H-alpha line on the basis of vector atomic model.

Unit 2 Spectra of Alkali & Alkaline Elements

Spectra of alkali elements: Screening constants for s, p, d & f orbitals; sharp, principle, diffuse & fundamental series; doublet structure of spectra and fine structure of Sodium D line. Spectra of alkaline elements: Singlet and triplet structure of spectra.

Unit 3 X-Rays & X-Ray Spectra

Nature & production, Continuous X-ray spectrum & Duane-Hunt's law, Characteristic X-ray spectrum & Mosley's law, Fine structure of Characteristic X-ray spectrum, and X-ray absorption spectrum.

Unit 4 Molecular Spectra

Discrete set of energies of a molecule, electronic, vibrational and rotational energies. Quantisation of vibrational energies, transition rules and pure vibrational spectra. Quantisation of rotational energies, transition rules, pure rotational spectra and determination of inter nuclear distance. Rotational-Vibrational spectra; transition rules; fundamental band & hot band; O, P, Q, R, S

Course Code : PHY 303

Course Title : Practical (Demonstrative Aspects of Optics & Lasers)

Credits : 0+2

List of Experiments

Course Code : PHY 304

Course Title : Solid State Physics & Nuclear Physics

Credits : 4+0

PART A

Unit 1 Crystal Structure

Lattice, Basis & Crystal structure. Lattice translation vectors, Primitive & non-primitive cells. Symmetry operations, Point group & Space group. 2D & 3D Bravais lattice. Parameters of cubic lattices. Lattice planes and Miller indices. Simple crystal structures - HCP & FCC, Diamond, Cubic Zinc Sulphide, Sodium Chloride, Cesium Chloride.

Unit 2 Crystal Diffraction

X-ray diffraction and Bragg's law. Experimental diffraction methods - Laue, Rotating crystal and Powder methods. Derivation of scattered wave amplitude. Reciprocal lattice, Reciprocal lattice vectors and relation between Direct & Reciprocal lattice. Diffraction conditions, Ewald's method and Brillouin zones. Reciprocal lattice to SC, BCC & FCC lattices.

Unit 3 Crystal Bindings

Classification of Crystals on the Basis of Bonding - Ionic, Covalent, Metallic, van der Waals (Molecular) and Hydrogen bonded. Crystals of inert gases, Attractive interaction (van der Waals- London) & Repulsive interaction, Equilibrium lattice constant, Cohesive energy and Compressibility & Bulk modulus. Ionic crystals, Cohesive energy, Madelung energy and evaluation of Madelung constant.

Unit 4 Lattice Vibrations

Lattice Vibrations: Lattice vibrations for linear mono & di atomic chains, Dispersion relations and Acoustical & Optical branches (qualitative treatment). Qualitative description of Phonons in solids. Lattice heat capacity, Dulong-Petit's law and Einstein's theory of lattice heat capacity. Free Electron Theory: Fermi energy, Density of states, Heat capacity of conduction electrons, Paramagnetic susceptibility of conduction electrons and Hall effect in metals.

Band Theory: Origin of band theory, Qualitative idea of Bloch theorem, Kronig-Penney model, Effectice mass of an electron & Concept of Holes & Classification of solids on the basis of band theory.

PART B

Unit 1 Nuclear Forces & Radioactive Decays

General Properties of Nucleus: Mass, binding energy, radii, density, angular momentum, magnetic dipole moment vector and electric quadrupole moment tensor. Nuclear Forces:

General characteristic of nuclear force and Deuteron ground state properties. Radioactive Decays: Nuclear stability, basic ideas about beta minus decay, beta plus decay, alpha decay, gamma decay & electron capture, fundamental laws of radioactive disintegration and radioactive series.

Unit 2 Nuclear Models & Nuclear Reactions

Nuclear Models: Liquid drop model and Bethe-Weizsacker mass formula. Single particle shell model (the level scheme in the context of reproduction of magic numbers included).

Nuclear Reactions: Bethe's notation, types of nuclear reaction, Conservation laws, Cross-section of nuclear reaction, Theory of nuclear fission (qualitative), Nuclear reactors and Nuclear fusion.

Unit 3 Accelerators & Detectors

Accelerators: Theory, working and applications of Van de Graaff accelerator, Cyclotron and Synchrotron. Detectors: Theory, working and applications of GM counter, Semiconductor detector, Scintillation counter and Wilson cloud chamber.

Unit 4 Elementary Particles

Fundamental interactions & their mediating quanta. Concept of antiparticles. Classification of elementary particles based on intrinsic-spin, mass, interaction & lifetime. Families of Leptons, Mesons, Baryons & Baryon Resonances. Conservation laws for mass-energy, linear momentum, angular momentum, electric charge, baryonic charge, leptonic charge, isospin & strangeness. Concept of Quark model.

Course Code : PHY 305

Course Title : Analog & Digital- Principles & Applications

Credits : 4+0

PART A

Unit 1 Semiconductor Junction

Expressions for Fermi energy, Electron density in conduction band, Hole density in valence band, Drift of charge carriers (mobility & conductivity), Diffusion of charge carries and Life time of charge carries in a semiconductor. Work function in metals and semiconductors. Expressions for Barrier potential, Barrier width and Junction capacitance (diffusion & transition) for depletion layer in a PN junction. Expressions for Current (diode equation) and Dynamic resistance for PN junction.

Unit 2 Transistor Modeling

Transistor as Two-Port Network. Notation for dc & ac components of voltage & current. Quantitative discussion of Z, Y & h parameters and their equivalent two-generator model circuits. h-parameters for CB, CE & CC configurations. Analysis of transistor amplifier using the hybrid equivalent model and estimation of Input Impedance, Output Impedance and Gain (current, voltage & power).

Unit 3 Field Effect Transistors

JFET: Construction (N channel & P channel); Configuration (CS, CD & CG); Operation in different regions (Ohmic or Linear, Saturated or Active or Pinch off & Break down); Important Terms (Shorted Gate Drain Current, Pinch Off Voltage & Gate Source Cut-Off Voltage); Expression for Drain Current (Shockley equation); Characteristics (Drain & Transfer); Parameters (Drain III Resistance, Mutual Conductance or Transconductance & Amplification Factor); Biasing w.r.t. CS configuration (Self Bias & Voltage Divider Bias); Amplifiers (CS & CD or Source Follower); Comparison (N & P channels and BJTs & JFETs).

MOSFET: Construction and Working of DE-MOSFET (N channel & P channel) and E-MOSFET (N channel & P channel); Characteristics (Drain & Transfer) of DE-MOSFET and E-MOSFET; Comparison of JFFET and MOSFET.

Unit 4 Other Devices

SCR: Construction; Equivalent Circuits (Two Diodes, Two Transistors & One Diode-One Transistor); Working (Off state & On state); Characteristics; Applications (Static switch, Phase control system & Battery charger).

UJT: Construction; Equivalent Circuit; Working (Cutoff, Negative Resistance & Saturation regions); Characteristics (Peak & Valley points); Applications (Trigger circuits, Relaxation oscillators & Sawtooth generators).

PART B

Unit 1 Number System

Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and their inter conversion. Binary Codes: BCD, Excess-3 (XS3), Parity, Gray, ASCII & EBCDIC Codes and their advantages & disadvantages. Data representation.

Unit 2 Binary Arithmetic

Binary Addition, Decimal Subtraction using 9's & 10's complement, Binary Subtraction using 1's & 2's compliment, Multiplication and Division.

Unit 3 Logic Gates

Truth Table, Symbolic Representation and Properties of OR, AND, NOT, NOR, NAND, EX-OR & EX-NOR Gates. Implementation of OR, AND & NOT gates (realization using diodes & transistor). De Morgan's theorems. NOR & NAND gates as Universal Gates. Application of EX-OR & EX- NOR gates as pairty checker. Boolean Algebra. Karnaugh Map.

Unit 4 Combinational & Sequential Circuits

Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Substractor, Full Substractor. Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders. Sequential Circuits: SR, JK & D Flip-Flops, Shift Register (transfer operation of Flip-Flops), and Asynchronous & Synchronous counters.

Course Code : PHY 306

Course Title : Practical (Analog & Digital Circuits)

Credits : 0+2

List of Experiments

B.Sc. Chemistry

DISTRIBUTION OF DIFFERENT COURSES AND CREDITS IN VARIOUS SEMESTERS

Offered By:

Department of Chemistry
Faculty of Science
Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur

Course Code: BCHE 101	
Course Title: Basics of Chemistry	
Credits: 2+0	
Unit	**Topics**
I	Introduction to Indian ancient Chemistry and contribution of Indian Chemists, in context to the holistic development of modern science and technology

Course Code: BCHE 102 (B020101T)	
Course Title: Fundamentals of Chemistry	
Credits: 4+0	
Unit	**Topics**
I	**Molecular polarity and Weak Chemical Forces**: Resonance and resonance energy, formal charge, hydrogen bonding, Van der Waals forces, ion-dipole forces, dipole- dipole interactions, induced dipole interaction, dipole moment and molecular Structure (Diatomic and polyatomic molecules), Percentage ionic character from dipole moment, polarizing power and polarizability.
II	**Simple Bonding theories of Molecules:** Atomic orbitals, Aufbau principle, multiple bonding (σ and π bond approach) and bond lengths, the valence bond theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry, Bents rule, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_5, SF_6, SF_4, ClF_3, I^-, ClF^- and SO^{2-} and H_3O^+. Molecular orbital theory (MOT). Molecular orbital diagrams, bond orders of homonuclear and heteronuclear diatomic molecules and ions (N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions)
III	A. **Periodic properties of Atoms (with reference to s & p-block)**: Brief discussion, factors affecting and variation trends of following properties in groups and periods. Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, electronegativity, Pauling's/Allred Rochow's scales, Ionization enthalpy, electron gain enthalpy. **B. Acid-Base concept** Lewis concept, concept and classification of Hard and Soft Acids and Bases. Applications of HSAB Principle.
IV	**Recapitulation of basics of Organic Chemistry:** Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bonding, hyperconjugation, Dipole moment; Electronic Displacements: Inductive, electromeric, resonance mesomeric effects and their applications
V	**Mechanism of Organic Reactions:** Curved arrow notation, drawing electron movements with allows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents electrophiles and nucleophiles, Types of organic reactions, Energy considerations. Reactive intermediates Carbocations, carbanions, free radicals, Assigning formal charges on intermediates and other ionic species.
VI	**Stereochemistry:** Concept of isomerism, Types of isomerism; Optical isomerism elements of

	symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, disasteromers, threo and erythro diastereomers, meso compounds, resolution of enantiomer, inversion, retention and recemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism determination of configuration of geometric isomers, E & Z system of nomenclature, Conformational isomerism conformational analysis of ethane and n-butane;
VII	**Basic Computer system (in brief)-**Hardware and Software; Input devices, Storage devices, Output devices, Central Processing Unit (Control Unit and Arithmetic Logic Unit); Number system (Binary, Octal and Hexadecimal Operating System)
VIII	**Environmental Chemistry :** The earth's atmosphere and its components., Types of pollutants and their sources. Green house effect and global warming. Acid rains, Ozone layer (Importance and its protection)

Course Code: BCHE 103 (B020102P)	
Course Title: Quantitative Analysis	
Credits: 0+ 2	
Unit	**Topics**
I	**Water Quality analysis** 1. Estimation of hardness of water by EDTA. 2. Determination of chemical oxygen demand (COD). 3. Determination of Biological oxygen demand (BOD).
II	**Estimation of Metals ions** 1. Estimation of ferrous and ferric by dichromate method. 2. Estimation of copper using thiosulphate.
III	**Estimation of acids and alkali contents** 1. Determination of acetic acid in commercial vinegar using NaOH. 2. Determination of alkali content antacid tablet using HCl. 3. Estimation of oxalic acid by titrating it with KMnO4.
IV	**Estimation of inorganic salts and hydrated water** 1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. 2. Redox titrations e.g. titration of ferrous ion with permanganate and dichromate using internal and external indicators 3. Iodometric Estimation of Copper Sulphate and Potassium dichromate 4. Estimation of water of crystallization of mohar's salt by titrating with $KMnO_4$.

Course Code: BCHE 104 (B020201T)	
Course Title: Bioorganic and Medicinal Chemistry	
Credits: 4+0	
Unit	**Topics**
I	**Chemistry of Carbohydrates**: Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Mechanism of mutarotation Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Inter conversions of sugars (ascending and descending of sugar series, conversion of aldoses to ketoses).
II	**Chemistry of Proteins:** Classification of amino acids,zwitter ion structure and Isoelectric point. Overview of primary, secondary, tertiary, and quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C terminal amino, Synthesis of simple peptides (upto dipeptides) by N-protection & C-activating groups and Merrifield solid phase synthesis.
III	**Chemistry of Nucleic Acids:** Constituents of Nucleic acids: Adenine, guanine, thymine, and Cytosine (Structure only), Nucleosides and nucleotides **(nomenclature**), Synthesis of nucleic acids, Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (**types of RNA**), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation
IV	**Introductory Medicinal Chemistry:** Drug discovery, design, and development; Basic Retrosynthetic approach. Drug action-receptor theory. Structure activity relationships of drug molecules, binding role of OH group, -NH2 group, double bond and aromatic ring.
V	**Solid State** Definition of space lattice, unit cell. Laws of crystallography (i) Law of constancy of interfacial angles, (ii) Law of rationality of indices and iii) Symmetry elements in crystals and law of symmetry .X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl and KCl.
VI	**Introduction to Polymer** Monomers, Oligomers, Polymers and their characteristics, Classification of polymers: Natural synthetic, linear, cross linked and network; plastics, elastomers, fibers, Homopolymers and Co-polymers, Bonding in polymers : Primary and secondary bond forces in polymers ; cohesive energy, and decomposition of polymers. **Silicones and Phosphazenes**Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.
VII	**Synthetic Dyes:** Color and constitution (electronic Concept), Classification of dyes, Chemistry and synthesis of Methyl orange, Congo red, Malachite green

Course Code: BCHE 105 (B020202P)	
Course Title: Biochemical Analysis	
Credits: 0+2	
Unit	**Topics**
I	**Qualitative and quantitative analysis of Carbohydrates:** . 1. Separation of a mixture of two sugars by ascending paper chromatography 2. Differentiate between a reducing/ non reducing sugar 3. Synthesis of Osazones.
II	**Qualitative and quantitative analysis of Proteins, amino acids, and Fats** 1. Isolation of protein. 2. Determination of protein by the Biuret reaction. 3. TLC separation of a mixture containing 2/3 amino acids 4. Paper chromatographic separation of a mixture containing 2/3 amino acids 5. Action of salivary amylase on starch 6. To determine the concentration of glycine solution by formylation method. 7. To determine the saponification value of an oil/fat. 8. To determine the iodine value of an oil/fat
III	**Determination and identification of Nucleic Acids** 1. Determination of nucleic acids 2. Extraction of DNA from onion/cauliflower
IV	**Synthesis of Simple drug molecules** 1. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC. 2. Synthesis of barbituric acid 3. Synthesis of propanol

Course Code: BCHE 201 (B020301T)	
Course Title: Chemical Dynamics & Coordination Chemistry	
Credits: 4+0	
Unit	**Topics**
I	**Chemical Kinetics:** Rate of a reaction, molecularity and order of reaction, concentration dependence of rates, mathematical characteristic of simple chemical reactions zero order, first order, second order, pseudo order, halflife and mean life. Determination of the order of reaction differential method, method of integration, half-life method and isolation method. **Theories of chemical kinetics:** Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects (no derivation).
II	**Phase Equilibrium:** Statement and meaning of the terms-phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system water, S, He and Diamond, graphite. Phase equilibria of two component systems Solid - liquid equilibria , simple eutectic. Pb-Ag systems.
III	**Kinetic theories of gases** **Gaseous State:** Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waals equation of state. **Critical phenomena:** PV isotherms of real gases, continuity of states, the isotherms of Van der Waals equation, relationship between critical constants and Van der Waals constants, the law of corresponding states, reduced equation of state.
IV	**Liquid State** **Liquid State:** Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesterol phases. Thermography and seven segmentcell.
V	**Coordination Chemistry** Coordinate bonding, double complex salts, Werner's theory of coordination complexes classification of ligands, ambidentate ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, geometrical and optical isomerism in square planar and octahedral complexes.
VI	**Theories of Coordination Chemistry** **I.** Metal- ligand bonding in transition metal complexes, limitations of valance bond theory, an elementary idea of crystal field theory, crystal field splitting

	in octahedral, tetrahedral and square planner complexes, factors affecting the crystal-field parameters. **II.** Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, stability constants of complexes and their determination, substitution reactions of square planar complexes
VII	**Inorganic Spectroscopy and Magnetism** **I.** Electronic spectra of Transition Metal Complexes, Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemicalseries,Orgel-energy level diagram for d1 and d9 states, discussion of the electronic spectrum of [Ti(H2O)6] 3+ complex ion. **II.** Magnetic properties of transition metal complexes, types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ s and μ eff values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes. General description of magnetic properties :Paramagnetism, diamagnetism, ferromagnetism and magnetic suspectibility

Course Code: BCHE 202 (B020302P)	
Course Title: Physical Analysis	
Credits: 0+2	
Unit	**Topics**
I	**Strengths of Solution** Calibration of fractional weights, pipettes, and burettes. Preparation of standards solutions. Dilution 0.1M to 0.001M solutions Mole Concept and Concentration Units: Mole Concept, molecular weight, formula weight, and equivalent weight. Concentration units: Molarity, Formality, Normality, Molality, Mole fraction, Percent by weight, Percent by volume, Parts per thousand, Parts per million, Parts per billion, pH, pOH, milli equivalents, Milli moles
II	**Surface Tension and Viscosity** 1. Determination of surface tension of pure liquid or solution 2. Determination of viscosity of liquid pure liquid or solution
III	**Boiling point and Transition Temperature** 1. Boiling point of common organic liquid compounds **ANY FIVE:** *n*-butylalcohol, cyclohexanol, ethyl methyl ketone, cyclohexanone, acetylacetone, isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehyde and acetophenone. [Boiling points of the chosen organic compounds should preferably be within 180^0C]. 2. Transition Temperature, Determination of the transition temperature of the given substance by thermometric /dialometric method (e.g. $MnCl_2.4H_2O/SrBr_2.2H_2O$)
IV	**Phase Equilibrium** 1. To study the effect of a solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol water system) and to determine the concentration of that solute in the given phenol-water system 2. To construct the phase diagram of two component (e.g. diphenylamine benzophenone) system by cooling curve method.

Course Code: BCHE 203 (B020401T)	
Course Title: Quantum Mechanics and Analytical Techniques	
Credits: 4+0	
Unit	**Topics**
I	**Atomic Structure:** Idea of de-Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of ψ and ψ2quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d, orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule
II	**Elementary Quantum Mechanics**: de-Broglie hypothesis. Heisenberg uncertainty principle, Schrödinger wave equation (time dependent and time independent) and its importance, physical interpretation of the wave function, Schrödinger wave equation for H-atom, separation into three equations (without derivation), bonding wave function, concept of σ, σ*, π, π*
III	**Molecular Spectroscopy**: Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom **Rotational Spectrum**: Diatomic molecules. Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell- Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect . **Vibrational Spectrum:** Infrared spectrum : Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. **Raman spectrum:** Concept of polarizability , pure rotational and pure vibrational, Raman spectra of diatomic molecules, selection rules.
IV	**UV-Visible Spectroscopy :** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, types of electronic transitions, λmax, chromophore and auxochromes, nBathochromic and Hypsochromic shifts, Intensity of absorption, application of Woodward Rules for calculation of λmax for the conjugated dienes, alicyclic, homoannualar and heteroannular; extended conjugated systems, distinction between cis and trans isomers.
V	**Infrared Spectroscopy:** **IR Spectroscopy**: Fundamental and non-fundamental molecular vibrations; Hooke's law, selection rule, IR absorption positions of various functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance, application in functional group analysis and and interpretation of I.R. spectra of simple organic compounds.
VI	**A. Volumetric Analysis** General principle of acid-base titrations, precipitation titrations, oxidation-reduction titrations, iodimetry and complexometric titrations, use of EDTA for the determination of Ca^{2+} and Mg^{2+} , Hardness of water, types of EDTA titrations and metal ion indicators. **B. Gravimetric Analysis** Precipitation from homogenous medium, purity of precipitates, coprecipitation,

	post-precipitation, washing and ignition of precipitates, contamination and their removal.
VII	**Errors and Evaluation** Definition of terms, mean and median, precision, standard deviation, relative standard deviation, accuracy- absolute error, types of error in experimental data determination (systematic), intermediate (or random) and gross, sources of errors and the effects upon the analytical results, methods for reporting analytical data, statistical evaluation and data -indeterminate errors, use of statistics
VIII	**Separation Techniques: Solvent** extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution, and displacement methods.

Course Code: BCHE 204 (B020402P)	
Course Title: Instrumental Analysis	
Credits: 0+2	
Unit	**Topics**
I	**Molecular Weight Determination** 1. Determination of molecular weight of a non-volatile solute by Rast method/ Beckmann freezing point method. 2. Determination of the apparent degree of dissociation of an electrolyte (e.g., NaCl) in aqueous solution at different concentrations by ebullioscopy
II	**Spectrophotometry** 1. Toverify Beer Lambert Law for $KMnO_4/K_2Cr_2O_7$ and determining the concentration of the given solution of the substance from absorption measurement 2. Determination of pKa values of indicator using spectrophotometry. 3. Determination of chemical oxygen demand(COD). 4. Determination of Biological oxygen demand (BOD).
III	**Spectroscopy** 1. Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H,O-H,N-H,C-O,C-N,C-X,C=C,C=O, N=O, C---C, stretching frequencies, characteristic bending vibrations are included. Spectra to be provided).
IV	**Chromatographic Separations** 1. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Cu(II) and Cd(II) 2. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer Chromatography(TLC) 3. Separation and identification of the amino acids present in the given mixture by paper chromatography. Reporting the R_f values TLC separation of a mixture of dyes (fluorescein and methylene blue)

Course Code: BCHE 301 (B020501T)	
Course Title: Organic Synthesis A	
Credits: 4+0	
Unit	**Topics**
I	**Chemistry of Alkanes and Cycloalkanes** **A) Alkanes** :Classification of carbon atom in alkanes, General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity andselectivity **B) Cycloalkanes:** Nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Chair, Boat and Twist boat forms of cyclohexane with energy diagrams ring strain in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds.
II	**Chemistry of Alkenes** Methods of formation of alkenes, Addition to **C=C:** mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, epoxidation, *syn* and *anti*-hydroxylation, ozonolysis, radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; *E*- and *Z*- alkenes;
III	**Chemistry of Alkynes** Methods of formation of alkynes, Addition of C triple bond C, mechanism, reactivity, regioselectivity and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration
IV	**Aromaticity and Chemistry of Arenes** Nomenclature of benzene derivatives, MO picture of benzene, Character of arenes, cyclic carbocations/carbanions. Electrophilic aromatic substitution - halogenation, nitration, sulphonation and Friedel- Craft's Alkylation with their mechanism, Directing effects of the groups. Birch reduction, Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl, naphthalene and anthracene.
V	**Chemistry of Alcohols** Classification and nomenclature, Monohydric alcohols nomenclature, methods of formation by reduction of Aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols. Dihydric alcohols, Trihydric alcohols - nomenclature, methods of formation, chemical reactions of glycerol.
VI	**Chemistry of Phenols** : Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols electrophilic aromatic substitution, acylation and carboxylation.

VII	**Chemistry of Ethers and Epoxides**: Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions cleavage and autoxidation, Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides,
VIII	**Chemistry of Organic Halides** Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides, SN2 and SN1 reactions with energy profile diagrams; Polyhalogencompounds : Chloroform, carbon tetrachloride; Methods of formation of aryl halides, nuclear and side chain reactions; The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions; Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides,

Course Code: BCHE 302 (B020502T)	
Course Title: Rearrangement and Chemistry of group elements	
Credits: 4+0	
Unit	**Topics**
I	**Rearrangements** A detailed study of the following rearrangements: Pinacol-pinacolone, BenzilBenzilic acid, and Fries rearrangement
II	**Catalysis** General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation, or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts. Enzyme catalysis: Michaelis-Menten equation, Lineweaver-Burkplot, turn-over number.
III	**Chemistry of Main Group Elements** **s-Block Elements:** Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls. **p-Block Elements**: Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of group 13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetra nitride, basic properties of halogens, interhalogens and polyhalides. **Chemistry of Noble Gasses**: Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.
IV	**Chemistry of Transition Elements** **Chemistry of Elements of First Transition Series** -Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry. **Chemistry of Elements of Second and Third Transition Series-** General characteristics, comparative treatment of Zr/Hf, Nb/Ta, Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.
V	**Chemistry of Lanthanides** Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, ceric ammonium sulphate and its analyticaluses.
VI	**Chemistry of Actinides** Electronic configuration, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.

VII	**Metal Carbonylsand Nitrosyls** 18-electron rule, preparation, structure and nature of bonding in the mononuclear and dinuclear carbonyls and nitrosyls.
VIII	**Bioinorganic Chemistry** Essential and trace elements in biological processes, metalloporphyrins with special reference to heamoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to $Ca^{2+}$and Mg $^{2+}$. Cu in plastocyanin and hemocyanin, Zn in carboxypeptidase and carbonic anhydrase.

Course Code: BCHE 303 (B020503P)	
Course Title: Qualitative Analysis	
Credits: 0+ 2	
Unit	**Topics**
I	**Inorganic Qualitative Analysis** SemimicroAnalysis cation analysis, separation and identification of ions from Groups I,II,III,IV,V and VI, Anion and interfering anion analysis .Mixture containing 6 radicals- 2+4 or 4+ or 3+3
II	**Elemental analysis and identification of functional groups** Detection of extra elements (N, S and halogens) and functional groups(phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organiccompounds.
III	**Separation of Organic Mixture** Analysis of an organic mixture containing two solid components using water, NaHCO3, NaOH for separation and preparation of suitablederivatives
IV	**Identification of organic compounds** Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitablederivatives.

Course Code: BCHE 304 (B020601T)	
Course Title: Organic Synthesis B	
Credits: 4+0	
Unit	**Topics**
I	**Reagents in Organic Synthesis** A detailed study of the following reagents in organic transformations, Oxidation with SeO2, Jones Oxidation, PCC, PDC, NaBH4, LiAlH4, DIBAL-H
II	**Organometallic Compounds-** Organomagnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organolithium compounds: formation and chemical reactions.
III	**Chemistry of Aldehydes and ketones:** Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, Physical properties. Mechanism of nucleophillic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Wittig reaction Oxidation of aldehydes, Cannizzaro reaction, ~~MPV~~, Clemmensen, Wolff-Kishner, An introduction to a,b – unsaturated aldehyde and ketones.
IV	**Carboxylic acids and their Functional Derivatives** Nomenclature and classification of aliphatic and aromatic carboxylic acids. Preparation and reactions. Acidity (effect of substituents on acidity) and salt formation, Reactions: Mechanism of reduction, substitution in alkyl or aryl group, stereospecific addition to maleic and fumaric acids. Preparation and reactions of acid chlorides, acid anhydrides, amides and esters, acid and alkaline hydrolysis of esters, trans-esterification.
V	**Organic Synthesis via Enolates** Acidity of σ- hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Synthesis of ethyl acetoacetate: the Claisen condensation, Keto-enol tautomerism of ethyl acetoacetate.
VI	**Organic Compounds of Nitrogen-** Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid, Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Gabriel- phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in arylamines,reactions of amines with nitrous acid.
VII	**Heterocyclic Chemistry** Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, Mechanism of nucleophilic substitution reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole. Mechanism of electrophilc substitution reactions of indole, quinoline and isoquinoline.

Course Code: BCHE 305 (B020602T)	
Course Title: Chemical Energetics and Radiochemistry	
Credits: 4+0	
Unit	**Topics**
I	**Thermodynamics-1 :** **First Law of Thermodynamics** : Statement , definition of internal energy and enthalpy. Heat capacity ,heat capacities at constant volume and pressure and their relationship. Joule's law Joule- Thomson coefficient and inversion temperature . **Thermochemistry:** Standard state, standard enthalpy of formation Hess's law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume . Enthalpy of neutralization . Bond dissociation energy and its calculation from thermo-chemical data , Kirchhoff's equation.
II	**Thermodynamics II** Second Law of Thermodynamics, Need for the law, different statements of the law, Carnot cycle and its efficiency. Carnot theorem. Thermodynamic scale of temperature. Concept of Entropy, Entropy as a state function, entropy as a function of V & T, entropy as a function of P&T, Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz Functions Gibbs function (G) and Helmhotz function (A) as thermodynamic quantities. A &G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change,
III	**Electrochemistry**: specific conductance molar and equivalent conductance, measurement of equivalent conductance, variation ofmolar,equivalent and specific conductances with dilution. Migration of ions and Kohlrausch law, , Arrhenius theory of electrolyte dissociation and its limitations. Weak and strong electrolytes . Ostwald's dilution law, its uses and limitations .
IV	**Colligative Properties-**Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point.

Course Code: BCHE 306 (B020603P)	
Course Title: Analytical Methods	
Credits: 0+2	
Unit	**Topics**
I	**Gravimetric Analysis** 1. Analysis of Cu as CuSCN, 2. Analysis of Ni as Ni(dimethylgloxime) 3. Analysis of Ba asBaSO4.
II	**Paper Chromatography** Ascending and Circular Rf of organic compounds, Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid Leucine and glutamic acid. Spray reagent ninhydrin. Separation of a mixture of D, L alanine, glycine, and L-leucine using n-butanol:acetic acid: water (4:1:5). Spray reagent ninhydrin. Separation of monosaccharaides a mixture of D- galactose and D –fructose using n- butanol: acetone: water (4:5:1). Spray reagent aniline hydrogen phthalate
III	Thin Layer Chromatography Determination of Rf values and identification of organic compounds: Separation of green leaf pigments (spinach leaves may be used) Preparation of separation of 2,4- dinitrophenylhydrazones of acetone, 2-butanone, hexan-2, and 3-one using toluene and light petroleum (40:60), Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5)
IV	**Thermochemistry** 1. To determine the solubility of benzoic acid at different temperatures and to determine H of the dissolutionprocess 2. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base To determine the enthalpy of solution of solid calcium chloride and calculate the latticeenergyofcalciumchloridefromitsenthalpydatausingBorn-Habercycle

B.Sc. Mathematics

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Course Code: MAT 101	
Course Title: BASICS OF MATHEMATICS	
Credits: 2+0	
Unit	**Topics**
	Assignment on "Indian Ancient Mathematics and Mathematicians" should be included under Continuous Internal Evaluation (CIE).
BASICS OF MATHEMATICS	
I	Set theory: Definition of sets, representation of sets, universal set, empty set, singleton set, finite and infinite set, equal set, cardinal number of finite set, equivalent set, set of set, subsets, proper subset, superset, power set, improper set, comparibility of sets, union and intersection of sets, complement of sets, de morgan's law, disjoint sets, difference and symmetric difference, algebra of sets, duality, counting principle, venn diagram and its applications.
II	Ordered pair, Cartesian product of two sets, relations, domain, co-domain and range of a relation, types of relations: identity relation, inverse relation, empty relation, universal relation, reflexive relation, symmetric relation, anti- symmetric relation, transitive relation, equivalence relation. Functions or mapping, domain, co-domain and range of a function, composition of functions, types of function: one-one function, many –one function, onto function, into function, one-one into function, one-one onto function, many- one into function, many-one onto function, and invertible functions.
III	Differentiation of functions, geometrical significance of derivatives, derivative of the product of functions, derivative of quotient of two functions, derivative of a function of function , Maxima and minima of a function of one variable. Integration of functions, properties of indefinite integrals, integration by substitution, integration by parts, integration of rational functions, integration using partial fractions. Definite integrals and its properties.
IV	Principle of mathematical induction, Polynomials, Linear polynomial, quadratic polynomial, cubic polynomial, roots of polynomial, Quadratic equations, Factorisation, Determinants and its applications, matrix theory, types of matrices: Horizontal matrix, vertical matrix, square matrix, row matrix, column matrix, null matrix, identity matrix, diagonal matrix, scalar matrix, sub matrix, triangular matrix, comparable matrix, Operation on matrices: Matrix addition, subtraction, product of matrices, difference of two matrices, transpose of a matrix, inverse of a matrix by adjoin method.

Course Code: MATH 102 (B030101T)	
Course Title: DIFFERENTIAL CALCULUS AND INTEGRAL CALCULUS	
Credits: 4+0	
Unit	**Topics**
PART-A **DIFFERENTIAL CALCULUS**	
I	Definition of a sequence, Theorems on limits of sequences, Bounded and Monotonic sequences, Convergent sequence, Cauchy's convergence criterion, BalzanoWeierstrass theorem for sequence, Cauchy sequence, Cauchy's first and second theorems on limits, limit superior and limit inferior of a sequence, Cantor's theorem on nested intervals, subsequence.
II	Limit, Continuity and differentiability of function of single variable, Cauchy's definition, Heine's definition, equivalence of definition of Cauchy and Heine, Uniform continuity, Borel's theorem, Bolzano's theorem, Intermediate value theorem, Extreme value theorem, Darboux's intermediate value theorem for derivatives, Chain rule.
III	Rolle's theorem, Lagrange and Cauchy Mean value theorems, mean value theorems of higher order, Taylor's theorem with various forms of remainders, Successive differentiation, and Leibnitz theorem, Maclaurin's and Taylor's series expansion.
IV	Partial differentiation, Euler's theorem on homogeneous function, Jacobians and its properties, Asymptotes, Curvature, Envelops and evolutes, Test for concavity and convexity.
PART-B **INTEGRAL CALCULUS**	
V	Lower and upper bounds, Supremum and infimum of the subsets of R and its basic properties, Completeness of R. Riemann integral and its properties, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus, Differentiation under the sign of Integration.
VI	Beta and Gamma functions, Tracing of curves in Cartesian and Polar forms, Improper integrals, their classification and convergence, Comparison test, μ-test, Abel's test, Dirichlet's test, quotient test.
VII	Areas of Curve, Lengths of curve, Volumes of solid of revolution, Multiple integrals: Double and Triple integrals, Change of order of double integration, Area as a double integral in Cartesian form, Dirichlet's theorem, and Liouville's theorem for multiple integrals.
VIII	Vector Differentiation, Point function, Vector differential operator, Gradient, Divergence and Curl, Normal on a surface, Directional Derivative, Second order differential operator, Laplacian operator. Vector Integration, Line integral, Circulation, Work done by a force, Surface integral, Volume integral, Gauss, Green, Stokes theorems with prove and related problems.

Course Code: MAT 103 (B030102P)		
Course Title: PRACTICAL		
Credits: 0+2		
Unit	**Topics**	
	• **Practical / Lab work to be performed in ComputerLab.** **List of the practicals to be done using Sage Math / Mathematica / MATLAB / Maple / Scilab / R programming / Python / C programming etc.**	
I.	Plotting the graphs of the following functions: I. ax II. $[x]$ (greatest integerfunction) III. x^{2n}; $n\epsilon N$ IV. x^{2n-1}; $n\epsilon N$ V. $\frac{1}{x^{2n-1}}$; $n\epsilon N$ VI. $\frac{1}{x^{2n}}$; $n\epsilon N$ VII. $\sqrt{ax+b}$,$\lvert ax+b\rvert$ VIII. $\lvert x\rvert$ $for x \neq 0$ IX. $e^{x} for x \neq 0$ X. $e^{-x} for x \neq 0$	
II.	Plotting the graph of the following functions: $\log_e x$, sin x, cos x, tan x, sin hx, cos hx, tan hx.	
III.	Sketching parametric curves: Trochoid, Cycloid, and Epicycloid.	
IV.	By plotting the graph find the solution of the equation: $x = e^x$, $x^2 + 1 = e^x$, $1 - x^2 = e^x$, $x = \log_{10}(x)$, $\cos(x) = x$, $\sin(x) = x$, $\cos(y) = \cos(x)$, $\sin(y) = \sin(x)$.	
V.	Plotting the graphs of polynomial of degree 2, 3, 4 and 5.	
VI.	Find numbers between two real numbers and plotting of finite and infinite subsetof R	
VII	Matrix operations: I. Addition, II. Multiplication, III. Inverse, IV. Transpose.	
VIII	Complex number and their representations: I. Addition, II. Multiplication, III. Division, IV. Modulus.	

Course Code: MAT 104 (B030201T)	
Course Title: MATRICES AND DIFFERENTIAL EQUATIONS	
Credits: 3+0	
Unit	**Topics**
MATRICES AND DIFFERENTIAL EQUATIONS	
I	Elementary operations on Matrices, Rank of a Matrix, Echelon form of a Matrix, Normal form or Canonical form of a Matrix, Inverse of a Matrix by elementary operations. Complex matrix, Conjugate of matrix, Transpose of Conjugate of matrix, Hermitian matrix and Skew-, Hermitian matrix , Periodic matrix, Idempotent matrix, Unitary matrix. System of linear homogeneous and non-homogeneous equations, Consistency and Inconsistency of a system of linear equations, Theorems on consistency of a system of linear equations, Cramer's Rule.
II	Vector, Linear Dependence and Independence of vectors, Dependence and Independence of vectors of vectors by rank method. Eigen values, Eigen vectors and characteristic equation of a matrix, Orthogonal Vectors. Algebraic Multiplicity, Geometric Multiplicity, Regular eigen value, Caley-Hamilton theorem and its use in finding inverse of a matrix, Diagonalisation of square matrix, Power of matrix by Diagonalisation.
III	Order and Degree of a Differential Equations, Formation of differential equations, General Solution, Particular Solution, Geometrical meaning of a differential equation, Equation of first order and first degree, Equation in which the variables are separable, Equation Reducible to Variable separable form, Homogeneous differential equations, Equations Reducible to Homogeneous form.
IV	Exact differential equations and equations reducible to the exact form, Linear differential equations, Equations Reducible to Linear form; First order higher degree differential equations solvable for p, y, x. Clairaut's differential equation, Singular Solutions, Determination of singular solution, Orthogonal Trajectories, Trajectories in Cartesian form and Polar form.

Course Code: MAT 105 (B030201T)	
Course Title: GEOMETRY	
Credits: 3+0	
Unit	**Topics**
GEOMETRY	
I	Three-Dimensional Coordinates in space, Distance between two points, Direction cosines and direction ratios, Projection of a segment on a straight line, Projection of the join of two points on a straight line, Angle between two lines, Distance of a point from a line.
II	Plane, General equation of plane ,Equation of the plane in various forms, Equation of a plane through given points, Straight line in three dimensions, Coplanar lines, The image of a point in a plane, Shortest distance between two lines.
III	Sphere, Equation of a sphere whose centre is given, Intersection of two spheres, Intersection of sphere and a straight line, Cone ,Equation of cone, Equation of right circular cone, enveloping cone.

IV	Cylinder, Right circular cylinder, Enveloping cylinder, Central conicoid, properties of the central conicoid in standard form, the ellipsoid, the hyperboloid one sheet, the hyperboloid of two sheets, intersection of line and a central conicoid, tangent plane, condition of tangency, director sphere, normal to a conicoid, polar plane, diametral plane.

Course Code: MAT 201(B030301T)	
Course Title: ALGEBRA	
Credits: 3+0	
Unit	**Topics**
ALGEBRA	
I	Properties of Integers, Divisor, Division algorithm. Greatest Common Divisor, Euclidean algorithm, Fundamental theorem of arithmemetic, Congruences and residue classes. Euler $\emptyset$ − function and its properties, Euler's, Fermat's and Wilson's theorem.
II	Algebraic Structure, Definition of a group with examples and simple properties, Subgroups, Generators of a group, Cyclic groups, Order of an element of a group, Centre of group.
III	Permutation groups, Cyclic permutation, Transposition, Even and odd permutations, The alternating group, Cayley's theorem, Direct products, Coset decomposition, Lagrange's theorem and its consequences.
IV	Homomorphism and isomorphism, Kernel of homomorphism, Normal subgroups, Simple group, Quotient groups, Fundamental theorem of homomorphism, Theorems on isomorphism.

Course Code: MAT 202(B030301T)	
Course Title: MATHEMATICAL METHODS	
Credits: 3+0	
Unit	**Topics**
MATHEMATICAL METHODS	
I	Limit and Continuity of functions of two variables, Differentiation of function of two variables, Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method. Exponential functions, hyperbolic functions, logarithm of a complex number,general exponential function. Inverse Circular function of complex quantities, inverse hyperbolic functions.
II	Laplace transform, Existence theorem for Laplace Transform, Linearity of Laplace transform and their properties, Laplace transform of the derivatives and integrals of a function, Heaviside expansion formula. Initial and Final value theorem, Unit step function and their properties. Laplace transform of periodic function, Unit impulse function, Inverse Laplace transforms, Convolution theorem, Solution of ordinary differential equation by using Laplace transform.
III	Periodic functions, Fourier series, Fourier expansion of piecewise monotonic functions, Fourier series for even and odd functions, Half - range expansions. Fourier transforms (finite and infinite) and properties of fourier transform.
IV	Calculus of variations-Variational problems with fixed boundaries- Euler's equation for functionals containing first order derivative and one independent variable, Extremals, Functionals dependent on higher order derivatives.

Course Code: MAT 203 (B030401T)	
Course Title: DIFFERENTIAL EQUATIONS	
Credits: 3+0	
Unit	**Topics**
	DIFFERENTIAL EQUATIONS
I	Linear differential equation with constant coefficients, Homogeneous Linear differential equation with constant coefficients, Equation Reducible to Homogeneous form.
II	Second order linear differential equations with variable coefficients: Use of a known solution to find another, normal form, Changing the independent variable, method of variation of parameters.
III	Ordinary Simultaneous Differential Equation, Method of solving simultaneous linear differential equation with constant coefficients, Solution of simultaneous differential equation in a different form
IV	Total differential equation, Necessary and sufficient condition for Integrability of total differential equation, Methods for solving the total differential equation: Soluion by inspection, one variable regarded as constant, homogeneous equations, method of auxiliary equations.

Course Code: MAT 204 (B030401T)	
Course Title: MECHANICS	
Credits: 3+0	
Unit	**Topics**
	MECHANICS
I	Forces in three dimensions. Poinsot's central axis. Wrenches. Null lines and null planes. Conjugate lines and conjugate forces.
II	Analytical conditions of equilibrium of coplanar forces, Virtual work, Stable and unstable equilibrium, Catenary, Catenary of uniform strength.
III	Motion in a straight line: velocity and acceleration, Accelerations in terms of different coordinate systems. Elastic and inelastic collisions between two objects, The coefficient of restitution, Motion in a plane: velocity and acceleration along radial and transverse direction, velocity and acceleration along tangential and normal directions, Elastic strings.
IV	Motion in resisting medium, Projectile motion in resisting medium Moments and products of inertia. The momental ellipsoid. Equimomental systems. Principle axes. Central orbits. Apses and apsidal distances. Kepler's laws of planetary motion, Motion of a particle in three dimensions.

Course Code: MAT 301 (B030501T)	
Course Title: RING THEORY AND LINEAR ALGEBRA	
Credits: 4+0	
Unit	**Topics**
PART-A RING THEORY	
I	Introduction to rings, integral domains and fields, Characteristic of a ring, Ring homomorphism, Ideals and quotient rings.
II	Field of quotients of an integral domain, Euclidean domain, Prime and maximal ideals, principal ideal domain, Principal ideal rings, Polynomial rings over commutative rings.
III	Division algorithm and consequences, Principal ideal domains, Factorization of polynomials, Reducibility tests, Irreducibility tests, Eisenstein criterion, Unique factorization in Z[x].
IV	Divisibility in integral domains, Irreducible, Primes, Unique factorization domains, Euclidean domains.
Unit	**Topics**
PART-B LINEAR ALGEBRA	
V	Vector spaces, Vector Subspaces, Linear combination, Linear independence and dependence of vectors, same and same spaces, Basis and Dimension, Quotient space.
VI	Linear transformations, The Algebra of linear transformations, Rank Nullity theorem, their representation as matrices.
VII	Linear functionals, Dual space, Dual Basis and Dimension, Bilinear and Quadratic forms.
VIII	Change of basis, diagonal forms, triangular forms, Inner product spaces and norms, Orthogonal vectors, Orthonormal sets and bases.

Course Code: MAT 302 (B030502T)	
Course Title: TENSOR ANALYSIS	
Credits: 3+0	
Unit	**Topics**
TENSOR ANALYSIS	
I	Tensor : Transformation of coordinates, Contravariant and covariant vectors and tensors, Scalar invariants, Mixed tensors, Symmetric and skew –symmetric tensor, Algebra of tensors, Contraction and inner product, Quotient law, Reciprocal tensors.
II	Associated tensors, Length of a vector, Unit Vector, Null vector and orthogonal vector, Riemannian Metric and Space and Christoffel symbols.
III	Covariant differentiation of vector and tensor, Ricci's theorem, Gradient of scalar, Divergence of a contravariant vector , covariant vector and conservative vector, Divergence of a contravariant tensor of order two, Divergence of a mixed tensor of type (1,1), Laplacian of an invariant ,curl of a covariant vector **.**
IV	Riemannian curvature tensor and their properties, Flat space, Ricci tensor and scalar curvature, Einstein space and Einsteintensor.

Course Code: MAT303 (B030502T)	
Course Title: DIFFERENTIAL GEOMETRY	
Credits: 3+0	
Unit	**Topics**
PART-A DIFFERENTIAL GEOMETRY	
I	Local theory of curves –space curves, Regular curve and Plane curve, twisted curve, equation of a plane and straight line, equation of curves in space, length of a curve, tangent to curve, Order of contact between curves and surfaces, osculating plane , equation of osculating plane, equation osculating plane at a point of curve of intersection of two surfaces. Tangent, principal normal and binormal, normal plane and rectifying plane.
II	Curvature and torsion, Serret-Frenet formulae, Direction cosines of the principal normal and binormal, Osculating circle, Osculating sphere. Involutes and evolutes of curves Curve on surface, Regular point and Singularities of surface, transformation of parameters, Parametric curves, tangent plane and normal line, First fundamental form and arc length. Angle between two curves on surface.
III	Special tensors and its properties, orthogonal trajectories, Differential equation of orthogonal trajectories. Second fundamental form of surface, Geometric interpretation of the second fundamental form, Gauss and Weingarten equation.
IV	Identities based on Weingarten equation, Normal curvature and its equation, Meusnier's theorem. Definition and Basic Properties of Geodesics, Geodesic Equation.

Course Code: MAT 304 (B030601T)	
Course Title: METRIC SPACES AND COMPLEX ANALYSIS	
Credits: 4+0	
Unit	**Topics**
PART-A METRIC SPACES	
I	Definition of a Metric Space, Examples of Metric Space, Bounded and Unbounded Metric Space, Pseudo-metric, Subspace of a Metric Space, Diameter of a Subset of a Metric Space, Distance of a Point from a Non-empty set, Distance between two Non- empty Subsets of a Metric Space. Open and Closed Spheres, Neighborhood of a point, Interior Point and Interior of a Set, Open sets, Equivalent Metrics, Exterior, Frontier and Boundary of a Set, Limit Point and Isolated Point, Derived Set, Closed Set, Closure of a Set ,Dense Sets and Separable Spaces.
II	Subspace of a Metric Space, Examples, Sequence in a Metric Space, Convergence in a Metric Space Cauchy Sequence, Complete Metric Space, Isometry and Isometric Space.
III	Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem.
IV	Cover, Compact Sets and compact Space, Finite Intersection Property and Compactness, Continuity and Compactness, Sequentially Compactness. Separated Sets, Disconnected Space and Disconnected Sets, Connected Space and Connected Sets, Components.
Unit	**Topics**
PART-B COMPLEX ANALYSIS	
V	Complex numbers as ordered pairs, geometric representation of complex number, Stereographic projection, Continuity and Differentiability of complex functions, Analytic functions, Cauchy Riemann equations, Harmonic functions.
VI	Complex integration, Cauchy-Goursattheorem, Cauchy's Integral formula, Formulae for first, second and nth derivatives, Cauchy's Inequality, Liouville's Theorem.
VII	Series of non-negative terms, convergence and divergence, Comparison tests, Cauchy's integral test, Ratio tests, Root test, Raabe's logarithmic, De Morgan and Cauchy's condensation test, Taylor Series, Laurent Series and its examples.
VIII	Zeroes and poles of order m, Isolated singular points, Types of isolated singular points , Residues, Residues at poles and its examples, Residue at infinity, Cauchy's residue theorem, Evaluation of improper real integrals, Definite integrals involving sines and cosines.

Course Code: MAT 305 (B030602T)	
Course Title: NUMERICAL ANALYSIS AND OPERATIONS RESEARCH	
Credits: 4+0	
Unit	**Topics**
PART-A **NUMERICAL ANALYSIS**	
I	Error in numerical computations ,Calculus of finite differences, Difference operators, Fundamental theorem of differential calculus, Interpolation with equal and unequal intervals, Newton's forward and backward interpolation formulae, Divided difference interpolation formula, Lagrange's interpolation formula.
II	Solutions of algebraic and transcendental equations, Direct and iterative methods,, Bisection method, Regula-falsi method, Newton- Raphson method, Iteration method. Solution of simultaneous linear equations: Gauss-elimination method, Guass-Jordan method, LU decomposition method, Guass-Seidel method.
III	Numerical differentiation derivatives using forward and backward formula, Numerical Integration, General Quadrature formula, Trapezoidal rule, Simpson's one-third and tree-eight formulae and Weddle's rules.
IV	Numerical solution of ordinary differential equation, Picard method, Taylor series method, Euler's method, Modified Euler's method, Runge-Kutta method.
PART-B **OPERATIONS RESEARCH**	
V	Developing mathematical models, Mathematical programming, Linear programming, Convex sets, Convex and concave functions, Theorems on convexity, Linear programming problem (LPP), Simple and general LPP, Solutions of simple LPP by graphical method, Analytical solution of general LPP, Canonical and standard forms of LPP, Slack and surplus variables.
VI	Solution of general LPP by Simplex method. Use of artificial variables in simplex method, Big-M method and Two-Phase method, Concept of duality in linear programming, Theorems on duality, Dual simplex method.
VII	Transportation problem, Solution of transportation problem, Methods for finding Initial basic feasible solution of transportation problem, Optimal solution of transportation problem by modified distribution (MODI) method, Degeneracy in transportation problem, Maximization transportation problem. Assignment problem, Balanced and unbalanced assignment problems. Solution of assignment Problem, Hungarian Method, Maximization Assignment problem.
VIII	Game Theory: Competitive game, Two-Person Zero-Sum (Rectangular) game, Minimax-maximin criteria, Saddle points, Solution of rectangular game with and without saddle points, Huge rectangular games, Dominance rules, Solution of huge rectangular games using rules of dominance, Graphical method for 2xn and mx2 games without saddle points.

Course Code: MAT 306 (B030603T)		
Course Title: PRACTICAL		
Credits: 2+0		
Unit	**Topics**	
	• **Practical / Lab work to be performed in Computer Lab.** **List of the practicals to be done using Sage Math / Mathematica / MATLAB / Maple / Scilab / R programming / Python / C programming etc.**	
I.	Solution of transcendental and algebraic equations by i. Bisection method ii. Regula Falsi method iii. Newton Raphson method iv. Iteration method	
II.	Solution of system of linear equations by i. LU decomposition method ii. Gaussian elimination method iii. Gauss-Seidel method	
III.	Interpolation by i. Newton's forward Interpolation ii. Newton's backward Interpolation iii. Lagrange Interpolation iv. Divided difference interpolation formula	
IV.	Numerical Integration by i. Trapezoidal Rule ii. Simpson's one third rule	
V.	Numerical Integration by i. Simpson's three-eight rule ii. Weddle's Rule	
VI.	Solution of ordinary differential equations by i. Euler method ii. Runge Kutta method	
VII.	Solution of ordinary difference equations by Picard method.	
VIII.	Solution of ordinary difference equations by Taylor series method.	