K.K. UNIVERSITY

NALANDA, BIHAR - 803115

SCHOOL OF APPLIED SCIENCES

Bachelor of Science in Chemistry

(Three Year Full Programme)

2023-2024

PROGRAMME STRUCTURE & SYLLABUS

DEPARTMENT OF CHEMISTRY, K.K UNIVERSITY, BIHARSHARIF

Pro Vice Chancellor
KK University
Berauti, Nepura, Bihar Sharif
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Programme Structure

Year	Semester	Course Code	Course Title	L	T	P	C
I	I	BSCH 1101	Physical Chemistry-I	3	1	0	4
		BSCH 1102	Inorganic Chemistry-I	3	1	0	4
		BSCH 1103	Organic Chemistry-I	3	1	0	4
		BSPH-S-1101	Physics-I	3	0	0	3
		BSMT-S-1101	Maths-I	3	0	0	3
		HNL 1101	Hindi-I	2	0	0	2
		BSCH 1104 P	Practical Chemistry-I	0	0	6	3
		BSPH-S-1101P	Practical Physics-I	0	0	4	2
							25
	II	BSCH 1201	Physical Chemistry-II	3	1	0	4
		BSCH 1202	Inorganic Chemistry-II	3	1	0	4
		BSCH 1203	Organic Chemistry-II	3	1	0	4
		BSPH-S-1201	Physics-II	3	0	0	3
		BSMT-S-1201	Maths-II	3	0	0	3
		ENL1201	English-I	2	0	0	2
		BSCH 1204 P	Practical Chemistry-II	0	0	6	3
		BSPH-S-1201P	Practical Physics-II	0	0	4	2
							25
II	III	BSCH 2101	Physical Chemistry-III	3	1	0	4
		BSCH 2102	Inorganic Chemistry-III	3	1	0	4
		BSCH 2103	Organic Chemistry-III	3	1	0	4
		BSPH-S-2101	Physics-III	3	0	0	3
		BSMT-S-2101	Maths-III	3	0	0	3

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		HNL 2101	Hindi-II	2	0	0	2
		BSCH 2104 P	Practical Chemistry-III	0	0	6	3
		BSPH-S-2101P	Practical Physics-III	0	0	4	2
							25
	IV	BSCH 2201	Physical Chemistry-II	3	1	0	4
		BSCH 2202	Inorganic Chemistry-IV	3	1	0	4
		BSCH 2203	Organic Chemistry-IV	3	1	0	4
		BSPH-S-2201	Physics-IV	3	0	0	3
		BSMT-S-2201	Maths-IV	3	0	0	3
		HNL 2201	English-II	2	0	0	2
		BSCH 2204 P	Practical Chemistry-IV	0	0	6	3
		BSPH-S-2201P	Practical Physics-IV	0	0	4	2
							25
III	**V**	BSCH 3101	Physical Chemistry-V	3	1	0	4
		BSCH 3102	Inorganic Chemistry-V	3	1	0	4
		BSCH 3103	Organic Chemistry-V	3	1	0	4
		BSCH 3104P	Practical Chemistry-V	0	0	4	2
		BSCH 3105P	Practical Chemistry-VI	0	0	4	2
							16
	VI	BSCH 3201	Physical Chemistry-VI	3	1	0	4
		BSCH 3202	Inorganic Chemistry-VI	3	1	0	4
		BSCH 3203	Organic Chemistry-VI	3	1	0	4
		BSCH 3204P	Practical Chemistry-VI	0	0	4	2
		BSCH 3205P	Practical Chemistry-VI	0	0	4	2
							16
			Total Credit	**132**			

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SEMESTER I

PHYSICAL CHEMISTRY-I

SUB CODE- BSCH-1101

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Understand the kinetic model of gases and Maxwell distribution.

CO2: Apply gas laws to real gases and their deviations from ideal behavior.

CO3: Analyze the physical properties of liquids and their solvent applications.

CO4: Evaluate the crystal structure of solids using lattice parameters and symmetry.

CO5: Synthesize ionic equilibria and hydrolysis concepts in chemical applications

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Course Objective

The course enables students to understand gas behavior using the van der Waals equation, analyze kinetic molecular theory and gas properties, evaluate liquid and solid properties like surface tension and crystal symmetry, and apply thermodynamic principles to chemical equilibria and Le Chatelier's principle.

Syllabus

Unit	Content	No. of hours	No. of week
I	**Gaseous state:** Deviations from ideal gas behavior, compressibility factor, and its variation with pressure for different gases. Causes of deviation from ideal behavior. van der Waals equation of state, its derivation and application in explaining real gas behaviour; van der Waals equation expressed in virial form, Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, critical and van der Waals constants, law of corresponding states.	8	1-3
II	Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation;collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities	8	3-5
	Liquid state:		

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III	(10 classes of 60 minutes duration each) Structure and physical properties of liquids; vapour pressure, surface tension, viscosity, and their dependence on temperature, Effect of addition of various solutes on surface tension, cleansing action of detergents. Qualitative discussion of Structure of water	8	5-8
IV	Solid State Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals	8	8-11
V	**Dilute solution and change of state-I:** Colligative properties,osmosis,van't Hoff factor, Roult's law of lowering vapour pressure, experimental determination. Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions.	8	11-13
VI	**Thermochemistry:** Heats in the chemical reaction,reaction enthalpy, Hess law, standard enthalpy change,bond enegies and their determination. **Thermodynamics-I:** Extensive and intensive properties, thermodynamic process,state function	8	13-14
	Chemical Kinetics: Rate of reaction,order ,molecularity ,expression for rate constant of first order reaction, half life period, unit.	8	14-15

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Reference Text books

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press
- (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007)
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier:

Reference Links

- https://ocw.mit.edu/courses/chemical-engineering/10-10-introduction-to-chemical- -2003/
- https://www.khanacademy.org/science/chemistry
- https://ocw.mit.edu/courses/chemistry/5-12-physical-chemistry-fall-2008/
- https://www.rsc.org/periodic-table/chemistry-terms/thermodynamics

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INORGANIC CHEMISTRY

SUB CODE- BSCH 1102

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Recall quantum models, quantum numbers, and periodic trends in elements.
CO2: Explain bonding theories and weak chemical forces.
CO3: Use VSEPR and radius ratio rules to predict molecular shapes.
CO4: Analyze MO diagrams and calculate bond orders.
CO5: Evaluate conductivity and material properties based on band theory

Course Objective

The course provides an understanding of atomic structure, bonding theories (VBT, MOT), and periodic properties of elements. It covers molecular shapes using VSEPR, MO diagrams, lattice energy, and band theory for conductivity. Students will also explore chemical bonds' effects on physical properties and practice metal content estimation through titration.

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Syllabus

Unit	Content	No. of hours	No. of week
I	**Atomic Structure:** Bohr's theory, Its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number	8	1-3
II	**Bonding models in Inorganic chemistry:** **Ionic bond:** Energetics involved in ionic bond, Born Haber cycle, radius ratio rule,Fajan's rule, Inert pair effect. Covalent Bond: Exceptions to octet rule, idea of orbital overlap,H-Bonding,van der Waals forces. Ionic character in covalent compounds: Bond moment and dipole moment. ionic character from dipole moment and electronegativities	8	3-6
III	**Hydrogen and Hydrides:** Hydrides,covalent,metallic,intermediate,H_2O_2 preparation,properties. Qualitative idea of free electron model, Semiconductors, Insulators. Weak Chemical Forces: van'der Waals, ion-dipole, dipole-dipole, induced dipole dipoleinduced dipole interactions, Lenard-Jones 6-12 formula, hydrogen bond,	8	6-9

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	effects of hydrogen bonding on melting and boiling points, solubility, dissolution Covalent character in ionic compounds, polarizing power and polarizability. Fajan rules, polarization.		
IV	**Principles of Metallurgy:** General methods of extraction, the position of metal in electrochemical series ,Gibbs free energy,Calcination,Roasting,Smelting,Electrolytic reduction,Carbon reduction,chromatographic ion exchange,solvent extraction,Mond's process,Van Arkel process,oxidative refining.	8	9-12
V	**Molecular symmetry:** Symmetry operation,centre of symmetry,axis of symmetry,plane of symmetry **Magnetochemistry:** Types of magnetic behavior,para,dia,ferromagnetism, Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules, MO diagrams of simple tri and tetra-atomic molecules, e.g., N2 , O2 , C2 , B2 , F2 , CO, NO, and their ions; HCl, BeF2 , CO2 , HCHO, (idea of s-p mixing and orbital interaction to be given).	8	12-15

Reference Text Books

- 1.Lee, J. D. Concise Inorganic Chemistry, Wiley, 5 th Edn .
- 2.Douglas, B.E., McDaniel, D.H., Alexander J.J., Concepts & Models of Inorganic Chemistry,(Third Edition) John Wiley & Sons,1999.
- 3.Atkins, P. W. and DePaula, J. Physical Chemistry, Tenth Edition, Oxford University Press, 2014.
- 4. Rodger, G. E. Inorganic and Solid State Chemistry, Cengage Learning, 2002.

Reference Links

- https://onlinecourses.nptel.ac.in/noc24_cy55/preview
- https://ocw.mit.edu/courses/chemistry/5-09-organic-chemistry-spring-2008

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ORGANIC CHEMISTRY -I

SUB CODE-BSCH 1103

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Understand the role of electronic factors (inductive, resonance, etc.) in determining the stability, polarity, and reactivity of organic species.

CO2: Apply knowledge of aromaticity to explain the stability of ring compounds and ions.

CO3: Analyze organic reaction mechanisms and stereochemistry in various reactions.

CO4: Evaluate the purity and composition of organic compounds using chromatographic techniques.

CO5: Synthesize organic compounds through crystallization and identify elements in unknown samples.

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Course Objective

The course enables students to understand organic compound classification, nomenclature, and electronic effects. They will apply stereochemistry principles and analyze reaction mechanisms in aliphatic and aromatic hydrocarbons. Students will evaluate stability and reactivity in organic reactions and synthesize knowledge of conformational analysis to predict reaction outcomes.

Syllabus

Unit	Content	No. of hours	No. of week
I	**Shapes and Structure of Orbital:** Basics of Organic Chemistry: Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples.	8	1-3
II	**Nomenclature of organic molecules:** IUPAC Nomenclature of aliphatic and aromatic compounds. Stereochemistry: Concept of asymmetry, Fischer Projection, Newmann and Sawhorse projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixtures, Relative and absolute configuration: D/L and R/S designations	8	3-6
	Detailed study of compounds: Alcohols ,Aldehydes,Ketones, Carboxylic acids,Organometalic		

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III	compound of Mg,Li.Chemistry of Aliphatic Hydrocarbons Carbon-Carbon sigma bonds Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz- Fittig Reactions, Free radical substitutions: Halogenation - relative reactivity and selectivity	8	6-9
IV	Carbon-Carbon pi-bonds Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: **Electrophilic additions** their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2- and 1, 4- addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-Butene, toluene, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Cycloalkanes and stability, Baeyer strain theory, Conformation analysis, Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms	8	9-12
V	**Analytical Techniques:** Qualitative and quantitative estimation of C,H,N,S,Halogens in organic compounds, Molecular weight determination of organic acids by silver salt method.	8	12-15

Reference Book List

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
- Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill, (2007)
- F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).
- Ghosh, S. K., Advanced General Organic Chemistry, Part-I & Part-II, 3rd Ed., New

Reference Links

- https://onlinecourses.nptel.ac.in/noc24_cy55/preview
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PRACTICAL CHEMISTRY-I

Sub Code-BSCH 1104P

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Understand surface tension measurement techniques (drop number and weight methods).

CO2: Apply viscosity measurements using an Ostwald viscometer on various aqueous solutions.

CO3: Analyze the impact of HCl and NaOH on the pH of buffer solutions.

CO4: Evaluate results from pH metric titrations of strong and weak acids against strong bases.

CO5: Determine the dissociation constant of a weak acid through experimental analysis.

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Course Objective

The course equips students with skills in measuring surface tension using drop methods, applying viscosity measurement with an Ostwald viscometer, and analyzing pH changes in buffer solutions. Students will evaluate pH metric titrations of strong and weak acids and determine the dissociation constant of a weak acid through practical experiments, enhancing their laboratory proficiency in chemistry.

Syllabus

Unit	Content	No. of hours	No. of week
I	Volumetric Analysis of Acidimetry and Alkalimetry.	8	1-3
II	Detection of nitrogen, sulphur, halogen in organic compounds.	8	3-6
III	Surface tension measurements. a. Determine the surface tension by (i) drop number (ii) drop weight method. b. Study the variation of surface tension of detergent solutions with concentration	8	6-9
IV	Viscosity measurements using Ostwald's viscometer. a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature. b. Viscosity of sucrose solution with the concentration of solution.	8	9-12
V	pH metry (a) Effect on pH of addition of HCl/NaOH to solutions of acetic acid,sodium acetate and their mixtures. (b) Preparation of buffer solutions of different pH Sodium acetate-acetic acid Ammonium chloride-ammonium hydroxide	8	12-14

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Reference Text Books

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.:New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.;McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman &Co.: New York (2003).
- Athawale V. D. amd Mathur P. Experimental Physical Chemistry,, New Age Intenational(2001)

Reference Links

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SEMESTER II

PHYSICAL CHEMISTRY- II

SUB CODE-BSCH-1201

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Understand thermodynamic laws and state vs. path functions.

CO2: Apply thermochemical data to calculate bond energies.

CO3: Derive expressions for Gibbs and Helmholtz free energy.

CO4: Analyze the impact of composition on partial molar properties.

CO5: Evaluate heat capacity, enthalpy changes, and perform pH titrations

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Course Objective

The course aims to understand thermodynamic principles, including laws of heat and work. Students will apply thermochemistry to calculate properties like enthalpy and free energy, analyze ionic equilibria, and evaluate colligative properties and their applications in molar mass determination.

Syllabus

Unit	Content	No. of hours	No. of week
I	**Thermodynamics-II:** Internal energy,relationship between Cp and Cv,isothermal and adiabatic process of ideal gas,Relationship between P-V-T,elementary idea of entropy,reversible expansion Partial molar properties in ideal gas mixture, Chemical Potential, its determination and variation with temperature and pressure, Gibbs Duhem equation, Fugacity and activity its variation with T and P. Fugacity of a gas mixture.	8	1-3
II	**Solid State:** Types of solids,crystal forces,seven crystal system,labeling plane,Miller indices,qualitative idea of point and space groups.	8	3-6
III	**Colloidal state:** Definition, classification of colloidal solution,properties of colloids,protection of colloids,application of colloid Surface Tension and Surface free energy on liquids, Vapour pressure of droplets (Kelvin equation), Gibbs adsorption Isotherm, Estimation of surface area. (B.E.T equation), Unimolecular and bimolecular surface reactions	8	6-9

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IV	**Ionic Equilibrium:** Ionic product of water, pH,pK_a,pK_b,pK_h,buffer solution,buffer capacity, dissociation constant of acid and bases,solubility prouct,commom ion effect, HSAB principle.	8	9-12
V	**Changes of state:** Elevation of boiling point, depression of freezing point, abnormal colligative properties		12-14
VI	**Processes at solid surface:** Adsorption,idea of catalytic activity on Surface,oxidation,cracking,reforming Types of Polymers, Kinetics and mechanisms of Polymerization, Molecular mass—number and mass average molecular mass.	8	14-15

Reference Text Books

- Atkins, P. W.; de Paula, J.; Keeler, J., Physical Chemistry, 11th Ed., Oxford University Press India (2018).
- Bahl, A.; Bahl, B. S.; Tuli, G. D., Essentials of Physical Chemistry, S. Chand and Company (2014).
- Negi, A. S.; Anand, S. C., Physical Chemistry, New Age International Publishers (2007).

Reference Links

- https://ocw.mit.edu/courses/chemical-engineering/10-10-introduction-to-chemical-engineering-thermodynamics-fall-2003/
- https://www.khanacademy.org/science/chemistry
- https://ocw.mit.edu/courses/chemistry/5-12-physical-chemistry-fall-2008/
- https://www.rsc.org/periodic-table/chemistry-terms/thermodynamics

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INORGANIC CHEMISTRY -II

SUB CODE-BSCH-1202

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Understand fundamental principles of metallurgy and metal extraction processes.

CO2: Analyze the stability of oxidation states in s & p-block elements and their complex formation.

CO3: Evaluate unusual oxidation states of elements in carbides and nitrides.

CO4: Apply various theories of acids and bases in chemical contexts.

CO5: Utilize Pearson's HSAB principle in assessing chemical behavior.

Course Objective

The course outcomes encompass understanding metallurgy principles and metal extraction processes, analyzing oxidation state stability in s and p-block elements, and evaluating

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unusual oxidation states in carbides and nitrides. Students will apply acid-base theories, utilize Pearson's HSAB principle, and examine the structures of boron, silicon, and phosphorus compounds. They will estimate metal and non-metal contents through iodometric titrations and synthesize metal salts, including double salts, in laboratory settings.

Syllabus

Unit	Content	No. of hours	No. of week
I	**Nomenclature of Inorganic compounds:** IUPAC names ,names for ions,radicals, poly ions. Chemistry of s- and p-Block Elements: Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements.	8	1-3
II	**Acid-Base Chemistry:** Bronsted-Lowry concept,Lewis concept, periodic trends of acid strength, HSAB concept. Arrhenius, Brönsted-Lowry, and Lewis concepts of acids and bases, Proton transfer equilibria in water, solvent levelling, Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid-base strength and hardness and softness. Theoretical basis of hardness and softness, electronegativity and hardness and softness. Applications of acid base chemistry in qualitative analysis and catalysis, superacids and superbases	8	3-6
III	**Periodicity:** Fundamental trends of atomic/ionic radii, ionization energy, electronegativity,d orbitals,periodic anomalies	8	6-9
	Chemistry of following metals: Li,Be,Sn, Chemistry of halogens with reference to extraction, oxidation state. Types of inorganic polymers. Comparison with organic		

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IV	polymer, synthesis, structural aspects and applications of Borazine or borazole, boron nitrides, boranes, carboranes, metallocarboranes, silicates, silicones, siloxanes. Phosphazenes.	8	9-12
V	Principles involved in volumetric estimation of Cu^{2+},Ca^{2+}. Principles involved in gravimetric estimation of Ba^{2+},Ni^{2+},Mg^{2+}. General Principles of Metallurgy: Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent Isotopes and Radio carbon dating.Types of Polymers, Kinetics and mechanisms of Polymerization, Molecular mass—number and mass average molecular mass.	8	12-14
VI	**Macro molecules:** Types of Polymers, Kinetics and mechanisms of Polymerization, Molecular mass—number and mass average molecular mass.	8	14-15

Reference Text Books

- Lee, J. D., Concise Inorganic Chemistry, 5th Ed., Wiley India (2008).
- Housecroft, C. E; Sharpe, A. G., Inorganic Chemistry, 5th Ed., Pearson Education (2018).
- Atkins, P.; Overton, T.; Rouke, J.; Weller, M.; Armstrong, F.; Hagerman, M., Shriver Atkins's Inorganic Chemistry, 6th Ed., Oxford University Press India (2010).

Reference Links

- https://onlinecourses.nptel.ac.in/noc24_cy55/preview
- https://ocw.mit.edu/courses/chemistry/5-09-organic-chemistry-spring-2008

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ORGANIC CHEMISTRY-II

Sub Code-BSCH-1203

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Objective

CO1: Understand properties and reactions of haloalkanes, haloarenes, and oxygen/sulfur-containing groups.

CO2: Analyze reaction mechanisms of these groups.

CO3: Identify key named organic reactions.

CO4: Apply functional group transformations in synthesis.

CO5: Evaluate green chemistry practices.

Course Objective

This course aims to enable students to understand the properties and reactions of haloalkanes, haloarenes, and functional groups containing oxygen and sulfur. Students will analyze and apply reaction mechanisms, gaining insight into various named organic reactions and

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functional group transformations. Additionally, the course will provide an opportunity to evaluate green chemistry practices in organic synthesis, promoting sustainable approaches in chemical processes.

Syllabus

Unit	Content	No. of hours	No. of week
I	**Introduction to the organic reaction mechanism:** Inductive effect,Electromeric effect,mesomeric effect,bond fission and fusion. Alkyl Halides: Methods of preparation, nucleophilic substitution reactions – SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination. Aryl Halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg and Li; use in the synthesis of organic compounds.	10	1-3
II	**Stereochemistry:** Idea of geometrical and optical isomerism. Alcohols, Phenols, Thiols, Ethers, Thioethers and Epoxides (10 classes of 60 minutes each) Preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc reduction; preparation and properties of glycols: oxidation by periodic acid and lead tetraacetate, PinacolPinacolone rearrangement. Phenols: Preparation and properties; acidity and factors effecting it, ring substitution reactions, Reimer-Tiemann and Kolbe's-Schmidt reactions, Fries and Claisen 25 | P a g e rearrangements with mechanism. Preparation and reactions of thiols and thioethers. Ethers and Epoxides:	10	3-6

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III	**Amines and Urea**: Preparation,identification and organosulphur compounds. Structure, reactivity and preparation; nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives and their mechanisms; mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, WolffKishner, LiAlH4, NaBH4, MPV and PDC); Addition reactions of unsaturated carbonyl compounds: Michael addition. Active Methylene Compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.	10	6-9
IV	**Aromaticity and structure of Benzene:** Monosubstituted benzene,directive influence of different groups in benzene. Preparation, physical properties and reactions of monocarboxylic acids. Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids.	10	9-12
V	**Purification of organic compounds:** Chromatography,criteria of purity. Preparation and reactions of acid chlorides, anhydrides, esters and amides; Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann bromamide degradation and Curtius rearrangemen.	10	12-14
	Synthetic fibres, plastics,soaps, detergents and their chemistry		

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VI		10	14-15

Reference Text Books

- Greeves, N.; Clayden, J.; Warren, S., Organic Chemistry, 2nd Ed., Oxford University Press India (2014).
- Sykes, P., A Guidebook to Mechanism in Organic Chemistry, 6th Ed., Pearson Education India (2003)
- Ghosh, S. K., Advanced General Organic Chemistry, Part-I & Part-II, 3rd Ed., New Central Book Agency (2010). 26 | P a g e
- Bhal, B. S.; Bhal, A., A Textbook of Organic Chemistry, 22nd Ed., S. Chand and Company (2016).
- Sengupta, S., Basic Stereochemistry of Organic Molecules, 2nd Ed., Oxford University Press India (2018)

Reference Links

- http://www.sydney.edu.au/science/our-research/school-of-chemistry.html
- https://ocw.mit.edu/courses/chemistry/5-111-principles-of-chemical-science-fall-2008/

  https://onlinecourses.nptel.ac.in/

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Practical Chemistry-II

Sub code-(BSCH-1204P)

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Detect elements in unknown organic compounds.

CO2: Purify organic compounds via crystallization and determine melting points.

CO3: Analyze purity and component separation using chromatography.

CO4: Evaluate the number of components in a mixture using chromatographic techniques.

CO5: Apply chromatography for separating amino acids and nitrophenols, calculating Rf value

Course Objective

The course focuses on organic compound purification and analysis. Students will learn to detect elements, purify compounds through crystallization, and apply chromatography techniques for purity checks and component separation, including calculating Rf values.

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Syllabus

Unit	Content	No. of hours	No. of week
I	Volumetric Analysis of Potassium permanganate and Sodium thiosulphate.	8	1-3
II	Identification of organic compounds containing one functional group including monosacacharides.	8	3-6
III	Purification of organic compounds by crystallization using Water /Alcohol /AlcoholWater and determination of their melting points.	8	6-9
IV	Detection of elements (nitrogen, sulphur and halogens) in unknown organic compounds**.**	8	9-12
V	Chromatography (a) Checking the purity of supplied organic sample using paper/thin layer chromatographic technique. (b) Determination of the number of components present in a supplied organic mixture using paper/thin layer chromatographic technique. (c) Separation of a mixture of two amino acids by paper chromatography and determination of Rf. (d) Separation of a mixture of o-and p-nitrophenol or o- and p-aminophenol by thin layer chromatography (TLC) and determination of Rf of each of the component	8	12-14

Reference Text Books

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical Organic Chemistry,5th Ed. Pearson (2012)
- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation andQuantitative Analysis, University Press (2000).

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- Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: QualitativeAnalysis, University Press (2000)

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- https://www.sciencebuddies.org/science-experiments/chemistry
- https://phet.colorado.edu/

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Semester III

PHYSICAL CHEMISTRY -III

Sub Code-BSCH2101

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Understand phase equilibrium, phase rule, and phase diagrams.

CO2: Apply Nernst distribution law in extraction processes.

CO3: Analyze reaction rates using steady-state approximations and temperature effects.

CO4: Evaluate adsorption processes and isotherms.

CO5: Synthesize knowledge on catalysis and demonstrate practical skills in phase diagrams and adsorption studies.

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Course Objective

The course will equip students with knowledge of phase equilibrium, phase rules, and phase diagrams, while applying the Nernst distribution law in extraction processes. Students will analyze reaction rates, explore adsorption processes and isotherms, and gain insights into catalytic processes, including enzyme catalysis. Additionally, practical skills in constructing phase diagrams and verifying adsorption isotherms will be developed.

Syllabus

Unit	Content	No. of hours	No. of week
I	**Gaseous state:** Critical phenomena,intermolecular forces,liquefaction of gases,law of corresponding states,relation between critical constants and van der Waals constants. Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, Jablonski diagram, simple ideas of fluorescence, phosphorescence, and chemiluminescence	8	1-3
II	**Liquid State:** Critical temperature, physical properties of liquids: viscosity, refractive index, idea of liquid crystal.	8	3-6
III	**Thermodynamics:** Second law of thermodynamics, Carnot cycle, entropy change in reversible and irreversible processes, free energy and work function,	8	6-9

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	Gibbs–Helmholtz equation ,Clausius-Clapeyron equation.		
IV	**Ionic Equilibrium:** Ostwald's Dilution law, salt hydrolysis, conductance, degree of ionization, hydrolysis constant. Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid liquid, liquid-vapour and solid-vapour equilibria, Phase diagram of one component systems (water and sulphur) and two component systems (silver-lead and KI-H2O). Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions.	8	9-12
V	**Chemical Kinetics:** Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws. Steady state approximation and kinetics of simple reactions (e.g., decomposition of ozone, reaction between NO and O2, iodination of acetone, decomposition of gaseous N2O5). Kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions, (iii) consecutive reactions and (iv) chain reactions and their differential rate equations Rate constant of second order reaction, Arrhenius equation, effect of catalyst on reaction rate, saponification of ester, hydrolysis of methyl acetate.	8	12-14
VI	**Catalysis:** Definition and classification of catalyst,acid-base catalysis,enzyme catalysis,promoter,poison. Physical adsorption, chemisorption, adsorption isotherms, nature of adsorbed state. Homogeneous and heterogeneous catalysis and their significant features; advantages and drawbacks, specificity and selectivity, mechanisms of catalysed	8	14-15

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	reactions at solid surfaces. Enzyme catalysis; points of difference with general heterogeneous catalysis, characteristics, effect of pH and temperature; kinetics of enzyme catalysed reactions (Michaelis-Menten equation). Acid-Base catalysis		

Reference Text Books

- Atkins P. and De Paula, J. Physical Chemistry Tenth Ed., OUP, 2014.
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa, 2004. 30 | P a g e
- Engel, T. and Reid, P. Physical Chemistry 3rd Ed., Prentice Hall, 2012.
- McQuarrie, D. A. and Simon, J. D. Molecular Thermodynamics Viva Books, 2004.
- Roy, B. N. Fundamentals of Classical and Statistical Thermodynamics Wiley, 20016
- Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill, 2010.

Reference Links

- https://ocw.mit.edu/courses/chemical-engineering/10-10-introduction-to-chemical-engineering-thermodynamics-fall-2003/
- https://www.khanacademy.org/science/chemistry
- https://ocw.mit.edu/courses/chemistry/5-12-physical-chemistry-fall-2008/

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INORGANIC CHEMISTRY -III

Sub Code- BSCH 2102

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Understand chemical bonding and Valence Bond Theory in metal complexes.

CO2: Analyze the impact of Δo, Δt, and CFSE on properties like color and magnetism.

CO3: Identify isomers in complexes with 4 and 6 coordination numbers.

CO4: Explain transition metal properties and oxidation states using Latimer diagrams.

CO5: Conduct lab techniques for estimating metal ions and preparing metal complexes.

Course Objective

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This course introduces atomic structure concepts, including electron charge and the uncertainty principle. Students will understand bonding theories like Werner's and valence bond theory, and apply crystal field theory to analyze transition metal coordination. They will explain molecular structures and evaluate the roles of metal ions in biological systems. The course also covers noble gas inertness and lanthanide properties, with students synthesizing knowledge of their bonding and separation. Finally, students will interpret basic spectroscopy and apply complexation reactions in analytical chemistry.

Syllabus

Unit	Content	No. of hours	No. of week
I	**Atomic structure:** Determination of electronic charge ,dual nature of electrons, uncertainty principle ,idea of excited state and ground state. Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry.	10	1-3
II	**Bonding Models:** Expansion of valence –bond theory,Structure of BF_3,NH_3,PCl_5,SF_4,Metallic bond. Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Na+ /K+ pump, carbonic anhydrase and carboxypeptidase. Role of calcium in muscle contraction, blood-clotting. Excess and deficiency of some trace metals.	10	3-6

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III	**General chemistry:** Structure and bonding of noble gas,pseudo halogens. Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only). Rationalization of inertness of noble gases, preparation and properties of XeF2, XeF4 and XeF6, Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2), shapes of noble gas compounds using VSEPR theory.	10	6-9
IV	**Introduction to the transition metal chemistry:** Oxidation state, ionic sizes,magnetism,complexes	10	9-12
V	**Spectroscopy:** Elementary ides of UV-VIS, IR spectroscopy. **Analytical chemistry:** Use of complexation reaction by EDTA, DIMETHYL GLYOXIME in inorganic analysis.	10	12-14

Reference Text books

- Lee, J.D. Concise Inorganic Chemistry, 5th Ed., Wiley India (2008).
- Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry3rd Ed., John Wiley Sons, N.Y. 1994.

Reference Links

- https://onlinecourses.nptel.ac.in/noc24_cy55/preview
- https://ocw.mit.edu/courses/chemistry/5-09-organic-chemistry-spring-2008

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ORGANIC CHEMISTRY -III

SuB Code-BSCH-2103

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Remember the chemistry of nitrogen-containing functional groups, heterocycles, polynuclear hydrocarbons, alkaloids, and terpenes.

CO2: Understand the mechanisms of named reactions and synthetic processes for these compounds.

CO3: Apply knowledge of aromaticity to explain the stability and reactivity of heterocycles.

CO4: Analyze the structure and synthesis of selected alkaloids and terpenes in natural product chemistry.

CO5: Evaluate N-containing functional groups (e.g., nitro, amine, amide) through laboratory detection techniques.

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Course Objective

The course introduces the chemistry of nitrogen-containing compounds, heterocycles, alkaloids, and terpenes. Students will understand named reactions and aromaticity in heterocycles, apply lab techniques to detect and transform nitrogen-containing functional groups, and analyze structures of natural products. Finally, they will synthesize practical skills through the extraction of compounds like caffeine and piperine.

Syllabus

Unit	Content	No. of hours	No. of week
I	**Stereochemistry:** E-Z,D,L,R-S modes of nomenclature,idea of asymmetry,dissymmetry,keto-enol tautomerism,enantiomer, diastereoisomer.	8	1-3
II	Nomenclature and classification of glucose,fructose,ring structure, Kiliani-Fischer synthesis,Osazone interconversion. Natural occurrence of alkaloids, General structural features, Isolation and their physiological action. Hoffmann's exhaustive methylation, Emde's modification, structure elucidation and synthesis of nicotine. Medicinal importance of nicotine, hygrine, quinine, morphine, cocaine, and reserpine. Occurrence of terpenes, classification, isoprene rule; elucidation of structure and synthesis of citral and α-terpineol	8	3-6
III	**Aromaticiy and Huckel's Rule:** Preparation and properties of benzene, nitrobenzene, benzaldehyde, benzoic acid,aniline, diazonium salt. Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom (pyrrole, furan, thiophene and pyridine); synthesis, reactions	8	6-9

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	and mechanism of substitution reactions of: furan, pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), thiophene, pyridine (Hantzsch synthesis), pyrimidine, structure elucidation of indole,		
IV	**Applied chemistry:** Synthetic application of $AlCl_3$,brief introduction of TLC paper, gas chromatography. Structures and reactions of naphthalene, phenanthrene and anthracene. Preparation and structure elucidation of important derivatives of naphthalene and anthracene.	8	9-12
V	**Spectroscopy:** Elementary ides of UV-VIS, IR spectroscopy. **Analytical chemistry:** Use of complexation reaction by EDTA, DIMETHYL GLYOXIME in inorganic analysis.	8	12-14

Reference Text Books

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical Organic Chemistry,5th Ed. Pearson (2012)
- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation andQuantitative Analysis, University Press (2000).
- Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: QualitativeAnalysis, University Press (2000)

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PRACTICAL-III

Sub Code-BSCH 2104P

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Recall principles of molecular weight determination, surface tension, viscosity, and gravimetric analysis.
CO2: Understand laboratory techniques for these measurements.
CO3: Apply methods to determine molecular weight, surface tension, and viscosity.
CO4: Analyze experimental data for accuracy.
CO5: Evaluate gravimetric analysis results for Ag^{+}, $Ba^{2+,}$ and Cl^{-}

Course Objective

The course aims to introduce students to practical techniques for determining molecular weight using the Victor-Meyer and Duma's bulb methods, measuring surface tension with a stalagmometer, and evaluating viscosity using an Ostwald Viscometer. Students will

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understand the principles behind these methods and apply them in laboratory settings. They will also analyze experimental data for accuracy and evaluate results from gravimetric analysis of ions like Ag^{+}, Ba^{2+}, and Cl^{-} to ensure proper identification and quantification.

Syllabus

Unit	Content	No. of hours	No. of week
I	Determination of molecular weight of volatile liquid by Victor-Meyer method.	8	1-3
II	Determination of Surface tension of liquid using Stalagtometer.	8	3-6
III	Determination of molecular weight of volatile liquid by Duma's bulb method	8	6-9
IV	Determination of coefficient of viscosity of liquids using Ostwald Viscometer .	8	9-12
V	Gravimetric analysis of Ag^{+},Ba^{2+},Cl^{-}.	8	12-14

Reference Text Books

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical Organic Chemistry,5th Ed. Pearson (2012)
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SEMESTER IV

PHYSICAL CHEMISTRY—IV

Sub Code- BSCH-2201

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Recall standard electrode potentials and calculate EMF using the Nernst equation.
CO2: Understand EMF measurements for thermodynamic parameters.
CO3: Apply conductance and potentiometric titration techniques.
CO4: Analyze dielectric constants and magnetic properties of atoms and molecules.
CO5: Evaluate conductometric and potentiometric titration results for physical chemistry insights.

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Course Objective

The objective of this course is to develop students' understanding of electrochemical principles, including standard electrode potentials and EMF calculations using the Nernst equation. Students will explore EMF measurements for thermodynamic parameters and apply conductance and potentiometric titration techniques. The course will also focus on analyzing dielectric constants and magnetic properties, while evaluating titration results to enhance their skills in physical chemistry experiments and data interpretation.

Syllabus

Unit	Content	No. of hours	No. of week
I	**Solid State:** Bragg's law,Lattice energy and calculation,crystal structure of KCl,ZnS,NaCl, Radius ratio rule,co-ordination number. Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.	8	1-3
II	**Colloids:** Lyophilic and lyophobic colloids,coagulation,Tyndalleffect,Brownianmovement,electrophoresis,Hardy-Schulze rule,emulsion.	8	3-6
III	**Phase equilibrium:** Phase rule,onecomponent,two component solid-liquid system,azeotropicmixture,eutectic mixture. Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities,	8	6-9

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	determination of transference numbers using Hittorf and Moving Boundary methods. A		
IV	**Distribution law:** Nernst distribution law,factors affecting partition co-effeicient,thermodynamic derivation.	8	9-12
V	**Conductance:** Electrolytes,equivalent,molecularconductance,Kohlrausch's law of independent migration,application. Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells	8	12-14
	Electrochemical cell: Reversible,irreversiblecell,electrode potential, Nernst equation,redox titration.	8	14-15

Reference Text Books

- Atkins, P. W.; de Paula, J.; Keeler, J., Physical Chemistry, 11th Ed., Oxford University Press India (2018). 2.
- Bahl, A.; Bahl, B. S.; Tuli, G. D., Essentials of Physical Chemistry, S. Chand and Company (2014). 3.
- Negi, A. S.; Anand, S. C., Physical Chemistry, New Age International Publishers (2007). 4.
- Puri, B. R.; Sharma, L. R.; Pathania, M. S., Principles of Physical Chemistry, 47th Ed., Vishal Publishing (2017). 5.
- Silbey, R. J.; Alberty, R. A.; Bawendi, M. G., Physical Chemistry, 4th Ed., Wiley India (2006). 6.
- Rakshit, P. C., Physical Chemistry, Revised Ed. Sarat Book House (2014).

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- https://www.khanacademy.org/science/chemistry
- https://ocw.mit.edu/courses/chemistry/5-12-physical-chemistry-fall-2008/

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INORGANIC CHEMISTRY-IV

Sub Code- BSCH 2202

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course outcome

CO1: Recall the principles of qualitative inorganic analysis.

CO2: Understand inorganic reaction mechanisms and the trans effect in complexes.

CO3: Apply the 18-electron rule to assess metal carbonyl stability.

CO4: Analyze metal alkyl structures and multicenter bonding concepts.

CO5: Evaluate catalytic mechanisms and conduct qualitative analyses of inorganic mixtures

Course Outcome

The course aims to introduce students to qualitative inorganic analysis and understand inorganic reaction mechanisms, including the trans effect and substitution reactions. Students will apply the 18-electron rule to assess metal carbonyl stability and analyze metal alkyl structures and multicenter bonding. Additionally, they will explore catalytic mechanisms,

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including Wilkinson's and Ziegler-Natta catalysts, and gain practical skills in qualitative analysis and the synthesis of metal complexes with multidentate ligands.

Syllabus

Unit	Content	No. of hours	No. of week
I	**General chemistry of elements:** Oxidation states,halides,complexes of Sc,La,Y,Ti,V,Fe,Co,Ni. Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.	10	1-3
II	**Chemistry of group 14 elements:** Carbides,silicates of C,Si,Ge. Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans-effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes	10	3-6
III	**Oxidation and Reduction:** Redox half reaction.redox stability of water. Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series.	10	6-9

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IV	**Distribution law:** Nernst distribution law,factors affecting partition co-effeicient,thermodynamic derivation. Preparation and structure of Zeise's Salt, evidences of synergic effect and comparison of synergic effect with that in carbonyls. Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds.	10	9-12
V	**Applied chemistry:** Chemistry of Cement,steel,chemical pollutants,fuel. . Role of triethylaluminium in polymerisation of ethene (Ziegler-Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium. Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene	10	12-14
	Electrochemical cell: Reversible,irreversiblecell,electrode potential, Nernst equation,redox titration.		15

Reference Text Books

- Svehla, G. Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall (1996). 41 | P a g e 2. Housecroft, C. E; Sharpe, A. G., Inorganic Chemistry, 5th Ed., Pearson Education (2018).
- Atkins, P.; Overton, T.; Rouke, J.; Weller, M.; Armstrong, F.; Hagerman, M., Shriver Atkins's Inorganic Chemistry, 6th Ed., Oxford University Press India (2010).

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- https://onlinecourses.nptel.ac.in/noc24_cy55/preview
- https://ocw.mit.edu/courses/chemistry/5-09-organic-chemistry-spring-2008

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ORGANIC CHEMISTRY-IV

Sub Code-(BSCH-2203)

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Demonstrate understanding of UV and IR spectroscopy for organic compound structure determination.

CO2: Describe polymer characteristics and polymerization processes, including Ziegler-Natta catalysis.

CO3: Identify and classify carbohydrates, highlighting their biological significance.

CO4: Analyze the ring size determination of glucose and fructose and reactions of aldoses and ketoses.

CO5: Conduct caffeine extraction and perform sugar estimations and analyses in practical experiments.

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Course Objective

This course will analyze the principles of UV and IR spectroscopy for organic compound structure determination, describe polymer properties and polymerization processes including Ziegler-Natta catalysis, and identify the occurrence and biological significance of carbohydrates. Students will explain the chemistry of glucose and fructose ring size determination, demonstrate knowledge of aldose and ketose reactions and their interconversions, and elucidate the structures of selected disaccharides. Practical experience will include conducting caffeine extraction and analyzing sugars

Syllabus

Unit	Content	No. of hours	No. of week
I	**Reaction mechanism:** Electrophilic and nucleophilic substitution reaction in benzene.UV Spectroscopy: Types of electronic transitions, λmax, chromophores and auxochromes, bathochromic and hypsochromic shifts, intensity of absorption; application of Woodward rules for calculation of λmax for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; conjugated dienes: alicyclic, homoannular and heteroannular; extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans-isomers. FTIR Spectroscopy:	8	1-3
II	**Name reaction in organic chemistry** **Hydroxy acid:** Preparation of lactic acid, citric acid,stereochemistry of hydroxy acids.	8	3-6
III	**Polymethelene and Bayer's strain theory** Introduction and classification including di-block, tri-block and amphiphilic polymers; number average & weight average molecular weight, degree of polymerization, polydispersity index. 43 | P a g e Polymerisation reactions,	8	6-9

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	addition and condensation, mechanism of cationic, anionic and free radical addition polymerization; metallocene-based Ziegler-Natta polymerisation of alkenes; preparation and applications of plastics, thermosetting (phenol-formaldehyde, polyurethanes) and thermosoftening (PVC, polythene) Fabrics, natural and synthetic (acrylic, polyamido, polyester); rubbers - natural and synthetic: Buna-S, chloroprene and neoprene; vulcanization; polymer additives; introduction to liquid crystal polymers; biodegradable and conducting polymers with examples		
IV	**Applied chemistry**: Organic polymers and resins,proteins.Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; interconversions of aldoses and ketoses; KillianiFischer synthesis and Ruff degradation;	8	9-12
V	**Applied chemistry:** Classification, colour and constitution; mordant and vat dyes; chemistry of dyeing; synthesis and applications of: azo dyes - methyl orange and congo red (mechanism of diazo Coupling); triphenyl methane dyes -malachite green, rosaniline and crystal violet; phthalein dyesphenolphthalein and fluorescein; natural dyes, structure elucidation and synthesis of alizarin and indigotin; edible dyes with examples.	8	12-14

Reference Text Books

- Morrison, R. T.; Boyd, R. N.; Bhattacharjee, S. K. Organic Chemistry, 7th Ed., Pearson Education India: New Delhi (2010).
- Billmeyer, F. W. Textbook of Polymer Science, John Wiley & Sons, Inc.
- Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. Polymer Science, New Age International (P) Ltd. Pub.
- Finar, I. L. Organic Chemistry: Volume 1 & 2, 6th Ed., Pearson Education (2002).

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PRACTICAL CHEMISTRY-IV

Sub Code-(BSCH-2204P)

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Measure the refractive index of liquids using a refractometer.

CO2: Determine the partition coefficient of solutes between two immiscible liquids.

CO3: Conduct gravimetric analysis to quantify Ni^{2+}, Ba^{2+}, and SO_4^{2-} ions.

CO4: Evaluate the rate constant of ester hydrolysis by H^+ ions at room temperature

Course Objective

The course will measure the refractive index of liquids with a refractometer, determine the partition coefficient of solutes between immiscible liquids, and conduct gravimetric analysis for quantifying Ni^{2+}, Ba^{2+}, and SO_4^{2-} ions. Students will also evaluate the rate

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constant of ester hydrolysis by H^+ ions at room temperature, synthesizing data to draw conclusions about reaction kinetics.

Syllabus

Unit	Content	No. of hours	No. of week
I	Determination of partition coefficient of solutes between two immiscible liquids.	10	1-3
II	Determination of rate constant of hydrolysis of esters by H^+ ions at room temperature.	10	3-6
III	Determination of refractive index of liquids by refractometer.	10	6-9
IV	Gravimetric analysis of Ni^{2+},Ba^{2+},SO_4^{2-}	10	9-12

Reference Text Books:

- Vogel, A.I. - Vogel's Textbook of Quantitative Chemical Analysis (Latest Edition)
- Svehla, G. - Vogel's Qualitative Chemical Analysis (Latest Edition)
- Gabriel, S. - Practical Organic Chemistry (Latest Edition)
- Willard, H.H., Merritt, L.L., and Dean, J.A. - Instrumental Methods of Analysis (Latest Edition)

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- https://www.sciencebuddies.org/science-experiments/chemistry
- https://phet.colorado.edu/

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PHYSICAL CHEMISTRY -V

Sub Code-3101

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Describe gas collision properties and their relation to viscosity.

CO2: Determine Avogadro's number experimentally.

CO3: Analyze crystal forces and stoichiometry in solids.

CO4: Calculate molal constants and apply the van't Hoff equation.

CO5: Investigate kinetics of complex reactions and evaluate electrochemical principles

Course Objective

The course aims to describe gas collision properties and their relation to viscosity, determine Avogadro's number experimentally, and analyze crystal forces and

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stoichiometry in solids. Students will calculate molal constants using the van't Hoff equation and investigate reaction kinetics while evaluating key electrochemical principles.

Syllabus

Unit	Content	No. of hours	No. of week
I	**Gaseous State:** Collision number and collision frequency, relation between mean free path and coefficient of viscosity, determination of Avogadro number.	10	1-3
II	**Solid state:** Crystal forces,radiusratio,stoichiometry,non-stoichiometry.	10	3-6
III	**Equilibrium:** Molal elevation and depression constants,van't Hoff equation,partial molar quantities.	10	6-9
IV	**Phase equilibrium:** Three component system,partially miscible liquids,phase diagram	10	9-12
V	**Chemical kinetics:** Third order reaction,kinetics of complex reaction,consecutive reaction,opposing reaction.	10	12-13
VI	**Electrochemistry:** EMF,Liquid junction potential,calomelelectrode,hydrogenelectrode,glass electrode.	10	13-15

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Reference Books

- Levine, I. N., Quantum Chemistry, 7th Ed., Pearson Education India (2016).
- Prasad, R. K., Quantum Chemistry, 4th Ed., New Age International Publications (2010).
- McQuarrie, D. A., Quantum Chemistry, Viva Books (2016).

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- https://ocw.mit.edu/courses/chemistry/5-12-physical-chemistry-fall-2008/
- https://www.rsc.org/periodic-table/chemistry-terms/thermodynamics

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Inorganic Chemistry-V

Sub Code-BSCH 3102

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Describe the manufacture and safe handling of gaseous and inorganic industrial chemicals.

CO2: Analyze principles of industrial metallurgy and energy generation.

CO3: Understand processes in the silicate industry.

CO4: Determine calcium and phosphorus content in fertilizers through practical experimentation.

CO5: Evaluate alloys and catalytic processes, estimating metal content in various alloys.

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Course Objective

The course aims to describe the manufacture and safe handling of gaseous and inorganic industrial chemicals, ensuring students are aware of safety protocols. Students will analyze the principles of industrial metallurgy and energy generation industries to understand their roles in the chemical sector. The curriculum will provide an understanding of processes within the silicate industry and enable students to determine the calcium and phosphorus content in fertilizers through practical experimentation. Finally, learners will evaluate various alloys and catalytic processes, applying techniques to estimate metal content in different alloys.

Syllabus

Unit	Content	No. of hours	No. of week
I	**Atomic structure:** Schrodinger wave equation and its application,probability density function,significance of wave function. Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.	10	1-3
II	**Bonding Models:** LCAO combination,Antibonding,bonding,bondorder.efficiency of packing,factors of radius ratio,electronic structure of carbonate,nitrate,sulphate ion. Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, 50 | P a g e fluorosilicate, coloured glass, photosensitive glass. Carbon nanotubes	10	3-6

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	and inorganic nanowires. Bioinorganic nanomaterials, natural and artificial nanomaterials, bio-nanocomposite		
III	Complex formation in block elements,general chemistry of oxygen,sulphur,selenium,nitrogen,phosphorous. Fertilizers: Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates, polyphosphate, superphosphate compound and mixed fertilizers, potassium chloride, potassium sulphate	10	6-9
IV	**Organometallic chemistry:** EAN rule,elementary idea of carbonyl,nitrosyl,ferrocoene.	10	9-12
V	**Organometallic chemistry:** EAN rule,elementary idea of carbonyl,nitrosyl,ferrocoene. Alloys: Classification of alloys, ferrous and non-ferrous alloys, specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonisation, demanganisation, desulphurisation dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels	10	12-15

Reference Text Books

- De, A. K., Environmental Chemistry, 9th Ed., New Age International, New Delhi (2018). 2. Khopkar, S. M., Environmental Pollution Analysis, 2nd Ed, New Age International, New Delhi (2020).
- Manahan, S. E., Environmental Chemistry, 10th Ed, CRC Press (2017).
- Benvenuto, M. A., Industrial Inorganic Chemistry, De Gruyter (2010).
- Dara, S. S.; Umare, S. S., A Textbook of Engineering Chemistry, S. Chand & Company, New Delhi (2004)

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ORGANIC CHEMISTRY -V

Sub Code: BSCH-3103

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

Course Outcome

CO1: Describe basic concepts of nucleic acids and lipids.

CO2: Understand the structure and synthesis of peptides and proteins.

CO3: Analyze the chemistry and energetics of food conversion in biological systems.

CO4: Examine carbohydrate chemistry, focusing on monosaccharides and polysaccharides.

CO5: Conduct practical determinations of saponification value and iodine number of fats, and synthesize α-phenylglycine in the laboratory.

Course Objective

The course aims to describe fundamental concepts of nucleic acids and lipids, and understand the structure and synthesis of peptides and proteins. Students will analyze the

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chemistry and energetics of food conversion in biological systems and examine carbohydrate chemistry, focusing on monosaccharides and polysaccharides. Finally, learners will conduct practical determinations of saponification value and iodine number of fats, and synthesize α-phenylglycine in the laboratory.

Syllabus

Unit	Content	No. of hours	No. of week
I	**General principle:** Hyperconjugation ,carbocation,carbanion,benzyne system. Disaccharides: Concept of glycosidic linkages, structure of sucrose, inversion of cane sugar. Polysaccharides: Elementary idea about starch and cellulose	8	1-3
II	**Types of reaction:** Nucleophilic,electrophilicaddition,substitution reaction in saturated and unsaturated system,Saytzeff rule.	8	3-6
III	**Polynuclear hydrocarbon:** Naphthalene,Anthracene,Amino acids. Monosaccharides: Structure of D-glucose & D-fructose (configuration & conformation); ring structure of monosaccharides (furanose and pyranose forms): Ring-size determination, Haworth representations and non-planar conformations; anomeric effect (including stereoelectronic explanation); mutarotation; epimerization; reactions (mechanisms in relevant cases): osazone formation, bromine-water oxidation, HNO3 oxidation, selective oxidation of terminal –CH2OH of aldoses	8	6-9
IV	**Heterocyclic compounds:** Furan, Thiophene,Pyrrole,Pyridine.	8	9-12
	Components of nucleic acids, Nucleosides and nucleotides. Structure, synthesis and reactions of Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of	8	12-13

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V	polynucleotides. Amino acids, Peptides and their classification. Essential and non-essential amino acids. α-Amino Acids: Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and 52 | P a g e electrophoresis. Study of peptides: determination of their primary structures, end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and Cactivating groups; Solid-phase synthesis. Introduction to proteins, primary and secondary structure.		
VI	**Electrochemistry:** EMF,Liquid junction potential,calomelelectrode,hydrogenelectrode,glass electrode.	8	13-15

Reference Text Books

- Berg, J. M.; Tymoczko, J. L.; Stryer, L., Biochemistry, 9th Ed., W. H. Freeman (2019). 2. Voet, D.; Voet, J. G., Pratt, C. W., Biochemistry, 4th Ed., John Wiley and Sons (2012). 3. Campbell, M. K.; Farrell, S. O.: McDougal, O. M., Biochemistry, 8th Ed., Cengage Learning (2013).
- 4. Nelson, D. L.; Cox, M. M.; Lehninger, A. L., Principles of Biochemistry, 4th Ed., W.H. Freeman and Co. (2009).
- 5. Murray, R. K.; Granner, D. K.; Mayes, P. A.; Rodwell, V. W., Harper's Illustrated Biochemistry. 28th Ed., Lange Medical Books/ McGraw-Hill (2009).

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PRACTICAL CHEMISTRY-V

Sub Code-BSCH-3104P

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environments.

Course Outcome

CO1: Conduct iodometric titrations to estimate Cu(II) and $K_2Cr_2O_7$ concentrations.

CO2: Analyze the estimation of arsenite and antimony in antimony potassium tartrate.

CO3: Determine available chlorine content in bleaching powder through titration.

CO4: Prepare cuprous chloride from copper sulfate and demonstrate synthesis skills.

CO5: Synthesize manganese phosphate and both chrome and potash alum in the lab

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Course Objective

The course aims to conduct iodometric titrations for estimating Cu(II) and $K_2Cr_2O_7$ concentrations while enabling students to analyze the estimation of arsenite and antimony in antimony potassium tartrate. Students will also determine the available chlorine content in bleaching powder through quantitative titration techniques. Additionally, the curriculum will focus on the preparation of inorganic compounds, including cuprous chloride from copper sulfate, and the synthesis of manganese phosphate, chrome alum, and potash alum, enhancing practical laboratory skills.

Syllabus

Unit	Content	No. of hours	No. of week
I	INORGANIC- Qualitative inorganic analysis of Ag^{+},Hg^{2+},Fe^{3+},Ni^{2+},Co^{2+},SO_4^{2-},CO_3^{2-}	8	1-3
II	Iodometric Titrations (a) Estimation of Cu(II) and K2Cr2O7 using sodium thiosulphate solution. (b) Estimation of (i) Arsenite and (ii) Antimony in antimony potassium tartarate. (c) Estimation of available chlorine in bleaching powder.	8	3-6
III	Inorganic preparations (a) Cuprous Chloride (Cu2Cl2) from copper sulphate. (b) Preparation of Manganese phosphate (MnPO4·xH2O) from manganese nitrate [Mn(NO3)2].	8	6-11
IV	Preparation of chrome alum [K2SO4·Cr2(SO4)3·24H2O] and potash alum [K2SO4·Al2(SO4)3·24H2O]	8	12-15

Reference Text Books:

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- Vogel, A.I. - Vogel's Textbook of Quantitative Chemical Analysis (Latest Edition)
- Svehla, G. - Vogel's Qualitative Chemical Analysis (Latest Edition)
- Gabriel, S. - Practical Organic Chemistry (Latest Edition)
- Willard, H.H., Merritt, L.L., and Dean, J.A. - Instrumental Methods of Analysis (Latest Edition)

Reference List

- https://www.educationcorner.com/chemistry-experiments/
- https://www.sciencebuddies.org/science-experiments/chemistry
- https://phet.colorado.edu/

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PHYSICAL CHEMISTRY-VI

BSCH 3201

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

Course Outcome

CO1: Analyze equilibrium using thermodynamic parameters.

CO2: Apply Le Chatelier's principle based on thermodynamics.

CO3: Evaluate the link between thermodynamic probability and entropy.

CO4: Understand symmetry and group theory for molecular classification.

CO5: Create sustainable processes using green chemistry principles.

Course Objective

This course aims to provide students with a solid foundation in thermodynamic principles, focusing on equilibrium, Le Chatelier's principle, and the relationship between

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thermodynamic probability and entropy. It covers symmetry and group theory, adsorption isotherms, colloids, and electrokinetic phenomena, along with the electrical properties of molecules and intermolecular forces. Additionally, students will learn the fundamentals of green chemistry, promoting sustainable chemical practices.

Syllabus

Unit	Content	No. of hours	No. of week
I	**Spectroscopy:** Basic principles of IR,UV-VIS spectroscopy, Boltzmann distribution formula (with derivation), application to barometric distribution, partition function and thermodynamic properties (U, H & P), Einstein's theory of heat capacity of solids and its limitations. Nernst heat theorem and its implications, approach to zero Kelvin, Planck's formulation of third law and absolute entropies	8	1-3
II	**Photochemistry:** LambertBeerlaw,Photochemicalreaction,Phosphorence,Fluorescence,quantum yield.rule. Introduction, symmetry elements and operations with illustrations, symmetry elements and physical properties, group and symmetry group, group multiplication table, point group	8	3-6
III	**Wave mechanics:** Idea to operators,uncertaintyprinciple,Schrodinger wave equation. Special feature of interfaces, physical and chemical adsorptions, Langmuir and Freundlich adsorption isotherms, surface excess and Gibbs adsorption isotherms, heterogeneous catalysis (single reactant). Electrical double layers, zeta potential, overvoltage, Stern double layer (qualitative idea), Tyndall effect, electrokinetic phenomena (qualitative idea), colloids and electrolytes, micelle and reverse micelle, critical micelle constant (CMC)	8	6-9

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IV	**Dynamic electrochemistry:** Transport number,meanactivity,overpotential,corrosion,fuel cell. **Dynamic electrochemistry:** Transport number,meanactivity,overpotential,corrosion,fuel cell.	8	9-12
V	Introduction to green chemistry: What is green chemistry? Need for green chemistry. Goals of green chemistry. Limitations/ obstacles in the pursuit of the goals of green chemistry. Principles of green chemistry and designing a chemical synthesis: Twelve principles of green chemistry with their explanations and examples.	8	12-14

Reference Text Books

- Anastas, P. T.; Warner, J. C., Green Chemistry: Theory and Practice, Oxford University Press, Oxford (2005).
- Ahluwalia, V. K.; Kidwai, M. R., New Trends in Green Chemistry, Springer India, New Delhi (2012).
- Matlack, A., Introduction to Green Chemistry, 2nd Ed., CRC Press (2016).
- Cann, M. C.; Connely, M. E., Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).

Reference Links

- https://ocw.mit.edu/courses/chemical-engineering/10-10-introduction-to-chemical-engineering-thermodynamics-fall-2003/
- https://www.khanacademy.org/science/chemistry
- https://ocw.mit.edu/courses/chemistry/5-12-physical-chemistry-fall-2008/
- https://www.rsc.org/periodic-table/chemistry-terms/thermodynamics

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INORGANIC CHEMISTRY-VI

Sub Code-BSCH 3202

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment.

Course Outcome

CO1: Understand Crystal Field Theory and gain a basic understanding of Ligand Field

Theory in coordination compounds.

CO2: Apply the concept of Jahn-Teller distortion to Z-in and Z-out chemistry in complexes.

CO3: Analyze the origin of color in complexes using electronic transitions.

C**O4**: Evaluate the magnetic properties of coordination complexes, including those of d-block

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Course Objective

This course aims to provide students with a solid understanding of coordination chemistry, focusing on Crystal Field and Ligand Field Theories. Students will explore Jahn-Teller distortion and its impact on Z-in and Z-out chemistry, as well as the origin of color in complexes. The course covers the magnetic properties of coordination complexes, d-block chemistry, and f-block chemistry, including lanthanide contraction and abnormal electronic configurations. Additionally, students will learn about inorganic reaction mechanisms, particularly substitution reactions and the trans-/cis-effect, equipping them to analyze and predict chemical behavior in coordination compounds.

Unit	Content	No. of hours	No. of week
I	**Co-ordination chemistry:** CFSE Calculation,chelates,CF splitting. Crystal field theory: Splitting of d-orbitals in different geometries (octahedral, tetrahedral and square planar), crystal field stabilization energy (CFSE), Jahn-Teller distortion, low-spin and high-spin complexes, pairing energy, factors affecting 10Dq value, critical 10 Dq value. Origin of colour in coordination complexes: L-S coupling, ground state terms, selection rules, Orgel diagrams, charge transfer spectra (preliminary idea), limitations of CFT, nephelauxetic effect, introduction to LFT, spectrochemical series.	8	1-3
II	**Metallic bonding:** MO method of explaining bonding in metals, superconductivity Different types (dia-, para-, ferro- and antiferro-magnetic), orbital and spin magnetic moment, spin only moments of dn ions, super exchange and antiferromagnetic interactions (simple examples); stabilization of unusual oxidation states of metal centres.	8	3-6

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III	**Metallic bonding:** MO method of explaining bonding in metals, superconductivity micelle constant (CMC)	8	6-9
IV	General chemistry of f- block elements. d-Block elements: general comparison of 3d, 4d and 5d elements with special reference to electronic configuration, variable valency, ability to form coordination complexes, spectral magnetic catalytic properties f-Block Elements: comparison of the general properties (e.g. electronic configuration, oxidation state, variation in atomic and ionic (3+) radii, complex formation, magnetic and spectral properties) of lanthanides and actinides, fcontraction, similarities between the later actinides and the later lanthanides	8	9-12
V	Raman ,Mossbaur spectroscopy. Labile and inert complexes, various factors on reaction rate, substitution reaction on square planer complexes, tetrahedral, octahedral (preliminary concept), trans-effect, cis-effect (preliminary concept) in square planar complexes.	8	12-14

Reference Text Book

- Atkins, P.; Overton, T.; Rouke, J.; Weller, M.; Armstrong, F.; Hagerman, M., Shriver Atkins's Inorganic Chemistry, 6th Ed., Oxford University Press India (2010).
- Miessler, G.; Tarr, D. A., Inorganic Chemistry, 3rd Ed., Pearson Education India (2008).
- Huheey, J. E.; Keiter, E. A.; Keiter, R. L.; Medhi, O. K., Inorganic Chemistry: Principles of Structures and Reactivity, 4th Ed., Pearson Education India (2006).
- Cotton, F. A.; Wilkinson, G.; Gaus, P. L., Basic Inorganic Chemistry, 3rd Ed., Wiley India (2007). 59
- Elias, A.; Gupta, B. D., Basic Organometallic Chemistry: Concepts, Syntheses and Applications, 2nd Ed., Universities Press, Hyderabad (2013).

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- https://onlinecourses.nptel.ac.in/noc24_cy55/preview
- https://ocw.mit.edu/courses/chemistry/5-09-organic-chemistry-spring-2008

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ORGANIC CHEMISTRY-VI

Sub Code- BSCH-3203

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

Course Outcome

CO1: Understand the basic concepts, definitions, and classifications of polymers.

CO2: Analyze the significance of separation and analytical techniques in qualitative and quantitative characterization.

CO3: Apply various analytical methods for the characterization and molecular weight determination of polymeric materials.

CO4: Conduct chromatographic separation of inorganic ions and organic compounds.

CO5: Explore the principles and applications of spectrophotometry in chemical analysis.

Course Objective

This course provides a foundational understanding of polymers, focusing on their definitions and classifications. Students will learn the significance of analytical techniques for qualitative

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and quantitative characterization, gain practical experience in polymer analysis, and perform chromatographic separations. Additionally, the course introduces the principles of spectrophotometry and its applications in chemical analysis.

Syllabus

Unit	Content	No. of hours	No. of week
I	Name reaction and rearrangement of aromatic compounds. Different schemes of classification of polymers, polymer nomenclature, molecular forces and chemical bonding in polymers, texture of polymers. Criteria for synthetic polymer formation, classification of polymerization processes, relationships between functionality, extent of reaction and degree of polymerization. bi-functional systems, poly-functional systems	8	1-3
II	Dyes: Azo,Zanthenedye,natural colouring pigment,anthocyanins etc. Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers.	8	3-6
III	**Alkaloids and Terpenes:** Isolation and structural elucidation.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	8	6-9
IV	Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Aspects of Chromatographic Methods of Analysis: Ionchromatography (IC), gas-liquid	8	9-12

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	chromatography (GLC), gel permeation chromatography (GPC), thin-layer chromatography (TLC) and high-performance liquid chromatography (HPLC). Stereoisomeric Separation and Analysis:		

Reference Text Books

- Berg, J. M.; Tymoczko, J. L.; Stryer, L., Biochemistry, 9th Ed., W. H. Freeman (2019). 2. Voet, D.; Voet, J. G., Pratt, C. W., Biochemistry, 4th Ed., John Wiley and Sons (2012). 3. Campbell, M. K.; Farrell, S. O.: McDougal, O. M., Biochemistry, 8th Ed., Cengage Learning (2013).
- 4. Nelson, D. L.; Cox, M. M.; Lehninger, A. L., Principles of Biochemistry, 4th Ed., W.H. Freeman and Co. (2009).
- 5. Murray, R. K.; Granner, D. K.; Mayes, P. A.; Rodwell, V. W., Harper's Illustrated Biochemistry. 28th Ed., Lange Medical Books/ McGraw-Hill (2009).

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https://onlinecourses.nptel.ac.in/noc24_cy55/preview
https://ocw.mit.edu/courses/chemistry/5-09-organic-chemistry-spring-2008

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PRACTICAL CHEMISTRY-VI

Sub Code-BSCH-3204P

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

Course Outcome

CO1: Understand qualitative analysis of anions and cations.

CO2: Apply spot tests for ion identification.

CO3: Analyze mixtures to detect and separate ions.

CO4: Synthesize coordination complexes in the lab.

CO5: Evaluate λmax values of complexes using spectrophotometry.

Course Objective

This course aims to teach students qualitative semimicro analysis of mixtures containing various anions and cations, focusing on understanding the reactions involved. Students will

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also perform spot tests and prepare coordination complexes, including acetylacetonato and glycinato complexes, while determining their λmax values. The course emphasizes practical skills in analysis and synthesis in chemistry.

Syllabus

Unit	Content	No. of hours	No. of week
I	Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested: CO3 2− , NO− , CH3COO− , F− , Cl− , Br− , I− , NO3 − , C2O4 2− , PO4 3− , NH4 + , K+ , Cu2+, Cd2+ , Fe3+, Al3+, Cr3+, Zn2+, Mn2+, Co2+, Ni2+, Ba2+ , Sr2+, Ca2+, Mg2+ . Spot tests should be done whenever possible.)	10	1-3
II	Preparation the following complexes and determine the λmax value. (a) Acetylacetonato complexes of Cu2+/Fe3+ . (b) Tris(thiourea)copper(II) sulphate. (c) cis- and trans-bis(glycinato)copper(II) monohydrate.	10	3-6
III	INORGANIC- Qualitative inorganic analysis of Ca^{2+},Ba^{2+},Sr^{2+},Na^{+},K^{+},S^{2-} ,NO_3^{2-}.	10	6-9

Reference Text Books:

- Vogel, A.I. - Vogel's Textbook of Quantitative Chemical Analysis (Latest Edition)
- Svehla, G. - Vogel's Qualitative Chemical Analysis (Latest Edition)
- Gabriel, S. - Practical Organic Chemistry (Latest Edition)
- Willard, H.H., Merritt, L.L., and Dean, J.A. - Instrumental Methods of Analysis (Latest Edition)

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- https://www.sciencebuddies.org/science-experiments/chemistry
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PRACTICAL CHEMISTRY-VI

(BSCH-3205P)

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

Course Outcome

CO1: Understand conductometry and potentiometry principles.

CO2: Apply conductometric techniques to determine dissociation constants and study kinetics.

CO3: Analyze conductometric and potentiometric titration data.

CO4: Evaluate activation energy for saponification using conductance measurements.

CO5: Perform conductometric and potentiometric titrations for various acid-base systems

Course Objective

The objective of this course is to equip students with a thorough understanding of conductometry and potentiometry. They will learn to determine cell constants, equivalent conductance, and dissociation constants, as well as analyze kinetic reactions. The course will also cover various conductometric and potentiometric titrations, enabling students to

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accurately determine end points and evaluate activation energy for specific reactions. Through hands-on practice, students will develop strong analytical skills in these key electrochemical techniques.

Syllabus

Unit	Content	No. of hours	No. of week
I	Conductometry (a) Determination of cell constant of a given conductivity cell. (b) Determination of equivalent conductance of a weak electrolyte at different concentration and the dissociation constant of the electrolyte. (c) Study the kinetics of saponification of ethyl acetate by NaOH at two temperatures by conductance measurements and hence determine the energy of activation of the reaction. (d) Perform the following conductometric titrations: (i) Strong acid vs. strong base (ii) Weak acid vs. strong base (iii) Mixture of strong acid and weak acid vs. strong base (iv) Strong acid vs. weak base	10	1-7
II	erform the following potentiometric titrations: (a) Strong acid vs. strong base (b) Weak acid vs. strong base	10	7-10
III	ORGANIC-Preparation of para nitro acetanilide, Preparation of benzoic acid from benzaldehyde	10	10-14

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SUBSIDIARY SUBJECTS

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SEMESTER I

PHYSICS - I

Sub Code- BSPH-S- 1101

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

Course Outcomes:

1. Understand the basic knowledge of Electricity and Magnetism.
2. Evaluate and analyze the laws and principles of electromagnetism, from descriptive and numerical approaches.
3. Understand the basic use of algebra in simple physics.
4. Apply algebra to solve the core problem of physics including divergence and rotation mechanism.
5. Understand the simple quantum mechanics to explain the interaction between electromagnetic waves and matter.

Syllabus details:

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UNITS	CONTENTS
Unit I	**Electrostatics and Electromagnetic Theory:** Electrostatics, Electric charge, Coulomb's law, Electric field, Electric field intensity, Electric field intensity due to a point charge, Continuous charge distribution, Electric potential, Potential due to different shapes: wire, cylinder, spherical shell.
Unit II	**Vector algebra:** Scalars and vectors, Scalar and vector double products, Scalar and vector triple products, Divergence of a vector field, Gauss's divergence theorem, Curl of a vector field, Stoke's theorem, and Green's theorem.
Unit III	**Quantum Mechanics:** Wave, Radiation, Black body radiation, photoelectric effect, Compton's effect, Dual nature of wave-particle, De-Broglie wave, Davission-Germer's experiments, Concept of group and phase velocity, Heisenberg's uncertainty principle, experimental verification through single slit diffraction and gamma-ray microscope.

Practical -I

BSPH-S 1101-P

Syllabus details:

1. Measurements of length (or diameter) using a vernier caliper, screw gauge, and traveling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the motion of spring and calculate (a) spring constant, (b) g, and (c) modulus of rigidity.
5. To determine the moment of inertia of a flywheel.

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MATHEMATICS –I

Sub Code-BSMT-S- 1101

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

Syllabus

UNIT	CONTENTS
I	Real-valued functions defined on an interval, limit of a function (Cauchy's definition). Algebra of limits. Continuity of a function at a point and in an interval. Acquaintance (on proof) with the important properties of continuous functions no closed intervals. Statement of existence of inverse function of a strictly monotone function and its continuity.
II	Derivative – its geometrical and physical interpretation. Sign of derivative- Monotonic increasing and decreasing functions. Relation between continuity and derivability. Differential – application in finding approximation. Successive derivative – Leibnitz's
III	Matrices of Real Numbers: Equality of matrices. Addition of Matrices. Multiplication of a matrix by scalar. Multiplication of matrices _ Associative properties. Transpose of matrix – Its properties. Inverse of a non-singular matrix .

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	Elementary operations on Skew – Symmetric matrices. Scalar matrix. Orthogonal matrix. Elementary operations on matrices. Rank of a matrix: Determination of rank either by considering minors or by sweep-out process. Consistency and solution of system of linear equations with not more than 3 variables by matrix method.

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HINDI –I

Sub Code-HNL – 1101

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

Syllabus

UNIT	CONTENTS
I	Hindi Bhasha ke Vibhinna Roop – Rashtra bhasha, Rjabhasha, Janbhasha. Tippan, Aalekhan, Sankshepa, Sarkari patra ke prakar, paribhashik shabdawali. Anuvaad ki paribhasha, prakar, Upyogita aur mahatva, Achhe Anuvaad ke Gun, Anuvaad prayog (Hindi se English me Anuvaad).
II	Sabhashan Kala ka Artha, Sambhashan ke Vibhinn Roop – Vaartalap, Vyakhyan, Vaad-Vivaad, Ekaalap, Avaachik Abhivyakti, Jan Sambodhan, Sambhashan Kala ke Upaadan- Bhasha Gyan,

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	Antaraal Dhwani (Volume), Lahaja (Accent).
III	Sambhashan Kala ke Vibhinn Roop – Udgoshana, Sanchalan, Aankho Dekha Haal, Vachan Kala, Vaad- Vivaad Pratiyogita, Samuh samvaad.

Reference List

- *Pandey, Dr. Kailashnath.* Karyalayeeya Hindi. *Prabhat Prakashan, New Delhi, 2009.*
- *Sonatakke, Madhav.* Prayojanmulak Hindi – Prayukti aur Anuvaad. *2007.*
- *Tiwari, Bholanath.* Anuvaad Vigyan. *1984.*
- *Sharma Aacharya, Shri Ram.* Bhashan aur Sambhashan ki Divya Shakti. *Yug Nirman Yojana Press, Mathura, 1990.*

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SEMESTER II

PHYSICS – II

Sub Code-BSPH-S- 1201

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

Course Outcomes:

1. Understand the fundamental concepts of work and energy.
2. Apply the work and energy concept to solve the problem of the conservative and non-conservative systems of physics.
3. Understand the role of dynamic principles in demonstrating the revolution of the earth and harmonic motion.
4. Evaluate and apply the various laws of motion to find the general solution of the revolutionary and oscillatory body.

Syllabus details:

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UNITS	CONTENTS
Unit I	**Work and Energy:** Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force is the gradient of potential energy. Work & Potential Energy. Work done by non-conservative forces. Law of conservation of Energy. Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.
Unit II	**Gravitation and Central Force Motion:** Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due tospherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts.
Unit III	**Oscillations: SHM:** Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy, and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.

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Practical -II

BSPH-S 1201-P

Syllabus details:

1. To determine the coefficient of viscosity of water by capillary flow method (Poiseuille's method).
2. To determine the Young's Modulus of a wire by optical level method.
3. To determine the modulus of rigidity of a wire by Maxwell's needle.
4. To determine the elastic constants of a wire by Searle's method.
5. To determine the value of g using a bar pendulum.

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MATHEMATICS –II

Sub Code- BSMT-S- 1201

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment.

Syllabus

I	Differential equations of first order and first degree: Statement of existence theorem. Separable, Homogeneous and Exact differential equations. Condition of exactness, Integrating factor. Rules of finding integrating factor, (statement of relevant results only).
II	First order linear differential equation and Bernoulli Equation Integrating factor (Statement of relevant results only). Equations reducible to first order linear equations. Equations of first order but not of first degree. Clairaut's equation: General and singular solutions. Higher order linear equations with constant coefficients: Complementary function Particular Integral. Method of undermined coefficients, Symbolic operator D. Method of variation of parameters.
III	Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method.

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ENGLISH – I

Sub Code-ENL-1201

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment.

Syllabus

UNIT	CONTENTS
I	I. Prose: 1. The Bet — Anton Chekov 2. Socrates and the Schoolmaster — F. L. Brayne 3. An Astrologer's Day — R. K. Narayan 4. The Gift of the Magi — O' Henry 5. With the Photographer — Stephen Leacock
II	II. Spoken Communication: 1) Meeting People, Exchanging Greetings and Taking Leave

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	2) Introducing Yourself 3) Introducing People to Others 4) Answering the Telephone and Asking for Someone 5) Dealing with a Wrong Number 6) Taking and Leaving Messages 7) Making Inquiries on the Phone 8) Calling for Help in an Emergency
III	Grammar and Vocabulary: Articles, prepositions, modal auxiliaries, antonyms, synonyms, one-word substitutes.
IV	Written Communication: Summarizing

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SEMESTER III

PHYSICS –III

Sub Code-BSPH-S- 2101

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

Course Outcomes:

1. Understand the basic properties of dielectric material used in energy storage devices.
2. Understand the concept of wave equation equation associated with dynamical particles.
3. Evaluate and determine the fundamental solution of wave equation for different systems of physics.
4. Understand the basic knowledge of nuclear physics and crystallography.

Syllabus details:

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UNITS	CONTENTS
Unit I	**Dielectric Properties of Matter:** Electric Field in Matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P, and D. Gauss' Law in dielectrics, Clausius-Mossotti equation.
Unit II	**Advanced Quantum Mechanics:** Schrodinger's wave equation, Solution of Schrodinger's wave equation for a free particle, Solution of Schrodinger's wave equation for a particle enclosed in a 1D box, Potential barrier, Rectangular potential barrier, Solution of Hydrogen atom, Solution of simple harmonic oscillator, Operators.
Unit III	**Nuclear Size and Shape:** Basic properties of Nucleus, Scattering, p-p scattering, Radioactive decay, Gammo's theory of alpha decay, liquid drop model, shell model, concept of Mass defect, binding energy, packing fractions.
Unit IV	**Condensed Matter Physics:** Crystalline and amorphous solids, basis, lattice, miller indices, seven segments of crystals, bravais lattice, Brillouin zone, Laue's equation, X-ray diffraction, Powder X-ray diffractometer.

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Practical -III

BSPH-S 2101-P

Syllabus details:

1. Measurement of Planck's constant using Blue LED.

2. To draw the I-V characteristic curve of NPN and PNP transistors.

3. To determine the bandgap of a given sample material.

5. To determine the dielectric constant of a given sample material.

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MATHEMATICS –III

Sub Code -BSMT-S- 2101

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

UNIT	CONTENTS
I	Introduction of Group Theory: Definition and examples taken from various branches (example from number system, roots of Unit, 2x2 real matrices, non-singular real matrices of a fixed order). Elementary properties using definition of Group. Definition and examples of sub-group – Statement of necessary and sufficient condition and its applications. Definitions and examples of (i) Ring, (ii) Field, (iii) Sub-ring, (iv) Sub-field.
II	Concept of Vector space over a field: Examples, Concepts of Linear combinations, Linear dependence and independence of a finite number of vectors, Sub- space, concepts of generators and basis of a finite dimensional vector space. Problems on formation of basis of a vector space (No proof required).
III	Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, change of coordinate matrix (simple problems). Algebra of linear transformations. Eigen values, eigen vectors and characteristic equation of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix.

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HINDI –II

Sub Code-HNL – 2101

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

Syllabus

UNIT	CONTENTS
I	अक्षंका & सेपान्ज
II	कहुकियां & डॉ. चित्रसिंह वर्त, राजा रघुदेव चरण प्रसाद सिंह (मां), धर्मवीर भारती (गुल्दी बुनाई), हर्षित साहनी (अमरेंद्र आ गया), शिष्य प्रसाद सिंह (कर्मशक्ति की हार), मनु बखानजी (रानी मां का पचवारा), उषा प्रियंका (ओलिफा), निस्सकर्देश्वर (माटी-टिला)

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SEMESTER IV

PHYSICS –IV

Sub Code- BSPH-S- 2201

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

Course Outcomes:

1. Understand the concept of relativity via Newton's law.
2. Apply Newton's law to solve the problems related to relativity including length contraction, dime dilation, etc.
3. Understand the limitations of statistical physics over thermodynamics.
4. Apply the concept of statistical physics to solve the classical particles, bosons, and fermions distribution.
5. Understand the properties of semiconducting material to design physical devices with diode, LED, transistors, etc.

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6. Understand and expand the basic knowledge of physics to get some ideas and concepts related to nanotechnology and nanophysics.

Syllabus details:

UNITS	CONTENTS
Unit I	**Special Theory of Relativity:** The frame of references, inertial and non-inertial frame of references, rotatory frame, Coriolis force, coordinate system velocity and acceleration: cartesian, plane polar, spherical, and cylindrical, length contraction, time dilation, velocity addition theorem, variation of mass with velocity, Einstein energy mass relation.
Unit II	**Statistical Physics:** Probability, ensemble, Gibb's ensemble, microstate, macrostates, accessible and non-accessible microstates, the principle of equal a priori probability, concept of phase space, thermal equilibrium, Maxwell-Boltzmann's probability relation, indistinguishability and indistinguishability of particles, classical statistics: Maxwell-Boltzmann's statistics, Quantum statistics: Bose-Einstein and Fermi-Dirac statistics, partition function.
Unit III	**Atomic and Molecular Physics:**Vector atomic model, Electronic spectra, rotational and vibrational spectra, Rigid rotator, Raman effect, and its classical and quantum explanation.
Unit IV	**Semiconductor:**Types of materials, intrinsic and extrinsic semiconductors, doping, P type and N type semiconductors, P-N junction diode, potential barrier, depletion region, band theory, photodiode, tunnel diode, Schottky diode, transistor, LED.
Unit V	**Nano-Physics:**Introduction and basic definition of nanotechnology, properties of nanomaterials, Synthesis of nanomaterials, characterization of nanomaterials.

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Practical -IV

BSPH-S 2201-P

Syllabus details:

1. To verify Ohm's law.

2. To draw the I-V characteristic Zener diode.

3. To draw the I-V characteristic P-N junction diode.

4.. To draw the I-V characteristic curve of a photodiode.

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MATHEMATICS –IV

Sub Code- BSMT-S- 2201

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

Syllabus

I	Sequence of real numbers: Definition of bounds of a sequence and monotone sequence. Limit of a sequence. Statements of limit theorems. Concept of convergence and divergence of monotone sequences-applications of the theorems, in particular, definition of e. Statement of Cauchy's general principle of convergence and its application.
II	Infinite series of constant terms; Convergence and Divergence (definitions). Cauchy's principle as applied to infinite series (application only). Series of positive terms: Statements of comparison test. D. Alembert's Ratio test. Cauchy's nth root test and Raabe's test Applications. Alternating series. Statement of Leibnitz test and its applications.

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III	Real-Valued functions defined on an interval: Statement of Rolle's Theorem and its geometrical interpretation. Mean value theorems of Lagrange and Cauchys' from of remainders. Taylor's and maclaurin's Infinite series of functions likee^{x}, sinx, conx, $(1+x)^{n}$, log (1+x) with restrictions wherever necessary. Application of the principle of Maxima and minima for a function of single variable in geometrical, physical and to other problems.

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ENGLISH – Il

Sub Code-ENL-2201

Programme Outcome

PO1: Understand core concepts, principles, and facts from Chemistry, Physics, Mathematics.

PO2: Apply scientific methods and modern instrumentation techniques in designing and conducting laboratory experiments.

PO3: Develop skills, including reading, writing, and oral presentations, to clearly convey scientific ideas and findings.

PO4: Evaluate ethical situations and apply appropriate ethical principles and professional standards in scientific practices and decision-making.

PO5: Demonstrate the ability to work both independently and collaboratively in diverse scientific teams to achieve common goals.

PO6: Create new ideas or methods based on the integration of chemical knowledge and related scientific disciplines.

PO7: Collaborate: team work and contribute effectively in multidisciplinary environment

Syllabus

Unit	Content
I	Maupassant - The Necklace O. Henry - The Last Leaf Catherine Mansfield - A Cup of Tea R.K. Narayan – Selvi MR Anand - The Lost Child Jhumpa Lahiri - The Interpreter of Maladies .Shashi Deshpande - Hear Me Sanjaya!

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II	James Bryce - Some hints of Public Speaking C.E.M. .Toad - A Dialogue on Civilization Hill - Principles of good writing Bapsi Sidhwa - Why do I write? Jawahar Lal Nehru - The Reawakening of India Subhash Chandra Bose - To Delhi, To Delhi . Dr. Rukhmabai - Purdah - The Need for its Abolition
III	Novel

Reference Book List

- Maupassant, Guy de. *The Necklace*. (Published in 1884).
- Henry, O. *The Last Leaf*. (Published in 1907).
- Mansfield, Katherine. *A Cup of Tea*. (Published in 1922).
- Narayan, R. K. *Selvi*. In *Malgudi Days*. Indian Thought Publications, 1943.
- Anand, Mulk Raj. *The Lost Child*. (Published in 1934).

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