As per the NEP 2020

Bachelor of Science

Chemistry

(Effective from Academic Year 2024-2025 onwards)

Pandit Deendayal Upadhyaya Shekhawati University

Sikar (Rajasthan) 307026

E-mail: reg.shekhauni@gmail.com

Website: www.shekhauni.ac.in

Dy. Registrar
Pandit Deendayal Upadhyaya
Shekhawati University,
Sikar(Rajasthan)

Semester – I

Learning Objectives

The objective of this course is to provide students with a theoretical understanding of the different types of bonding and stereochemistry of organic compounds with an understanding of the enantiomers, diastereomers, D/L and R/S nomenclature. The aim of this course is to explain the structure and reactivity of aromatic hydrocarbons, and to explain the order and molecularity of the reactions, the rate law and ordere of reactions determination. In addition, the laboratory course is designed to provide students with practical experience in basic quantitative analytical techniques including volumetric analysis, qualitative analytical techniques, and the determination of kinetic parameters of reactions.

Learning outcomes

Upon completion of the course, students should be able to:

- By the end of this course, students will have a clear understanding of drawing logical and detailed different types of bonding, classifying the molecules as chiral or achiral, determining the D/L and R/S nomenclature of stereoisomers and identifying the formation of racemic mixture or optically active compounds during the reactions. Students will also have an understanding about order and molecularity of reactions, rate law and methods determining of order and kinetic parameters of reactions. Students will also have practical experience in quantitative analytical techniques including volumetric analysis, identification of organic compounds by determination of functional groups, determination of order and rate constant of various reactions.

Course Title:	**Chemistry Paper – I**	**Course Code: 24BCH5101T**
Total Lecture hour 45		**Hours**
Unit I	**Atomicstructure:** Bohr'stheoryand its limitations, dual behaviour of matterandradiation, de Broglie's relation, Heisenberg's uncertainty principle, hydrogen atom spectra, radial and angular wave functions, probability distribution curves, shapesofs, p, dorbitals, nodalplanes time independent Schrodinger equation, significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Significance of quantum numbers, orbital angular momentum, quantum numbers, rules for filling electrons in various orbitals, electronic configurations of the atoms, stability of half-filled and fully filled orbitals, concept of exchange energy, relative energies of atomic orbitals, anomalous electronic configurations.	**11**
Unit II	**Covalent Bond:** Valance bond approach of covalent bond, shapes of some inorganic molecules and ions on the basis of VSEPR theory, the concept of hybridization with suitable examples of linear, trigonal planar, tetrahedral, trigonal pyramidal, trigonal bipyramidal, octahedral, and square planar arrangements. Concept of resonance and resonating structures in various inorganic compounds. **Metallic Bond:** Introduction, free electron theory, concept of band theory, importance of metallic bond, properties of semiconductors, insulators with examples. **Ionic Bonding:** General characteristics of ionic bonding, energy considerations in ionic bonding, lattice energy, solvation energy, their importance in the context of stability and solubility of ionic compounds, statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power, and polarizability, Fajan's rules, ionic character in covalent compounds, dipole moment and percentage ionic character. **Weak Chemical Interactions:** van der Waals forces, ion-dipole forces, dipole-dipole interactions, instantaneous dipole-induced dipole interactions, induced dipole interactions, repulsive forces, hydrogen bonding, theories of inter- and intra-molecular hydrogen bonding, valence bond treatment, effects of chemical forces on melting point, boiling point	**12**

	and solubility.	
Unit III	**Fundamentals of Organic Chemistry:** Covalent bond, hybridization and shapes of molecules, geometry and structure of sp3, sp2, and sp hybridized orbitals, influence of hybridization on bond properties. **Electronic displacements:** Inductive, electromeric, resonance, and field effect. Hyperconjugation, concept of dipole moment, homolytic and heterolytic fission, curved arrow notation, electrophiles and nucleophiles, types of organic reactions. **Types of reactive intermediates:** Generation, shape, and relative stability of different reactive intermediates namely carbocation, carbanion, free radicals, nitrene, carbene, and benzyne. **Aromaticity:** Introduction, electronic structure and Huckel's rule, aromaticity in carbocyclic, heterocyclic, benzenoid, non-benzenoid, aromatic ions, anti-aromatic and non-aromatic compounds. **Isomerism**: Concept and significance of isomerism, structural isomerism and stereoisomerism. **Stereochemistry:** Types of stereoisomerism, geometrical and optical isomerism. **Chirality:** Concept of chirality (chirality up to two carbon atoms), stereogenic centre, optical activity, Cahn-Ingold-Prelog (CIP) rules and priority assignments, enantiomers, diastereomers and meso compounds. **Nomenclature systems:** Cis-trans nomenclature, E/Z nomenclature, R/S nomenclature (up to two chiral carbon atoms), threo and erythro, D and L nomenclature. Conformational isomerism: Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge formula, Newmann, Sawhorse and Fischer representations.	**12**
Unit IV	**Gaseous State:** Postulates of kinetic theory of gases, deviation from ideal behaviour, van der Waals equation of state. Critical Phenomena: PV isotherms of real gases, continuity of states, the isotherms of van der Waals equation, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of state. **Molecular Velocities:** Root mean square, average and most probable velocities. Qualitative discussions of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquification of gases (based on Joule-Thomson effect). **Liquid State:** Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid Crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesteric phases. Thermography and seven segment cells.	**10**

Reference Books:

1	Lee,J.D.;(2010),**Concise Inorganic Chemistry**, 5th Edition, Wiley India.
2	Atkins, P. W.; Overton, T. L.; Rourke, J. P.; Weller, M. T.; Armstrong, F. A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.
3	Miessler, G. L.; Fischer P. J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.
4	Housecraft, C. E.; Sharpe, A. G. (2018), **Inorganic Chemistry**, 5thEdition, Pearson.
5	Douglas,B. E.,McDaniel,D. H.;Alexander,J. J. (2007) **Concepts and Models in Inorganic Chemistry**, 3rd Edition, John Wiley & Sons.
6	Morrison, R. N.; Boyd, R. N.; Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
7	Solomons,T.W.G.; Fryhle,C.B.; Snyder, S.A. (2017),**Organic Chemistry**,12th Edition, Wiley.
8	Eliel,E.L. (2000),**Stereochemistry of Carbon Compounds**, Tata McGraw Hill education.
9	Puri, B.R.; Sharma, L.R.; Pathania M.S. (2020) **Principles of Physical Chemistry**, Vishal Publishing Co.
10	Castellan, G.W.(2004), **Physical Chemistry**, 4thEdition, Narosa.
11	Atkins, P.; de Paula, J. (2013), **Elements of Physical Chemistry**, 6th Edition, Oxford University Press.

12	Alberty, R. A.; (1987), **Physical Chemistry**, 7th Edition, Wiley Eastern Ltd., Singapore.
13	Dogra, S.K.; Dogra, S. (2015), **Physical Chemistry Through Problems**, 2nd Edition, New Age International Publication.

Course Title:	Chemistry Practical	Course Code: 24BCH5101P
1	**Inorganic Chemistry** Separation and identification of six radicals (3 cations and 3 anions) in the given inorganic mixture including special combinations.	
2	**Organic Chemistry** **Laboratory Techniques** (a) Determination of melting point (Naphthalene, benzoic acid, urea, atc.); boiling point (methanol, ethanol, cyclohexane,etc.): mixed melting point (urea- cinnamic acid, etc). (b) Crystallization of phthalic acid and benzoic acid from hot water, acetanilide from boiling water, naphthalene from ethanol etc. Sublimation of naphthalene, camphor, etc. **Qualitative Analysis** Identification of functional groups (unsaturation, phenolic, alcoholic, carboxylic, carbonyl, ester, carbohydrate, amine, amide nitro and hydrocarbon) in simple organic compounds (solids or liquids) through element detection (N, S and halogens).	
3	**Physical Chemistry** **Viscosity and Surface Tension:** a) To determine the viscosity/ surface tension of a pure liquid (alcohol etc.) at room temperature. (Using the Ostwald viscometer/ stalagmometer). b) To determine the percentage composition of a given binary mixture (acetone and ethylmethyl ketone) by surface tension method. c) To determine the percentage composition of a given mixture (non-interacting systems) by viscosity method. d) To determine the viscosity of amyl alcohol in water at different concentration and calculate the excess viscosity.	
4	**Viva voce**	
5	**Practical Record**	

Semester – II

Learning Objectives

- To impart in-depth knowledge about the structural patterns and a comparative account of the different organ systems of vertebrates.
- The objective of this course is to provide students with a theoretical understanding of the S and P block elements from periodic table and basic knowledge about thermodynamics. In addition, the laboratory course is designed to provide students with practical experience in basic quantitative analytical techniques including volumetric analysis, qualitative analytical techniques, and the determination of kinetic parameters of reactions.

Learning outcomes

- By the end of this course, students will have a clear theoretical understanding of the S and P block elements from periodic table and basic knowledge about thermodynamics.

- Students will also have practical experience in quantitative analytical techniques including volumetric analysis, identification of organic compounds by determination of functional groups, determination of order and rate constant of various reactions.

Course Title:	**Chemistry Paper – II**	**Course Code: 24BCH5201T**
Total Lecture hour 45		**Hours**
Unit I	**s-block elements:** General characteristics, diagonal relationships and anomalous behavior of first member of each group. Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water, common features of hydrides, oxides, carbonates, nitrates, sulphates of alkali and alkaline earth metal compounds, complex formation tendency and solutions of alkali metals in liquid ammonia. **p-block elements:** Periodicity in properties of p-block elements with special reference to atomicand ionicradii, ionizationenergies, electron-affinity, electronegativity, allotropy, inert pair effect, catenation including diagonal relationship. Structure, bonding and properties of hydrides of group 13, oxides of phosphorus and sulphur, oxoacids of phosphorus and sulphur, halides of silicon and phosphorus, borazine, silicates, silicones.	11
Unit II	**Alkanes:** Preparation, physical properties and chemical reactions, mechanism of free radical substitution with reference to halogenation, orientation, reactivity and selectivity. **Cycloalkanes**: Nomenclature, preparation, chemical reactions, Baeyer strain theory and its limitation, ring strain in small rings (cyclopropane and cyclobutane), theory of strain less rings, banana bond in cyclopropane. **Alkene:** Introduction of alkenes, preparation, physical properties and relative studies of alkenes, their preparation with reference to mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration, Saytzeff's rule, Hofmann elimination. Chemical reactions of alkenes-mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration-oxidation, oxymecuration-demercuration, epoxidation, ozonolysis, hydration, hydroxylation, oxidation with KMnO4, polymerization of alkenes, substitution at the allylic and vinylic positions of alkene, industrial applications of ethylene and propene. **Dienes:** Nomenclature, classification, isolated, conjugated and cumulated dienes, structure of allenes and butadiene, preparation, chemical reactions-polymerization, 1,2-and 1,4-additions, Diels-Alder reaction. **Alkynes:** Nomenclature, preparation, physical properties and chemical reactions, mechanism of electrophilic and nucleophilic addition reactions, hydroboration, metal ammonia reductions, oxidation and polymerization.	12
Unit III	**Chemical Energetics-I:** Review of thermodynamics and first law of thermodynamics, Joule's law, Joule-Thomson coefficient and inversion temperature, important principles and definitions of thermochemistry, concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution, calculation of bond energy, bond dissociation energy and resonance energy from thermo-chemical data, variation of enthalpy of a reaction with temperature - Kirchhoff's equation. Second law of thermodynamics, different statements of the law, Carnot cycle and its efficiency, Carnot theorem, Concept of entropy, entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical processes.	11
Unit IV	**Chemical Energetics-II and Equilibrium:** Third law of thermodynamics, calculation of absolute entropies of substances, free energy (G), work function (A), variation of G and A with P, V and T. Thermodynamic derivation of the law of mass action. Le Chatelier's principle. Relationships between KP, KC and KX for reactions involving ideal gases. Reaction isotherm and reaction isochore, Clausius-Clapeyron equation and applications.	11

	Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale, common ion effect, salt hydrolysis - calculation of hydrolysis constant, degree of hydrolysis and pH for different salts, buffer solutions, solubility and solubility product of sparingly soluble salts and its applications.	

Reference Books:

1	Lee,J.D.;(2010),**Concise Inorganic Chemistry**, 5th Edition, Wiley India.
2	Atkins, P. W.; Overton, T. L.; Rourke, J. P.; Weller, M. T.; Armstrong, F. A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.
3	Miessler, G. L.; Fischer P. J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.
4	Housecraft, C. E.; Sharpe, A. G. (2018), **Inorganic Chemistry**, 5thEdition, Pearson.
5	Greenwood,N.N.;Earnsaw,A.(1997),**Chemistry of Elements**, 2ndEdition, Elsevier.
6	Douglas,B. E.,McDaniel,D. H.;Alexander,J. J. (2007) **Concepts and Models in Inorganic Chemistry**, 3rd Edition, John Wiley & Sons.
7	Morrison, R. N.; Boyd, R. N.; Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
8	Solomons,T.W.G.; Fryhle,C.B.; Snyder,S.A. (2017), **Organic Chemistry**,12th Edition, Wiley.
9	Puri, B.R.; Sharma, L.R.; Pathania M.S. (2020) **Principles of Physical Chemistry**, Vishal Publishing Co.
10	Castellan,G.W.(2004),**Physical Chemistry**,4thEdition,Narosa.
11	McQuarrie,D.A.;Simon,J.D.(2004),**Molecular Thermodynamics**,Viva Books Pvt. Ltd.
12	Atkins, P.; de Paula, J. (2013), **Elements of Physical Chemistry**, 6th Edition, Oxford University Press.
13	Alberty, R. A.; (1987), **Physical Chemistry**, 7th Edition, Wiley Eastern Ltd., Singapore.
14	Dogra, S.K.; Dogra, S. (2015), **Physical Chemistry Through Problems**, 2nd Edition, New Age International Publication.

Course Title:	**Chemistry Practical**	**Course Code: 24BCH5201P**
1	**Inorganic Chemistry** **Volumetric Analysis** (a) Determination of acetic acid in commercial vinegar using NaOH. (b) Determination of alkali content in antacid tablet using HCl. (c) Estimation of Calcium content in chalk as calcium oxalate by permanganometery. (d) Estimation of hardness of water by EDTA. (e) Estimation of ferrous and ferric by by dichromate/permanganate method. (f) Estimation of copper using thiosulphate by iodometric method.	
2	**Organic Chemistry** **Qualitative Analysis** Identification of organic compound through the functional group analysis, determination of melting point,boiling point and specific test.	
3	**Physical Chemistry** **Chemical Kinetics:** **a)** To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature. **b)** To study the effect of acid strength on the hydrolysis of an ester. **c)** To compare the strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of ethyl acetate. **d)**. To study kinetically the reaction rate of decomposition of iodide by H_2O_2.	
4	**Viva voce**	
5	**Practical Record**	

Semester – III

Learning Objectives

- The objective of this course is to provide students with a theoretical understanding of the Transition elements and Rare earth elements from periodic table, Aromatic hydrocarbon and basic knowledge about Electrochemistry. In addition, the laboratory course is designed to provide students with practical experience in basic quantitative analytical techniques including volumetric analysis, qualitative analytical techniques, and the determination of kinetic parameters of reactions.

Learning outcomes

- By the end of this course, students will have a clear theoretical understanding of the the Transition elements and Rare earth elements from periodic table, Aromatic hydrocarbon and basic knowledge about Electrochemistry.
- Students will also have practical experience in quantitative analytical techniques including volumetric analysys, identification of organic compounds by determination of functional groups, determination of order and rate constant of various reactions.

Course Title:	**Chemistry Paper – III**	**Course Code: 24BCH6301T**
Total Lecture hour 45		**Hours**
Unit I	**Chemistry of Elements of First Transition Series:** Characteristics properties of d-block elements, properties of the elements of the first transition series, their binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry. **Chemistry of Elements of Second and Third Transition Series:** General characteristics, comparative treatment with their 3d-analogues in respect to ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry. **Chemistry of Lanthanides:** Electronic structure, oxidation states, ionic radii and lanthanide contraction, complex formation, occurrence and isolation, lanthanide compounds. **Chemistry of Actinides:** General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, similarities between the later actinides and later lanthanides.	**10**
Unit II	**Benzenoid Aromatic Chemistry:** Aromatic electrophilic substitution – general pattern of the mechanism, role of σ- and π- complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction. **Arenes:** Nomenclature of benzene derivatives. Aryl group. Aromatic nucleus and side chain. Structure of benzene: molecular formula and Kekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture. Methods of formation and chemical reactions of alkylbenzenes, Structure, preparation and properties of naphthalene. **Alkyl and Aryl Halides:** Nomenclature and classification of alkyl halides, preparation, physical properties and chemical reactions, mechanism of nucleophilic substitution (SN1, SN2 and SNi)reactions, hydrolysis, nitrite and nitro formation, nitrile and isonitrile formation. Williamson's ethersynthesis, haloformreaction, freons. Preparation of arylhalides,nuclearand side chain reactions, addition-elimination and elimination-addition reactions, mechanism of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides v/s allyl, vinyl, and aryl halides, synthesis and uses of DDT and BHC.	**12**
Unit III	**Alcohols:** Classification and nomenclature. Monohydric alcohols: Nomenclature, method of preparation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen	**12**

	bonding. Acidic nature. Reactions of alcohols. **Dihydric alcohols:** Nomenclature, methods of preparation, chemical reaction of vicinal glycols, oxidative cleavage [Pb(OAc)4 and HIO4] and pinacol-pinacolone rearrangement. **Trihydric alcohols:** Nomenclature and methods of preparation, chemical reactions of glycerol. **Phenols:** Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols: electrophylic aromatic substitution, acylation and carboxylation. Mechanism of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction. **Ethers and Epoxides:** Nomenclature of ethers and methods of preparation, physical properties. Chemical reactions: cleavage and autoxidation. Ziesel's method. Synthesis of epoxides. Acid and base catalyzed ring opening of epoxides, orientation of epoxide ring opening. Reactions of Grignard and organolithium reagents with epoxides.	
Unit IV	**Electrochemistry-I:** Charge transport, conductance in metals and electrolyte solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution and temperature. Migration of ions and Kohlrausch law, Arrhenius theory of electrolytic dissociation, Ostwald dilution law, Debye-Huckel-Onsager equation for strong electrolytes (elementary treatment only). Applications of conductivity measurements- determination of degree of dissociation, acid dissociation constant (Ka), solubility product of sparingly soluble salts, conductometric titrations. **Electrochemistry-II:** Types of reversible electrodes – gas-metal ion, metal-metal ion, metal insoluble salt-anion and redox electrodes, electrode reactions, Nernst equation-derivation of cell E.M.F, single electrode potential, standard hydrogen electrode, reference electrodes, standard electrode potential, electrochemical chemical series and its significance. Electrochemical Cells: Electrolytic and Galvanic cells- reversible and irreversible cells, conventional representation of electrochemical cells.EMF of a cell and its measurements, computation of cell EMF, calculation of thermodynamic quantities of cell reactions (ΔG,ΔH& K), polarization and overpotential. **Corrosion**: types, theories and methods of combating it.	**11**

Reference Books:

1	Lee, J.D.;(2010), **Concise Inorganic Chemistry**, 5th Edition, Wiley India.
2	Huheey, J. E.; Keiter, E. A.; Keiter; R.L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education.
3	Atkins, P. W.; Overton, T. L.; Rourke, J. P.; Weller, M. T.; Armstrong, F. A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.
4	Miessler, G. L.; Fischer P. J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.
5	Housecraft, C. E.; Sharpe, A. G. (2018), **Inorganic Chemistry**, 5thEdition, Pearson.
6	Greenwood, N.N.; Earnsaw,A. (1997),**Chemistry of Elements**, 2nd Edition, Elsevier.
7	Douglas, B. E., McDaniel, D. H.; Alexander, J. J. (2007) **Concepts and Models in Inorganic Chemistry**, 3rd Edition, John Wiley & Sons.
8	Morrison, R. N.; Boyd, R. N.; Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
9	Finar, I.L. (2002), **Organic Chemistry**, Volume 1, 6th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
10	Solomons, T. W.G.; Fryhle, C.B.; Snyder, S.A. (2017), **Organic Chemistry**, 12th Edition, Wiley.
11	Puri, B.R.; Sharma, L.R.; Pathania M.S. (2020) **Principles of Physical Chemistry**, Vishal Publishing Co.

12	Atkins, P.; de Paula, J. (2013), **Elements of Physical Chemistry**, 6th Edition, Oxford University Press.
13	Alberty, R. A.; (1987), **Physical Chemistry**, 7th Edition,Wiley Eastern Ltd., Singapore.
14	Dogra, S.K.; Dogra, S. (2015), **Physical Chemistry Through Problems**, 2nd Edition, New Age International Publication.

Course Title:	**Chemistry Practical**	**Course Code: 24BCH6301P**
1	**Inorganic Chemistry** Gravimetric Analysis (a) Cu as [Cu(SCN)] (b) Ni as Ni-dimethylglyoxime	
2	**Organic Chemistry** (i) Laboratory Techniques Thin Layer Chromatography Determination of Rf, values and identification of organic compounds. (a) Separation of green leaf pigments (spinach leaves may be used). (b) Preparation and separation of 2,4-dinitrophenylhydrazones of acetone, 2-butanone, hexan-2-one and hexan-3- one using toluene and light petroleum (40-60) solvent System. (c) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5 : 1.5). (ii) Qualitative Analysis Identification of two organic compounds (one solid and one liquid) through the functional group analysis, determination of melting point. boiling point and preparation of suitable derivatives.	
3	**Physical Chemistry** (i) Transition Temperature a) Determination of the transition temperature of the given substance by thermometric / dialometric method e.g $MnCl_2.4H2O$ / $SrBr_2.2H2O$) (ii) Thermo chemistry (a) To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process. (b) To determine the enthalpy of neutralization of a weak acid/ weak base versus strong base /strong acid and determine the enthalpy of ionization of the weak acid/ Weak base. (c) To determine the enthalpy of solution of sold calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle	

Semester – IV

Learning Objectives

- The objective of this course is to provide students with a theoretical understanding of the coordination bonding between metal and ligand, carbonyl compounds, carboxylic acid and their derivatives, kinetics of chemical reaction. In addition, the laboratory course is designed to provide students with practical experience in basic quantitative analytical techniques including volumetric analysis, qualitative analytical techniques, and the determination of kinetic parameters of reactions.

Learning outcomes

- By the end of this course, students will have a clear theoretical understanding of the coordination bonding between metal and ligand, carbonyl compounds, carboxylic acid and their derivatives, kinetics of chemical reaction.

- Students will also have practical experience in quantitative analytical techniques including volumetric analysis, identification of organic compounds by determination of functional groups, determination of order and rate constant of various reactions.

Course Title:	**Chemistry Paper – IV**	**Course Code: 24BCH6401T**
Total Lecture hour 45		**Hours**
Unit I	**Coordination Compounds:** Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes. **Metal-Ligand Bonding in Transition Metal Complexes:** Limitations of valence bond theory, an elementary idea of crystal field theory, crystal field stabilization energy (CFSE), crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal field parameters, comparison of CFSE for Oh and Td complexes, Jahn-Teller distortions, applications and limitations of crystal field theory. **Magnetic Properties of Transition Metal Complexes:** Types of magnetic behaviour, methods of determining magnetic susceptibility, spin only formula, L-S coupling, correlation of ns and neff and values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.	10
Unit II	**Acids and Bases:** Arrhenius, Bronsted-Lowry, the Lux-Flood solvent system and Lewis's concept of acids and bases, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents. **Hard and Soft Acids and Bases (HSAB):** Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid-base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness. **Non-aqueous Solvents:** Physical properties of solvents, type of solvents and their general characteristics, reactions in liquid NH_3, liquid SO_2 and liquid HF. **Oxidation and Reduction:** Use of redox potential data-analysis of redox cycle, redox stability in water, Frost, Latimer and Pourbaix diagrams. Principle involved in the extraction of the elements.	12
Unit III	**Aldehydes and Ketones:** Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids. Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro's reaction, Meerwein Pondorf-Verlley, Clemmensen, Wolff-Kishner, LiAlH4 and NaBH4 reductions. Halogenation of enolizable ketones. An introduction to α,β-unsaturated aldehydes and ketones. **Carboxylic Acids:** Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effect of substituents on acid strength. Preparation of carboxylic acids. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reductions of carboxylic acids. Mechanism of decarboxylation. Methods of	12

	formation, chemical reactions of haloacids. Hydroxyacids: malic, tartaric and citric acids. Methods of formation and chemical reactions of unsaturated monocarboxylic acids. **Dicarboxylic acids:** Methods of synthesis and effect of heat and dehydrating agents. **Carboxylic Acid Derivatives:** Structure and nomenclature of acid chlorides, esters, amides and acid anhydrides. Relative stability and reactivity of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution. Preparation of carboxylic acid derivatives and chemical reactions. Mechanism of esterification and hydrolysis (acidic and basic).	
Unit IV	**Chemical Kinetics:** Rate, order, molecularity and stoichiomettry of a reaction, Derivation of Integrated rate law and characteristics of zero, first and second order reactions, Pseudo-first order reaction, Determination of the order of reaction, differential method, method of integration (hit and trial method), half-life method and isolation method. First order opposing reactions, consecutive reactions and parallel reactions of first order. Steady state approximation and Chain reactions: $H_2 + Br_2$ reaction. **Theories of Reaction Rate:**Dependence of reaction rates on temperature, activation energy, simple collision theory and its limitations, transition state theory (equilibrium hypothesis) and derivation of the rate constant, Thermodynamical formulation of rate constant, Comparison of collision theory and transition state theory. **Catalysis:** introduction and type of catalysis, specified and general acid-base catalysis. Surface and enzyme catalysis, Michalis-Menten mechanism. **Solid State:** Definition of spacelattice, unitcell, Braviaslattices, lawsofcrystallography- law of constancy of interfacial angles, law ofrationality of indices, Weiss and Miller indices, law of symmetry, symmetry elements in crystals, classification of crystals, X-ray diffraction by crystals, derivation of Bragg equation, determination of crystal structure of NaCl, KCl and CsCl (Laue's method and powder method).	11

Reference Books:

1	Lee, J.D.;(2010), **Concise Inorganic Chemistry**, 5th Edition, Wiley India.
2	Huheey, J. E.; Keiter, E. A.; Keiter; R.L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education.
3	Atkins, P. W.; Overton, T. L.; Rourke, J. P.; Weller, M. T.; Armstrong, F. A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.
4	Miessler, G. L.; Fischer P. J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.
5	Housecraft, C. E.; Sharpe, A. G. (2018), **Inorganic Chemistry**, 5thEdition, Pearson.
6	Greenwood, N.N.; Earnsaw,A. (1997),**Chemistry of Elements**, 2nd Edition, Elsevier.
7	Douglas, B. E., McDaniel, D. H.; Alexander, J. J. (2007) **Concepts and Models in Inorganic Chemistry**, 3rd Edition, John Wiley & Sons.
8	Morrison, R. N.; Boyd, R. N.; Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
9	Finar, I.L. (2002), **Organic Chemistry**, Volume 1, 6th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
10	Solomons, T. W.G.; Fryhle, C.B.; Snyder, S.A. (2017), **Organic Chemistry**, 12th Edition, Wiley.
11	Puri, B.R.; Sharma, L.R.; Pathania M.S. (2020) **Principles of Physical Chemistry**, Vishal Publishing Co.
12	Atkins, P.; de Paula, J. (2013), **Elements of Physical Chemistry**, 6th Edition, Oxford University Press.
13	Alberty, R. A.; (1987), **Physical Chemistry**, 7th Edition,Wiley Eastern Ltd., Singapore.
14	Dogra, S.K.; Dogra, S. (2015), **Physical Chemistry Through Problems**, New Age International Publication.

Course Title:	Chemistry Practical	Course Code: 24BCH6401P
1	**Inorganic chemistry** Synthesis and Analysis of: (a) Preparation of sodium tri oxalate ferrate (III), $Na_3[Fe(C_2O_4)]$ and determination of its composition by permanganometry. (b) Preparation of Ni-DMG complex, $[Ni(DMG)_2]$ (c) Preparation of Tetra amine copper complex. $[Cu(NH_3)_4]SO_4$. (d) Preparation of cis- and trans- di oxalate di aqua chromate(III) ion.	
2	**ORGANIC CHEMISTRY** **(I) Paper Chromatography**: Ascending and Circular Determination of Rf values and identification of organic compounds. (A) Separation of mixture of phenylalanine and glycine. Ananine and aspartic acid. Leucine and glutamic acid. Spray reagent- ninhydrin. (B) Separation of a mixture of D.L - alanine, glycine and L-Leucine using n-butanol: acetic acid: water (4:1:5). Spray reagent-ninhydrin. (C) Separation of monosaccharides- a mixture of D- galactose and D-Fructose Using n-butanol :acetone :water (4:5:1) Spray reagent-aniline hydrogen phthalate. **(II) Synthesis of Organic Compounds** (a) Acetylation of salicylic acid, aniline, glucose and hydroquinone. Benzoylation of aniline and phenol. (b) Aliphatic electrophilic substitution. Preparation of iodoform from ethanol and acetone. (c) Aromatic electrophilic substitution Nitration: Preparation of m-dinitrobenzene Preparation of p-nitroacetanilide Halogenation: Preparation of p-bromoacetanilide Preparation of 2, 4, 6-tribromophenol	
3	**PHYSICAL CHEMISTRY** **(I) Phase Equilibrium** (a) To study the effect of a solute (e.g. Nacl, succinic acid) on the critical solution tempreture of two partially miscible liquids (e.g. phenol- water system) and to determine the concentration of that solute in the given phenol water system. (b) To construct the phase diagram of two component (e.g. diphenylamine benzophenone) system by cooling curve method. **(II) Distribution law** (a) To study the distribution of iodine between water and ccl_4. (b) To study the distribution of Benzoic acid between benzene and water.	

Dy. Registrar
Pandit Deendayal Upadhyaya
Shekhawati University,
Sikar(Rajasthan)