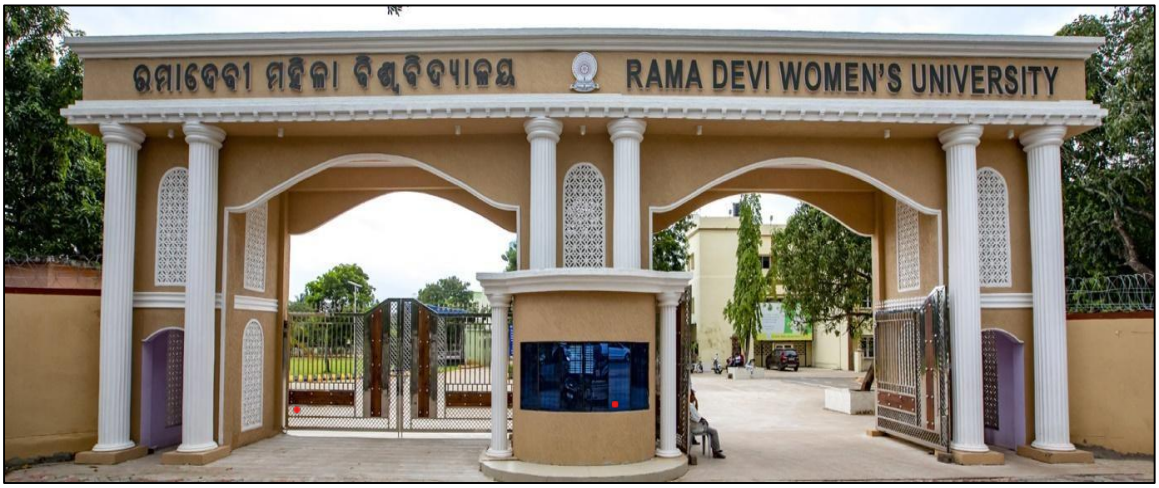
DEPARTMENT OF CHEMISTRY

SYLLABUS OF UG PROGRAMME (B.Sc.)



SKILLS	
EMPLOYABILITY	
ENTERPRENURESHIP	

RAMA DEVI WOMEN'S UNIVERSITY
Vidya Vihar, Bhubaneswar-751022, Odisha
Website: https://rdwu.ac.in

SYLLABUS FOR UNDER GRADUATE COURSE IN

CHEMISTRY

(Bachelor of Science Examination)

RAMA DEVI WOMEN'S UNIVERSITY

VIDYA VIHAR, BHUBANESWAR-23

UNDER CHOICE BASED CREDIT SYSTEM

12.10.23
Controller of Examinations
R.D. Women's University
Bhubaneswar

PROGRAMME: B.Sc. CHEMISTRY (CBCS)

PROGRAMME OUTCOME (PO)

PO-1: Students acquire knowledge about the concept of Organic, Inorganic and Physical Chemistry.

PO-2: Students be able to appreciate the applications of chemistry in day to day life and explore new areas of Chemistry and Allied fields of Science and technology.

PO-3: Identify and describe the underlying principles behind chemical techniques relevant to academic and industry.

PO-4: Knowledge will be gain on the safe handling of chemicals in research fields as well as in chemistry laboratory.

PO-5: The ability to implement chemistry in an integral activity of social, economic and environmental problems.

PO-6: Students develop the skill on different methods of qualitative and quantitative Analysis.

PO-7: Find out the green route for chemical reaction for sustainable development.

PO-8: Develop an efficient written and oral communication skills i.e. the ability to transmit the complex theories in an easier method.

PO-9: An ability to conduct experiments, analyse data and interpret data, while observing responsible and ethical scientific conduct.

PO-10: A familiarity with and application of safety and chemical hygiene regulations and practice.

PROGRAMME SPECIFIC OUTCOME (PSO)

Programme Specific Outcomes Students will be able to have

PSO-1 Clear understanding of the fundamental concepts in Organic, Inorganic and Physical Chemistry.

PSO-2 Ability to perform scientific experiments skillfully by application of procedural knowledge

PSO-3 Idea about research in chemistry and knowledge of the significance of the scientific concepts learnt which finds application in Industry, medicine and modern research.

PSO-4 Capacity of working in research labs and related fields and Skills necessary to be employed in the various sectors like chemicals, pharmaceuticals, food and materials industries and most importantly competency to clear different national level competitive examinations.

Mamata Mohanty

Course structure of UG Chemistry Honours

Semester	Course	Course Name	Credits	Total marks
I	AECC-I	AECC-I	04	100
	C-I	Inorganic Chemistry-I	04	75
	C-I Practical	Inorganic Chemistry-I Lab	02	25
	C-II	Physical Chemistry-I	04	75
	C-II Practical	Physical Chemistry-I Lab	02	25
	GE-I	GE-I	04	75
	GE-I Practical	GE-I Lab	02	25
		Total	**22**	**400**
II	AECC-II	AECC-II	04	100
	C-III	Organic Chemistry-I	04	75
	C-III Practical	Organic Chemistry-I Lab	02	25
	C-IV	PhysicalChemistry-II	04	75
	C-IV Practical	PhysicalChemistry-II	02	25
	GE-II	GE-II	04	75
	GE-II Practical	GE-II Lab	02	25
		Total	**22**	**400**
III	C-V	Inorganic Chemistry-II	04	75
	C-V Practical	Inorganic Chemistry-II Lab	02	25
	C-VI	Organic Chemistry-II	04	75
	C-VI Practical	Organic Chemistry-II Lab	02	25
	C-VII	Physical Chemistry-III	04	75
	C-VII Practical	Physical Chemistry-III Lab	02	25
	GE-III	GE-III	04	75
	GE-III Practical	GE-III Lab	02	25
	SEC-I	SEC-I	04	100

		Total	**28**	**500**
IV	C-VIII	Inorganic Chemistry-III	04	75
	C-VIII Practical	Inorganic Chemistry-III Lab	02	25
	C-IX	Organic Chemistry-III	04	75
	C-IX Practical	Organic Chemistry-III Lab	02	25
	C-X	Physical Chemistry-IV	04	75
	C-X Practical	Physical Chemistry-IV Lab	02	25
	GE-IV	GE-IV (Theory)	04	75
	GE-IV Practical	GE-IV (Practical)	02	25
	SEC-II	SEC-II	04	100
		Total	**28**	**500**
Semester	Course	Course Name	Credits	Total marks
V	C-XI	OrganicChemistry-IV	04	75
	C-XI Practical	OrganicChemistry-IV	02	25
	C-XII	PhysicalChemistry-V	04	75
	C-XII Practical	PhysicalChemistry-V	02	25
	DSE-I	DSE-I	04	75
	DSE-I Practical	DSE-I Lab	02	25
	DSE-II	DSE-II	04	75
	DSE-II Practical	DSE-II Lab	02	25
		Total	**24**	**400**
VI	C-XIII	Inorganic Chemistry- IV	04	75
	C-XIII Practical	Inorganic Chemistry-IV	02	25
	C-XIV	OrganicChemistry-V	04	75
	C-XIV Practical	OrganicChemistry-V	02	25
	DSE-III	DSE-III	04	75
	DSE-III Practical	DSE-III Lab	02	25
	DSE-IV	DSE-IV	04	75
	DSE-IV Practical	DSE-IV Lab	02	25

	OR			
	DSE-IV	Dissertation	06	100*
			24	**400**
		TOTAL	**148**	**2600**

Discipline Specific Elective Papers: (Credit: 06 each)

(4 papers to be selected by students of Chemistry Honours): DSE (1-IV)

1. PolymerChemistry
2. GreenChemistry
3. Industrial Chemicals &Environment
4. Inorganic Materials of IndustrialImportance
5. *Dissertation (can be opted as alternative of DSE-IV only and of 6 credits.
   Dissertation content: 60, Seminar cum Viva:40)
6. Analytical Methods in Chemistry(Alternative)

HONOURSPAPERS:

Core course – 14papers

Discipline Specific Elective – 4 papers (out of the 6 papers suggested)

Generic Elective for non-Chemistry students – 4 papers. In case the University offers 2subjects as GE, then papers 1 and 2 will be the GE paper.
Marks per paper - Midterm: 15 marks, End term: 60 marks, Practical- 25 marks Total – 100 marks Credit per paper – 6
Teaching hours per paper – 40 hours Theory classes + 20 hours Practical classes

SYLLABUS: CHEMISTRY
SEMESTER-I
CORE PAPER I
INORGANIC CHEMISTRY-I

COURSE OUTCOMES:

After reading this paper, students will be able to have

1. Basic idea of the atoms, about the history band recent developments.
2. Idea about the periodic properties of elements and relate the periodicity of elements with their properties.

3. Knowledge about different types of chemical bonds, hybridization and structure of compounds and molecules based on various theories.
4. Can distinguish metallic bonding from other types of bonds.
5. Skills on performing acid -base titrations of mixtures and oxidation-reduction titration in mixture systematically and also learnt safety handling of chemicals.

Unit-I

Atomic structure

Bohr's theory, its limitations and atomic spectrum of hydrogen atom, Sommerfeld's modification. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle (time independent) and its significance, Derivation of Schrödinger's wave equation (for hydrogen atom) in Cartesian coordinate, significance of ψ and ψ^2. Normalized and orthogonal wave functions. Sign of wave functions; Setting of Schrödinger's equation in polar coordinates (derivation not required), radial and angular wave functions for hydrogen atom. Radial and angular distribution curves; Shapes of s, p, d and f orbitals; Quantum numbers and their significance. Pauli's Exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations**.**

Unit-II

Periodicity of elements

Periodicity of Elements: s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s & p-blocks. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral) (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (f) Electron gain enthalpy, trends of electron gain enthalpy. (g) Electronegativity, Pauling's/ Mulliken's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization. Sanderson's electron density ratio.

Unit-III

Chemical bonding-I

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation. Madelung constant, Born-Haber cycle and its application, Solvation energy. (ii) Covalent bond: Valence Bond theory (Heitler-London approach). Hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements, equivalent and non-equivalent hybrid orbitals, Resonance and resonanceenergy.

Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions (CO^+, NO^+, NO^-).

Unit-IV

Chemical bonding-II

VSEPR theory, shapes of simple molecules and ions containing lone and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.
Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators. (ii) *Weak Chemical Forces:* van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process**.**
Oxidation-reduction: Redox equations, standard electrode potential and its applications to inorganic reactions. Principles involved in some volumetric analyses (iron and copper).
Recommended Text Books:

1. Lee J. D., Concise Inorganic Chemistry Wiley India, 5th Edn.,2008.

2. Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry – Principles of structure and reactivity, , Pearson Education, 4th Ed.2002.
3. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed.,2017

4. Selected Topic in Inorganic Chemistry, S. Chand, New Delhi, 17th Ed.,2010.

Referencebooks

1. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. I, CBS Publications, 2nd Ed. 2010.
2. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed.2017.

CORE PAPER I LAB

Students are required to learn the followings:

i. Calibration and use ofapparatus

ii. Preparation of solutions of different Molarity/Normality oftitrants.

List of experiments

A. Acid-BaseTitrations

i. Estimation of carbonate and hydroxide present together inmixture.

ii. Estimation of carbonate and bicarbonate present together in amixture.

iii. Estimation of free alkali present in differentsoaps/detergents

B. Oxidation-Reduction Titrimetry

i. Standardization of $KMnO_4$ with standard sodium oxalate and estimation of Fe (II) using standardized $KMnO_4$solution.
ii. Estimation of percentage of oxalic acid and sodium oxalate in a givenmixture.
iii. Estimation of Fe(II) and Fe(III) in a mixture by standard $K_2Cr_2O_7$solution.

Reference text:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson,2009.

2. Gulati Shikha , Sharma Gulati JL and ManochaShagun, Practical Inorganic Chemistry, 1st Edn., CBS Publishers & Distributors Pvt Ltd.,(2017).

MAPPING OF COURSE OUTCOMES WITH THE PROGRAMME OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	5	2	4	2	2	5	4	4
CO2	5	5	5	2	4	2	4	5	4	4
CO3	5	4	4	4	5	4	2	4	4	5
CO4	4	2	2	4	5	2	4	4	5	4
CO5	5	5	5	5	4	5	4	4	5	5

CORE PAPER II

PHYSICAL CHEMISTRY-I

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Describe the behaviour of gases and application of different laws on real gases.
2. Explain the liquid state of the matter and idea about the pH scale.
3. Explain the solid state of matter and the related properties.
4. Describe the buffer, solubility products etc.

Determine the physical constants of different solutions with precision and apply analytical techniques in qualitative and quantitative analysis

Unit-I

Gaseous state-I

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.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. van der Waal's equation of state, its derivation and application in explaining real gas behaviour. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Unit-II

Liquid state

Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water.

Ionic equilibria- I

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; dissociation constants of mono- and diproticacids.

Unit- III: 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, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analyses of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals (stoichiometric and non- stoichiometric). Glasses and liquid crystals.

Unit-IV

Ionic equilibria - II

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and theirlimitations.

Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

Recommended Text Books:

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Puri, Sharma &Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 47th Edn.,2017.
3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn.2017
4. Castellan G. W. Physical Chemistry 4thEdn. Narosa(2004).

Reference Books:

1. Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, PradeepPublications
2. Mortimer R. G., Physical Chemistry, Elsevier (Academic Press), 3rd Ed(2008).
3. Ball D. W. Physical Chemistry Thomson Press, India(2007).
4. Engel T. & Reid P., Physical Chemistry, 3rd Ed. Pearson(2013)

CORE PAPER II LAB

Surface tension measurements.

a. Determine the surface tension by (i) drop number (ii) drop weightmethod.

b. Study the variation of surface tension of detergent solutions withconcentration.

Viscosity measurement using Ostwald's viscometer.

a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at roomtemperature.

b. Study the variation of viscosity of sucrose solution with the concentration ofsolute.

pH-metry

a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and theirmixtures.

b. PreparationofbuffersolutionsofdifferentpH(i)Sodiumacetate-aceticacid(ii)Ammonium chloride-ammonium hydroxide.

c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strongbase.

d. Determination of dissociation constant of a weakacid.

Ionic equilibria

a. Determination of solubility product of PbI_2 by titrimetric method.

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co., New Delhi(2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry, 8th Ed.; McGraw-Hill, New York(2003).
3. Viswanathan, B., Raghavan, P.S. Practical Physical Chemistry, Viva Books(2009).
4. Halpern, A. M. &McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co., New York(2003).

MAPPING OF COURSE OUTCOMES WITH THE PROGRAMME OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	2	5	5	5	4	2	2	4	4
CO2	5	2	5	2	4	2	2	2	4	4
CO3	5	2	5	2	4	2	2	2	4	4
CO4	5	4	5	4	4	4	2	2	4	4
CO5	5	5	5	5	4	5	5	5	5	4

SEMESTER-II

CORE PAPER – III

ORGANIC CHEMISTRY I

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COURSE OUTCOMES:

After reading this paper, students will be able to

1. Describe the electronic forces present in the organic molecules and the different types of organic reactions, explain the stereochemistry of organic molecule, recognize the mechanism involved in various reactions also explain the optical activity and geometrical isomerism.
2. Discuss the preparation and interpret the physical and chemical properties of alkanes, alkenes and alkynes.
3. Distinguish different types of organic reactions and reactivity of different intermediates.
4. Apply the principles of organic qualitative analysis to identify organic compounds of CHO system and determine the melting point of pure samples.
5. Perform chromatographic separation of organic molecules by using TLC, Paper chromatographic technique.

Unit –I:

Basics of organic chemistry

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. Curly arrow rules; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and relative stability of carbocations, carbanions, free radicals and carbenes.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Carbon-carbon sigma bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

Unit – II:

Stereochemistry

Fischer Projection, Newmann and Sawhorse Projection formulae; 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 one and two chiral-centres, Distereoisomers, meso-structures, Racemic mixture and resolution, inversion. Relative and absolute configuration: D/L and R/S designations.

Unit – III:

Chemistry of aliphatic hydrocarbonsCarbon-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; Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformational analysis of alkanes (ethane and n-butane): Relative stability with energy diagrams. Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms.

Unit – IV:

Aromatic hydrocarbons

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups

Recommended Text Books:

1. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (PearsonEducation).

2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher,2012.

3. Kalsi, P. S., Stereochemistry Conformation and Mechanism; 8thEdn, New Age International,2015.

4.

Reference Books:

1. Graham Solomons T. W., Fryhle, Craig B., Snyder Scott A, Organic Chemistry, Wiley Student Ed, 11th Edition (2013)
2. Jonathan Clayden, Nick Greeves, Stuart Warren, Organic Chemistry, 2nd Edition, Oxford Publisher,2014.
3. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), PradeepPublications.CORE PAPER III LAB

Students are required to learn the followings:

1. Checking the calibration of thethermometer
2. Determination of melting point, effect of impurities on the melting point – mixed melting point of two unknown organiccompounds
3. Determination of boiling point of liquid compounds [boiling point lower than and more than 100°C (up to 160°C) by distillation and capillary method, respectively](**e**.g., ethanol, cyclohexane, ethyl methyl ketone, cyclohexanone, acetylacetone, anisole, crotonaldehyde, mesityl oxideetc.).

List of experiments

1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid groups and identification of unknown organic compounds of CHO system (without elementdetection).
2. Separation and purification of any one component of following binary solid mixture based on the solubility in common laboratory reagents like water (cold, hot), dil. HCl, dil.NaOH, dil. $NaHCO_3$, etc. and determination of meltingpoint.

Benzoic acid/p-Toluidine; p-Nitrobenzoic acid/p-Aminobenzoic acid; p-Nitrotolune/p-Anisidine etc.

A. Chromatography

1. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography

2. Separation of a mixture of two sugars by ascending paperchromatography

OR

3. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography(TLC)

Reference Books

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education(2009).

2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson(2012)

MAPPING OF COURSE OUTCOMES WITH THE PROGRAMME OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	2	5	5	5	4	2	2	4	5
CO2	5	2	5	5	5	4	2	2	2	5
CO3	5	2	5	5	5	4	2	2	2	5
CO4	5	5	4	4	5	2	5	5	5	5
CO5	5	5	4	4	5	2	4	5	5	5

SEMESTER-II

CORE PAPER IV

PHYSICAL CHEMISTRY II

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Define the terms and laws of thermodynamic; calculate various energy changes and heat capacities of different systems also predict the conditions of thermodynamic equilibrium and spontaneity of reactions.
2. Recognize the thermodynamic conditions for one and two component systems.
3. Describe about the quantitative treatment of principle of chemical equilibrium.
4. Explain about the colligative properties of different solutions.
5. Determine the heat capacity of calorimeter, calculate the integral enthalpies of various salts and enthalpy of hydration of salts and determine the enthalpy of neutralization of acid base mixture.

Unit-I:

Chemical thermodynamics

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabaticconditions.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.

Unit-II

Carnot cycle, efficiency of heat engine, Carnot theorem

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversibleprocesses.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters, inversion temperature, Gibbs-Helmholtz equation, Maxwell relations, thermodynamic equation of state.

Unit-III

Systems of variable composition

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Chemical equilibrium

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 (vant Hoff's reaction). Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p, K_c and K_x. Le Chatelier principle (quantitative treatment) and itsapplications.

Unit-IV

Solutions and Colligative Properties

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties: (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Recommended Text Books:

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6^{th} Ed., (2006).

2. Principles of Physical Chemistry, Puri, Sharma &Pathania, Vishal Publishing Co, 47^{th} Edn.,2017.

3. Text Book of Physical Chemistry, K. L. Kapoor, Mac Grow Hill, 3^{rd}Edn.2017.

4. Castellan G. W. Physical Chemistry 4th Ed. Narosa(2004).

Reference Books:

1. Engel T. & Reid P., Physical Chemistry 3rd Ed. Pearson(2013).
2. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi(2004).
3. Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, PradeepPublications.

CORE PAPER IV LAB

THERMOCHEMISTRY

1. Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy ofneutralization).
2. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodiumhydroxide.
3. Calculation of the enthalpy of ionization of ethanoicacid.
4. Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution ofsalts.
5. Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the firststep.
6. Determination of enthalpy of hydration of coppersulphate.
7. Determination of heat of solution (ΔH) of oxalic acid/benzoic acid from solubility measurement.

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi(2011).
2. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry, New Age International: New Delhi(2001).
3. Viswanathan, B., Raghavan, P.S. Practical Physical Chemistry, Viva Books(2009).

MAPPING OF COURSE OUTCOMES WITH THE PROGRAMME OUTCOMES:

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CO1	5	2	5	5	4	4	2	2	2	5
CO2	5	2	5	5	4	4	2	2	2	5
CO3	5	2	5	5	4	2	2	2	2	5
CO4	5	2	5	5	4	4	2	2	4	5
CO5	5	5	5	5	5	4	5	4	4	5

SEMESTER-III

CORE PAPER V

INORGANIC CHEMISTRY-II

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Classify different metallurgical operations, describer the HSAB principle.
2. Compare the structure and bonding in boranes, carboranes, metal clusters, polyhalides, pseudohalogens etc.
3. Describe the inert pair effect, different hydrides, and anomalous behaviour of s and p block elements.
4. Compare the compounds formed by noble gases and different types of inorganic polymers like silicones, silicates etc.
5. Prepare different inorganic compounds, estimate the amount of chlorine in bleaching powder, standardize amount of copper present in the given solution.

UNIT-I

General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

Acids and Bases

Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSABprinciple.

UNIT-II

Chemistry of *s* and *p* Block Elements - I

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.
Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

UNIT-III

Chemistry of *s* and *p* Block Elements - II

Study of the following compounds with emphasis on structure, bonding, preparation, properties anduses.
Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes. Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

UNIT-IV

Noble Gases

Occurrence and uses, rationalization of inertness of noble gases, clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).

Inorganic Polymers:

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

Recommended Text Books:

1. Lee J. D., Concise Inorganic Chemistry Wiley India, 5thEdn.,2008.
2. Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry – Principles of structure and reactivity, , Pearson Education, 4th Ed.2002.
3. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed.,2017.
4. ShriverD.E.,AtkinsP.W., InorganicChemistry, OxfordUniversityPres,5thEdn.(2010).

Reference books

1. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. I, CBS Publications, 2nd Ed. 2010.
2. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed.2017.

CORE PAPER V LAB

Iodometric / Iodimetric titrations

i. Standardization of sodium thiosulphate solution by standard of $K_2Cr_2O_7$solution.
ii. Estimation of Cu(II) using standard sodium thiosulphate solution(Iodometrically).

iii. Estimation of available chlorine in bleaching powderiodometrically.

Inorganic preparations

i. Cuprous oxide(Cu_2O)
ii. Cuprous chloride,Cu_2Cl_2
iii. Manganese(III) phosphate, $MnPO_4.H_2O$
iv. Aluminium potassium sulphate $K_2SO_4.Al_2(SO_4)_3.24H_2O$ (Potashalum).
v. Lead chromate($PbCrO_4$)

Reference Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis, 6th Ed., Pearson,2009.
2. Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).
3. Gulati Shikha , Sharma Gulati JL and ManochaShagun, Practical Inorganic Chemistry, 1stEdn., CBS Publishers & Distributors Pvt. Ltd.,(2017).

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CO3	5	2	5	5	5	4	4	2	4	5
CO4	5	2	5	5	4	4	5	2	4	5
CO5	5	5	5	5	4	2	5	5	5	5

SEMESTER-III

CORE PAPER VI

ORGANIC CHEMISTRY-II

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Describe the preparation and properties of halogenated hydrocarbons.
2. Explain various methods of preparation of alcohols, aldehydes, ketones and carboxylic acids and explain and predict the stereo chemical outcome of organic reactions by considering the reaction mechanism.
3. Propose mechanism of named reactions and rearrangement reactions and choose the right organic reagents for various functional group interconversions.

4. Perform acetylation, benzoylation, bromination and nitration reactions by conventional method.
5. Prepare the derivatives by green methods &Purify the derivatives by recrystallization

UNIT-I

Chemistry of Halogenated Hydrocarbons

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts, nucleophilic aromaticsubstitution; SNAr, Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitutionreactions.

Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

UNIT-II

Alcohols, Phenols, Ethers and Epoxides

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-BlancReduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitutionreactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements withmechanism;

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides withalcohols, ammonia derivatives and $LiAlH_4$

UNIT-III

Carbonyl Compounds

Structure, reactivity and preparation:

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Perkin, Cannizzaro and Wittig reaction, Beckmann rearrangements,α haloform reaction and Baeyer Villiger oxidation, - substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV.; Addition reactions of unsaturated carbonyl compounds: Michaeladdition.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

UNIT-IV

Carboxylic Acids and their Derivatives

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic, lactic, malic, tartaric, citric, maleic and fumaric acids;

Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

Sulphur containing compounds: Preparation and reactions of thiols and thioethers**.**

Recommended Text Books:

1. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (PearsonEducation).
2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher,2012.
3. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson,2009.

Reference Books:

1. Graham Solomons T. W., Fryhle, Craig B., Snyder Scott A, Organic Chemistry, Wiley Student Ed, 11th Edition(2013)
2. Jonathan Clayden, Nick Greeves, Stuart Warren, Organic Chemistry, 2nd Edition, Oxford Publisher,2014.
3. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), PradeepPublications

CORE PAPER VI LAB

Organic preparations:

i. Acetylationofoneofthefollowingcompounds:amines(aniline,*o*-,*m*-,*p*-toluidinesand o- , *m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any onemethod:

a. Using conventionalmethod.
b. Using greenapproach

ii. Benzolyation of one of the following amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine) and one of the following phenols (β-naphthol, resorcinol, p-cresol) by Schotten-Baumannreaction.

iii. Bromination of any one of thefollowing:

a. Acetanilide by conventionalmethods
b. Acetanilide using green approach (Bromate-bromidemethod)

iv. Nitration of any one of thefollowing:

a. Acetanilide/nitrobenzene by conventionalmethod

b. Salicylic acid by green approach (using ceric ammoniumnitrate).

The above derivatives should be prepared using 0.5-1g of the organic compound. Calculate percentage yield, based upon isolated yield (crude) and theoretical yield.

Purification of the crude product by recrystallisation from water/alcohol, or sublimation, whichever is applicable and determination of melting point.

Reference Books

1. Vogel, A. I. Elementary Practical Organic Chemistry, Part 1: Small scale Preparations, Pearson(2011).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education(2009.
3. Furniss,B.S.;Hannaford,A.J.; Smith, P.W.G.;Tatchell,A.R.*Practical OrganicChemistry, 5th Ed.,* Pearson (2012).
4. Ahluwalia,V.K. &Aggarwal, R.*ComprehensivePractical OrganicChemistry:Preparation and Quantitative Analysis,* University Press(2000).
5. Ahluwalia,V.K. &Dhingra,S. *ComprehensivePracticalOrganic Chemistry:QualitativeAnalysis,* University Press(2000).

MAPPING OF COURSE OUTCOMES WITH THE PROGRAMME OUTCOMES:

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CO4	5	5	4	5	5	4	5	5	5	5
CO5	5	5	4	5	5	4	5	5	5	5

SEMESTER-III

CORE PAPER VII

PHYSICAL CHEMISTRY-III

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Explain the phase equilibrium, phase diagrams.
2. Describe binary solution and can derive different laws.
3. Derive the rates of equations from mechanistic data.

4. Comprehend the applications of catalyst and its action and analyse the surface phenomena.
5. Skill to analyse and arrive at the adsorption isotherms, determine the distribution coefficients between two solvent systems, calculate the kinetics of different reactions.

UNIT-I

Phase Equilibria-I

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 for one component systems, with applications (H_2O and sulphursystem).

Phase diagrams for systems of solid-liquid equilibria involving eutectic (Pb-Ag system, desilverisation of lead), congruent (ferric chloride-water) and incongruent (sodium sulphate-water) melting points, completely miscible solid solutions (intermediate, medium, maximum freezing points).

UNIT-II

Phase Equilibria-II

Three component systems, water-chloroform-acetic acid system, triangular plots.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications tofractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, partial miscibility of liquids, CST, miscible pairs, steam distillation.

Nernst distribution law: its derivation and applications.

UNIT-III

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 orders.

Kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing

reactions (ii) parallel reactions (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, qualitative treatment of the theory of absolute reaction rates.

UNIT-IV

Catalysis

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis- Menten mechanism, acid-base catalysis.

Surface chemistry:

Physical adsorption, chemisorption, adsorption isotherms (Langmuir, Freundlich and Gibb's isotherms), nature of adsorbed state.

Recommended Text Books:

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Puri, Sharma &Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 47th Edn.,2017.
3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn.2017.
4. Castellan G. W. Physical Chemistry 4thEdn. Narosa(2004).

Reference Books:

1. Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, PradeepPublications
2. Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill(2011).
3. Ball D. W. Physical Chemistry Thomson Press, India(2007).
4. Engel T. & Reid P., Physical Chemistry 3rd Ed. Pearson(2013)

CORE PAPER VII LAB

1. Determination of distribution coefficientsof:
   a) Iodine between water and carbontetrachloride.
   b) Acetic/ benzoic acid between water andcyclohexane.
2. Study the equilibrium of at least one of the following reactions by thedistributionmethod:
   - $I_2(aq) + I^- \rightarrow I_3^-(aq)$
   - $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$
3. Study the kinetics of the followingreactions.
   (i) Integrated rate method:
   a) Acid hydrolysis of methyl acetate with hydrochloricacid.
   b) Saponification of ethylacetate.
   (ii) Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methylacetate.
4. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi(2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry8th Ed.*; McGraw-Hill: New York (2003).
3. Halpern, A. M. &McBane, G. C. *Experimental Physical Chemistry 3rdEd.;* W.H. Freeman & Co.: New York(2003).

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CO5	5	5	4	4	4	5	5	4	4	5

- Note related: 1
- From What Related: 2
- Nutral: 3
- Moderately Related: 4
- Highly Related: 5

SEMESTER-IV

CORE PAPER VIII

INORGANIC CHEMISTRY-III

Course Objectives

1. To study fundamentals of transition chemistry.

2. To study about the physicochemical properties of d-block and f-block elements.

3. To study the basic principles of bioinorganic chemistry.

COURSE OUTCOME MISSING

UNIT-I

Coordination Chemistry

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding.

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds.

Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, Labile and inertcomplexes.

Crystal field theory, measurement of CFSE weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq in octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry, Jahn-Teller theorem, square planar geometry. Qualitative aspect of ligand field and MO Theory.

UNIT-II

Transition Elements-I

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer &Bsworth diagrams). Difference between the first, second and third transition series.

UNIT-III

Transition Elements-II

Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy).

Lanthanoids and Actinoids

Electronic configuration, oxidation states, colour, spectral and magnetic properties,lanthanide contraction, separation of lanthanides (ion-exchange method only).

General features of actinoids, separation of Np, Pm, Am from U.

UNIT-IV

Bio-inorganic Chemistry

Metal ions present in biological systems, classification of elements according to their action in biological system. Na/K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine.

Iron and its application in bio-systems, Haemoglobin and myoglobin.

Recommended Text Books:

1. Lee J. D., Concise Inorganic Chemistry, Wiley India, 5th Edn.,2008.
2. Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry – Principles of structure and reactivity, , Pearson Education, 4th Ed.2002.
3. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed.,2017.
4. ShriverD. E.,Atkins P. W., InorganicChemistry, Oxford UniversityPres ,5thEdn..

Reference books

1. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. II, CBS Publications, 2nd Ed. 2010.
2. Bioinorganic Chemistry, Asim Kumar Das, Books & Allied (P) Ltd. 1st ed.2015.
3. Selected Topic in Inorganic Chemistry, Mallick, Madan and Tuli, S. Chand Publisher. 17th Ed. 2010.
4. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed.2017.

CORE PAPER VIII LAB

Inorganic preparations

Preparation of complexes:

i. Hexamine nickel(II),$[Ni(NH_3)_6]Cl_2$
ii. Potassium trioxalatoferrate(III) trihydrate
iii. Tetraamminecopper(II) sulphate,$[Cu(NH_3)_4]SO_4.H_2O$
iv. Tetraamminecarbonatocobalt(III)nitrate

Complexometric titration

i. Estimation of Ca byEDTA
ii. Estimation of Mg byEDTA

Gravimetric Analysis:

i. Estimation of nickel(II) using dimethylglyoxime(DMG).
ii. Estimation of copper asCuSCN
iii. Estimation of iron as Fe_2O_3 by precipitating iron as$Fe(OH)_3$.
iv. Estimation of Al(III) by precipitating with oxine and weighing as $Al(oxine)_3$(aluminiumoxinate).

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i. Ni(II) and Co(II)

ii. Fe(III) and Al(III)

Reference Books:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS(1978).
2. Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).
3. Gulati Shikha , Sharma Gulati JL and ManochaShagun, Practical Inorganic Chemistry, 1stEdn., CBS Publishers & Distributors Pvt Ltd.,(2017).

SEMESTER-IV

CORE PAPER IX

ORGANIC CHEMISTRY-III

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Explain different nitrogen containing compounds and their importance.
2. Elucidate the structure and chemistry of natural products (terpenes and alkaloids).
3. Explain the chemistry of heterocyclic chemistry and write the mechanisms involved in the reactions of nitrogen containing compounds.
4. Apply the principles of organic qualitative analysis to identify organic molecules containing extra elements (N, S, X).
5. Able to identify different nitrogen containing compounds and prepare derivatives of the compounds for conformation.

UNIT-I

Nitrogen Containing Functional Groups

Preparation and important reactions of nitro and compounds, nitriles.

Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid.

UNIT-II

Diazonium Salts

Preparation and their synthetic applications.

Polynuclear Hydrocarbons

Reactions of naphthalene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene. Polynuclear hydrocarbons.

UNIT-III

Heterocyclic Compounds

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine. Fischer indole synthesis and Madelung synthesis,Derivatives of furan: Furfural and furoic acid (preparation only).

UNIT-IV

Alkaloids

Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and

synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

Terpenes

Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral, Neral and α-terpineol.

Recommended Text Books:

Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (PearsonEducation).
Advanced Organic Chemistry, 2nd Edition, Arun Bahl & B S Bahl, S. Chand Publisher, 2012.

Reference Books:

1. Graham Solomons T. W., Fryhle, Craig B., Snyder Scott A, Organic Chemistry, Wiley Student Ed, 11th Edition(2013)
2. Jonathan Clayden, Nick Greeves, Stuart Warren, Organic Chemistry, 2nd Edition, Oxford Publisher,2014.
3. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), PradeepPublications.

CORE PAPER IX LAB

Qualitative organic analysis of organic compounds

1. Detection of extra elements (N, X, S) in organic compounds by Lassaigne'stest.
2. Qualitative analysis of unknown organic compounds containing simple functional groups under CHN system (amine, nitro, amide and imide), determination of melting/boiling point, and preparation of theirderivative.

Reference Books

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education(2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical OrganicChemistry, 5th Ed., Pearson (2012)
3. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry:Qualitative Analysis, University Press(2000).
4. Ghoshal, A., Mahapatra, B., Nad, A. K. An Advanced Course in Practical Chemistry, New Central Book Agency(2007).

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CO5	5	5	4	4	5	2	4	5	5	5

SEMESTER-IV

CORE PAPER X

PHYSICAL CHEMISTRY-IV

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Define theories of conductivity, laws of weak and strong electrolytes and its role in titrimetric analysis.
2. Explain different types of electrochemical cells.
3. Theories behind potentiometric and conductometric titrations and its application.
4. Explain electrical properties of microscopic particles.
5. Handle electrochemical instruments such as conductometer and potentiometer to carry out qualitative estimations and develop skill to handle instruments.

UNIT-I

Conductance-I

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, Wien effect, Debye-Falkenhagen effect, Walden's rules.

UNIT-II

Conductance-II

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

UNIT-III

Electrochemistry-I

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy andindustry.

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. Application of EMF measurements in determining free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glasselectrodes.

UNIT-IV

Electrochemistry-II

Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

Electrical properties of atoms and molecules

Basic ideas of electrostatics, Electrostatics of dielectric media. Clausius-Mosotti equation and Lorenz-Laurentz equation (no derivation), Dipole moment and molecular polarizabilities and their measurements.

Recommended Text Books:

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Puri, Sharma &Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 47th Edn.,2017.
3. Kapoor, K. L., Text Book of Physical Chemistry, Mac Grow Hill, 3rdEdn.,2017
4. Castellan G. W. Physical Chemistry 4th Ed. Narosa(2004).

Reference Books:

1. Engel T. & Reid P., Physical Chemistry 3rd Ed. Pearson(2013).
2. Levine, I. N. Physical Chemistry 6thEd., Tata McGraw-Hill(2011).
3. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi(2004).
4. Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, PradeepPublication.

CORE PAPER X LAB

Conductometry

I. Determination of cellconstant.

II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weakacid.

III. Perform the following conductometrictitrations:

i. Strong acid vs. strongbase
ii. Weak acid vs. strongbase

iii. Strong acid vs. weakbase

Potentiometry

I. Perform the following potentiometrictitrations:

i. Strong acid vs. strongbase
ii. Weak acid vs. strongbase
iii. Dibasic acid vs. strongbase

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand &Co.,New Delhi(2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P., Experiments in Physical Chemistry8th Ed.; McGraw-Hill: New York(2003).
3. Halpern, A. M. &McBane, G. C., Experimental Physical Chemistry 3rdEd.; W.H. Freeman & Co., New York(2003).
4. Viswanathan, B., Raghavan, P.S., Practical Physical Chemistry, Viva Books(2009).

MAPPING OF COURSE OUTCOMES WITH THE PROGRAMME OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	4	5	5	4	5	2	2	4	5
CO2	5	4	4	5	4	5	2	2	4	5
CO3	5	4	5	5	4	5	2	2	4	5
CO4	5	4	5	5	4	5	2	2	4	5
CO5	4	5	2	4	5	2	4	5	5	5

- Note related: 1
- From What Related: 2
- Nutral: 3
- Moderately Related: 4
- Highly Related: 5

SEMESTER-V

CORE PAPER XI

ORGANIC CHEMISTRY-IV

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Explain different spectroscopic methods for identification of organic molecules.
2. Illustrate the principle of UV-Vis, IR, NMR spectroscopy and Mass spectrometry.
3. Interpretation of spectral data of simple molecules and solving the problems related to it.
4. Comprehend the preparation, properties, structure and importance of carbohydrates (mono, di and polysaccharides).
5. Perform qualitative analysis of different carbohydrates, unknown organic compounds containing bi-functional groups, estimate the amounts of sugars present in the given sample qualitatively and also identify the labelled peaks of unknown organic compounds by NMR and IR data.

UNIT-I

Organic Spectroscopy-I

UV Spectroscopy: Types of electronic transitions, λ_{max}, Lambert-Beer's law and its limitations, Chromophores and Auxochromes,Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward rules for calculation of λ_{max} for the following systems: α,β the 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.

UNIT-II

Organic Spectroscopy-II

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorptionpositions of O and N containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in simple functional group analysis.

UNIT-III

Organic Spectroscopy-III

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift andfactors influencing it; Spin-spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics; Interpretation of NMR spectra of simple

compounds.
Mass Spectroscopy- Basic principle, Fragmentation pattern, instrumentation, determination of m/e ratio. Application of mass spectroscopy on CH_4, C_2H_6, *n*-butane and *neo*-pentane. Applications of IR, UV & NMR for identification of simple organic molecules.

UNIT-IV

Carbohydrates

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 projectionsand conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruffdegradation;
Disaccharides – Structure elucidation of maltose; Polysaccharides – Elementary treatment of starch, cellulose.

Recommended Text Books:

1. Kemp William, Organic Spectroscopy, 3rd Edition, Palgrave Publisher,1991.
2. Davis, B. G., Fairbanks, A. J., Carbohydrate Chemistry, Oxford ChemistryPrimer, OxfordUniversityPress.
3. J Kalsi P. S., Spectroscopy of Organic Compounds, 5th Edition, , New Age International Publishers,2016.
4. Advanced Organic Chemistry, 2nd Edition, Arun Bahl & B S Bahl, S. Chand Publisher, 2012.

Reference Books:

1. Y R Sharma, Elementary Organic Spectroscopy, 5th Edition, S. Chand & Company,2013.
2. Jag Mohan, Organic Spectroscopy and Applications, NarosaPublishrs,2012.
3. Graham Solomons T. W., Fryhle, Craig B., Snyder Scott A, Organic Chemistry, Wiley Student Ed, 11th Edition(2013).
4. Jonathan Clayden, Nick Greeves, Stuart Warren, Organic Chemistry, 2nd Edition, Oxford Publisher,2014.
5. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), PradeepPublications

CORE PAPER XI LAB

1. Qualitative analysis of carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.
2. Qualitative analysis of unknown organic compounds containing simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenolsetc.
3. Quantitative estimation ofsugars:
   A) Estimation glucose by titration with Fehling'ssolution.
   B) Estimation of sucrose by titration with Fehling'ssolution.
   C) Estimation glucose and sucrose in a givenmixture.

4. Identification of labelled peaks in the ^1H NMR spectra of the known organic compounds explaining the relative δ-values and splittingpattern.

5. Identification of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H,C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations areincluded).

Reference Books:

1. Vogel, A.I. *Quantitative Organic Analysis,* Part 3, Pearson(2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education(2009)
3. Furniss,B.S.;Hannaford, A.J.;Smith, P.W.G.;Tatchell,A.R.*Practical OrganicChemistry, 5th Ed.,* Pearson (2012)
4. Ahluwalia,V.K.&Aggarwal,R.*Comprehensive PracticalOrganicChemistry:Preparation and Quantitative Analysis,* University Press(2000).
5. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry:Qualitative Analysis,* University Press(2000).

MAPPING OF COURSE OUTCOMES WITH THE PROGRAMME OUTCOMES:

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CO3	5	4	5	5	5	5	2	2	4	5
CO4	5	4	5	5	5	5	2	2	4	5
CO5	5	5	5	5	5	5	2	2	4	5

SEMESTER-V
CORE PAPER XII
PHYSICAL CHEMISTRYV

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Describe the quantum mechanics and identify the application of quantum chemistry in Molecular Orbital and Valence Bond theories and construct hybridization schemes.
2. Describe the basic principles of molecular spectroscopy, Skill to elucidate the structure and chemical composition of the sample from the different molecular spectra.
3. Explain the chemical bonding in different covalent molecules qualitatively.
4. Describe the principles of absorption spectra in visible range, Raman spectra.
5. Verification of laws of absorption for qualitative estimation of inorganic sample, perform spectrophotometric titrations. Compare the laws of absorption by using colorimetric method and spectrophotometric method and estimate different metal cations by colorimetric method.

UNIT-I

Quantum Chemistry-I

Quantum mechanical operators, Postulates of quantum mechanics, Schrödinger equation and its application to particle in one-dimensional box (complete solution) - quantization of energy levels, zero-point energy, normalization of wave functions, probability distribution functions, nodal properties. Extension to three-dimensional boxes, separation of variables,degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.

Rigid rotator model of rotation of diatomic molecule: Schrödinger equation, transformation to spherical polar coordinates. Separation of variables (Preliminary treatment).

UNIT-II

Chemical Bonding

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO- MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wave functions, detailed solution not required) and their limitations. Localized and non-localized molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

UNIT-III

Molecular Spectroscopy-I

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopicsubstitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

UNIT-IV

Molecular Spectroscopy-II

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation.

Photochemistry

Characteristics of electromagnetic radiation, 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, chemiluminescence.

Recommended Text Books:

1. McQuarie D., Quantum Chemistry, University Science Publishers,2007.
2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill(2001).
3. Banwell, C. N. &McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi(2010).
4. Prasad R K., Quantum Chemistry, New Age International Publishers, 4thEdn,2010.
5. Rohatagi Mukherjee K K., Fundamentals of Photochemistry, Wiley Eastern Ltd.,1992.

Reference Books:

1. Puri, Sharma &Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 47th Edn.,2017.
2. Kapoor, K. L., Text Book of Physical Chemistry, McGraw Hill, Vol. II,IV
3. Levine, I. N. Quantum Chemistry,PHI.

CORE PAPER XII LAB

Spectroscopy/Colorimetry

1. Study of absorption spectra (visible range) of $KMnO_4$ and determine the λ_{max} value. Calculate the energies of the transitions in kJ mol^{-1}, cm^{-1}, andeV.
2. Verify Lambert-Beer's law and determine the concentration of$CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknownconcentration.
3. Determine the dissociation constant of an indicator(phenolphthalein).

Spectrophotometric titration

1. Determine the concentration of HCl against 0.1 N NaOHspectrophotometrically.
2. To find the strength of given ferric ammonium sulfate solution of (0.05 M) by using EDTA spectrophotometrically.
3. To find out the strength of $CuSO_4$ solution by titrating with EDTAspectrophotometrically.
4. To determine the concentration of Cu(II) and Fe(III) solution photometrically by titrating withEDTA.

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi(2011).

2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in PhysicalChemistry 8th Ed.;* McGraw-Hill: New York (2003).
3. Halpern, A. M. &McBane, G. C. *Experimental Physical Chemistry 3rdEd.;* W.H. Freeman & Co.: New York(2003).
4. J. N. Gurtu, R. Kapoor, Experimental PhysicalChemistry.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAMME OUTCOMES:

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CO3	5	2	5	5	4	4	2	2	2	5
CO4	5	2	5	5	4	4	2	2	2	5
CO5	5	5	4	5	5	4	4	2	2	5

SEMESTER-V

Discipline Specific Elective Paper-1

POLYMER CHEMISTRY

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Have an idea regarding the fundamentals of polymers, biopolymers and synthetic polymers.
2. Explain the mechanism and kinetics of polymerization.
3. Know the methods for characterizing the polymers.
4. Know the preparation, properties and uses of different polymers.
5. Synthesize different polymers in laboratory, analyse the polymers by colorimetric method, by the use of viscometer, and identify the labelled peaks in IR spectra of known polymer.

UNIT-I

Introduction and history of polymeric materials:

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

Functionality and its importance:

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.

UNIT-II

Mechanism & Kinetics of Polymerization:

Polymerization reactions – addition and condensation, mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization and crystallinity:

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

UNIT-III

Molecular weight of polymers and their determination (M_n,M_w, M_v, M_z) by end group analysis,viscometry and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Glass transition temperature (T_g) and it determination: WLFequation, Outlines of factors affecting glass transition temperature (T_g).

UNIT-IV

Properties of polymers (physical, thermal and mechanical properties).

Preparation, structure, properties and applications of the following polymers: polyolefins (polyethylene, polypropylene), polystyrene, polyvinyl chloride, polyvinyl acetate, polyacrylamide, fluoro polymers (Teflon), polyamides (nylon-6 and nylon 6,6). Thermosetting polymers - phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, conducting polymers (polyacetylene, polyaniline). Brief outline of biodegradable polymers.

Recommended Text Books:

1. V. R. Gowarikar, Jayadev Sreedhar, N. V. Viswanathan, Polymer Science 1st Edition, New Age International Publishers,1986.
2. Premamoy Ghosh, Polymer Science and Technology: Plastics, Rubber, Blends and Composites, 3rdEdition, McGraw Hill Education,2010.
3. P. Bahadur &N.V.Sastry, Principles of polymer science, Narosa Publishing house,New Delhi2002.
4. Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience(1984)

Reference books

1. L.H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005).
2. Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press(2005).
3. Seymour/Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr.(2013).
4. Nayak P.L., Polymer Chemistry, Kalyani Publisher(2017).

Discipline Specific Elective Paper I LAB

Polymer synthesis (At least three experiment)

1. Preparation of nylon-6,6 / Polyaniline
2. Preparations of phenol-formaldehyde resin-novalac / phenol-formaldehyde resin resold.
3. Preparation of urea-formaldehyderesin
4. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid(AA).
   a. Purification ofmonomer
   b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)
5. Redox polymerization ofacrylamide
6. Precipitation polymerization ofacrylonitrile

Polymer characterization/analysis (At least two different experiment)

1. Determination of molecular weight byviscometry:
   a. Polyacrylamide /Polystyrene
   b. (Polyvinyl pyrolidine(PVP)
2. Determination of acid value/saponification value of aresin.
3. Determination of hydroxyl number of a polymer using colorimetricmethod.
4. Estimation of the amount of HCHO in the given solution by sodium sulphitemethod
5. Analysis of some IR spectra of polymers – Identification of labelled peaks in IR spectra of knownpolymer.

Reference Books:

1. Hundiwale G.D., Athawale V.D., Kapadi U.R. and Gite V. V., Experiments in Polymer Science, New Age Publications(2009).
2. Malcohm P. Stevens, Polymer Chemistry: An Introduction, 3rdEd.
3. Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall(2003)
4. Petr Munk and Tejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons(2002)
5. Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press(2005).

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CO3	5	2	4	5	5	4	5	2	5	5
CO4	5	2	4	5	5	4	5	2	5	5
CO5	5	5	5	4	4	2	5	4	5	5

SEMESTER-V

Discipline Specific Elective Paper-1I

GREEN CHEMISTRY

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Comprehend the principles, limitation of green chemistry.
2. Design the chemical synthesis by using green approach.
3. Synthesize some real world reaction by using green method.
4. Have the idea of future trends in research by using green approach.
5. Synthesize some compounds by green methods. Use safer chemicals for different synthesis.

UNIT-I

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-I

Twelve principles of Green Chemistry. Explanations of principle with special emphasis on - Designing green synthesis processes: Prevention of Waste/ by-products; maximize the incorporation of the materials used in the process into the final products (Atom Economy) with reference to rearrangement, addition, substitution and elimination reactions; Prevention/ minimization of hazardous/ toxic products; Designing safer chemicals; Use of safer solventsandauxiliaries (e.g. separating agent) - green solvents (supercritical CO_2, water, ionic liquids), solventless processes, immobilized solvents.

UNIT-II

Principles of Green Chemistry and Designing a Chemical synthesis-II

Explanation of green chemistry principles with special emphasis on:

Energy efficient processes for synthesis - use of microwaves and ultrasonic energy. Selection of starting materials (use of renewable feedstock); avoidance of unnecessary derivatization (e.g. blocking group, protection groups, deprotection); Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products use of chemically safer substances for prevention of chemical accidents, inherent safer design greener - alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol); real-time, in-process monitoring and control to prevent the formation of hazardous substances; development of

green analytical techniques to prevent and minimize the generation of hazardous substances in chemicalprocesses;

UNIT-III

Examples of Green Synthesis/ Reactions and some real world cases-I

Green Synthesis of the following compounds: adipic acid, catechol, methyl methacrylate, urethane, disodium iminodiacetate (alternative to Strecker synthesis), paracetamol, furfural.

Microwave assisted reactions: Applications to reactions (i) in water: Hofmann Elimination, hydrolysis (of benzyl chloride, methyl benzoate to benzoic acid), Oxidation (of toluene, alcohols); (ii) reactions in organic solvents: Diels-Alder reaction and Decarboxylation reaction.

Ultrasound assisted reactions: Applications to esterification, saponification, Simmons-Smith Reaction (Ultrasonic alternative to Iodine).

UNIT-IV

Examples of Green Synthesis/ Reactions and some real world cases-II

Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments; Designing of Environmentally safe marine antifoulant; Rightfit pigment: synthetic azopigments to replace toxic organic andinorganic pigments; Synthesis of a compostable and widely applicable plastic (poly lactic acid) from corn; Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting

Future Trends in Green Chemistry

Oxidizing and reducing reagents and catalysts; multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; Green chemistry in sustainable development. (Bio-diesel, bio-ethanol and biogas)

Recommended Text Books:

1. Anastas P.T. & Warner J.K.: Green Chemistry- Theory and Practical, Oxford University Press(2000).
2. Ahluwalia V.K. & Kidwai M.: New Trends in Green Chemistry, Anamalaya Publishers, New Delhi(2004).
3. Kumar V., An Introduction to Green Chemistry, Vishal Publishing Co.,(2015).

Reference Books:

1. Matlack A.S. Introduction to Green Chemistry, Marcel Dekker(2001).
2. Das Asim K. amd Das Mahua , Environment Chemistry with Green Chemistry, Books and Allied (P) Ltd.(2010).

Discipline Specific Elective Paper II LAB

At least five experiments should be done:

1. Acetylation of primary amine (Aniline to N-phenylacetamide) using Zndust.

2. Nitration of salicylic acid by green method (Using calcium nitrate and aceticacid).
3. Bromination of acetanilide using ceric ammoniumnitrate/KBr.
4. Microwave assisted nitration of Phenols using $Cu(NO_3)_2$.
5. Detection of elements in organic compounds by green method (Sodium carbonatefusion)
6. Base catalyzed Aldol condensation (Synthesis ofdibenzalpropanone).
7. Vitamin C clock reaction using vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch. Effect of concentration on clockreaction.
8. Photoreduction of benzophenone to benzopinacol in the presence ofsunlight.
9. Diels Alder reaction in water: Reaction between furan and maleic acid in water and at room temperature rather than in benzene andreflux.
10. Preparation and characterization of nanoparticles (Cu, Ag) using plantextract.
11. Preparation of propene by following two methods or any other reactions like addition, elimination, substitution showing atomic economy can bestudied

I. Triethylamine ion + OH^- → propene + trimethylpropene +water

II. 1-propanol $\xrightarrow{H_2SO_4/\Delta}$ propene +water

Reference Books:

1. Monograph on Green Chemistry Laboratory Experiments, edited and published by Green Chemistry Task Force Committee, DST Govt. of India, p.1-79.
2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistryexperiment*. American Chemical Society, Washington DC(2002).
3. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment:A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN978-93-81141-55-7(2013).

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CO3	5	2	4	5	2	4	5	4	5	5
CO4	5	2	4	5	2	4	5	4	5	5
CO5	5	5	4	4	5	4	5	5	5	5

SEMESTER-VI

CORE PAPER XIII

INORGANIC CHEMISTRY-IV

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COURSE OUTCOMES:

After reading this paper, students will be able to

1. Explain the classification and bonding in organometallic compounds.
2. Describe the various theories for the explanation of stability of organometallic compounds and their application.
3. Know use of different organometallic compounds for the synthesis. Qualitatively analyse the inorganic salt mixture by H_2S scheme.
4. Deduce the thermodynamic and kinetic aspects of organometallic compounds.
5. Separate and estimate the salt mixture qualitatively and separate the salt mixtures containing insoluble components or combination of interfering anions.

UNIT-I

Organometallic Compounds-I

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. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of backbonding.

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

UNIT-II

Organometallic Compounds-II

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures.

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation), structure and aromaticity, comparison of aromaticity and reactivity with that of benzene.

UNIT-III

Catalysis by Organometallic Compounds

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinson'sCatalyst)
2. Hydroformylation (Cosalts)
3. WackerProcess
4. Synthetic gasoline (Fischer Tropschreaction)

Theoretical Principles in Qualitative Analysis (H_2S Scheme)

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 and phosphate) and need to remove them after Group II.

UNIT-IV

Thermodynamic & kinetic aspects and reaction mechanism of metal complexes Thermodynamic and kinetic stability, Stepwise and overall formation constants and theirrelationship, factors affecting stability. Introduction to inorganic reaction mechanisms-types ofreaction and classification od substitution reaction. Substitution reaction of square planar complexes, Trans effect and its applications, theories of trans-effect (electrostatic polarization and Static π-Bonding Theory). Kinetics of octahedral substitution (classification of metal ions based on water exchange rate), General mechanism of ligand substitution reactions in octahedral complexes (D, I, I_d,I_a).

Recommended Text Books:

1. Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry – Principles of structure and reactivity, , Pearson Education, 4th Ed.2002.
2. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed.,2017.
3. ShriverD. E.,Atkins P. W., InorganicChemistry, Oxford UniversityPres ,5thEdn..
4. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall,1996-0307.

Reference books

1. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. II, CBS Publications, 2nd Ed. 2010.
Selected Topic in Inorganic Chemistry, Mallick, Madan and Tuli, S. Chand Publisher. 17th Ed. 2010.
2. Mehrotra R.C. and Singh, A. *Organometallic Chemistry,* New Age International Publishers, 2ndEdn,2000.
3. Gupta B. D. and Elias A. J., Basic organometallic Chemistry, 2ndEdn., University Press (2013).

CORE PAPER XIII LAB

1. Qualitative analysis of mixtures containing 4 radicals (2 anions and 2 cations). Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals aresuggested:

CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, F^-, Cl^-, Br^-, I^-, NO_3^-, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}.

2. Mixtures may contain one insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 orAl_2O_3)**Or**combination of interfering anions e.g. CO_3^{2-} and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, Br^- and I^-, NO_3^- and Br^- , NO_3^- and I^-.

3. Spot tests should be done wheneverpossible.

Reference Books

1. Vogel's Qualitative Inorganic Analysis, 7th Ed, Revised by G. Svehela, 4th Ed., Person (2007).

2. Gulati Shikha , Sharma Gulati JL and ManochaShagun, Practical Inorganic Chemistry, 1stEdn., CBS Publishers & Distributors Pvt Ltd.,(2017).

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CO3	5	2	5	5	5	4	4	2	5	5
CO4	5	2	5	5	5	4	4	2	5	5
CO5	5	5	4	4	5	4	5	5	5	5

SEMESTER-VI

CORE PAPER XIV

ORGANIC CHEMISTRY-V

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Comprehend the classification and properties of amino acids and nucleic acids.
2. Explain the classification, characteristics and mechanism of enzyme action.
3. Know the various bio-metabolisms.
4. Describe the theories of important pharmaceutical compounds and dyes, identify biologically important molecules and their role in human life, and define the terminologies used in biological systems.
5. Prepare different organic compounds, estimate simple amino acid and vitamin-C, determine the iodine number of oil/fat. Develop skill of quantitative analysis of some bio-molecule.

UNIT-I

Amino Acids, Peptides and Proteins

Amino acids: Classification; α-Amino acids - Synthesis, ionic properties and reactions. Zwitterions, pK_a values, isoelectric point and electrophoresis.

Peptides: Classification, determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, CORE PAPERprotecting and CORE PAPERactivating groups -Solid-phasesynthesis.

Proteins: Structure of proteins, protein denaturation and renaturation

UNIT-II

Enzymes

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereo specificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

Nucleic Acids

Components of nucleic acids, Nucleosides and nucleotides;

Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine;

Structure ofpolynucleotides.

UNIT-III

Lipids

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenntion of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

Concept of Energy in Biosystems

Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism and anabolism).

Overview of catabolic pathways of fat and protein.

Interrelationship in the metabolic pathways of protein, fat and carbohydrate. Caloric value of food, standard caloric content of food types.

UNIT-IV

Pharmaceutical Compounds: Structure and Importance

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Dyes

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); *Triphenylmethane dyes* - Malachite Green, and crystal violet; *Phthalein dyes* – Phenolphthalein andFluorescein.

Recommended Text books

1. Nelson, D.L., Cox, M.M. and Lehninger, A.L. Principles of Biochemistry. 6thEdn. W.H. Freeman and Co.(2013).

2. Kar Ashutosh, Medicinal chemistry, New Age International (P) Ltd.,(2007).

3. Debojyoti Das, Biochemistry, (part-I) Academic Publishers(1979).

Reference Books:

1. Talwar, G.P. & Srivastava, M. Textbook of Biochemistry and Human Biology, 3rdEd. PHILearning.Berg, J.M., Tymoczko, J.L. &Stryer, L. Biochemistry, W.H. Freeman,2002.

2. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange Medical Books/McGraw-Hill.

3. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry, 6th Edition. W.H. Freeman and Co.(2002).

4. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press(2009).

5. The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.

CORE PAPER XIV LAB

1. Preparations of the followingcompounds
   i. Aspirin
   ii. Methylorange
2. Estimation of phenol and aniline by brominationmethod.
3. Saponification value of anoil/fat/ester.
4. Estimation of glycine by Sorenson's formalinmethod.
5. Estimation formaldehyde (formalin).
6. Estimation of ascorbic acid in fruit juices/Vitamin C tablet (Iodometricmethod)
7. Determination of Iodine number of an oil/fat.

Reference Books:

1. Arthur, I. Vogel, Elementary Practical Organic Chemistry, Part-1 Small scale preparations, Indian Edition, Pearson (2011).
2. Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
3. Arthur, I. Vogel, *Quantitative Organic Analysis,*Pearson.
4. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press(2009).

MAPPING OF COURSE OUTCOMES WITH THE PROGRAMME OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	2	4	5	2	4	4	2	5	5
CO2	5	2	4	5	2	4	4	2	5	5
CO3	5	2	4	5	2	4	4	2	5	5
CO4	5	2	4	5	2	4	4	2	5	5
CO5	5	5	4	5	5	4	4	2	5	5

SEMESTER-VI

Discipline Specific Elective Paper-1II

INDUSTRIAL CHEMICALS AND ENVIRONMENT

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Have idea about pollution causing by different industrial chemicals.
2. Take measures to control environmental pollution. Describe methods to take necessary action to reduce pollution.
3. Estimate different types of water pollutant.
4. Measure dissolved CO_2 in gives sample. Prepare some environmentally safer chemicals.
5. Assess the impact of environmental pollution by measuring various testing parameters

UNIT-I

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of thefollowing gases: oxygen, nitrogen, argon, hydrogen, acetylene, carbon monoxide, chlorine, sulphur dioxide.

Inorganic Chemicals: Manufacture, application and hazards in handling thefollowing chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, potassium dichromate and potassium permanganate.

Industrial Metallurgy

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

UNIT-II

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone. Major sources of air pollution.
Pollution by SO_2, CO_2, CO, NO_x, and H_2S and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and halogens, removal of sulphur from coal.

UNIT-III

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources andnature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.
Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, fertilizer. Sludgedisposal.
Industrial waste management: incineration of waste. Water treatment and purification (reverse osmosis, ion exchange). Water quality parameters for wastewater, industrial water and domestic water.

UNIT-IV

Energy and Environment

Sources of energy: Coal, petrol and natural gas. Nuclear fusion/fission, solar energy, hydrogen, geothermal, tidal and hydel.
Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

BiocatalysisIntroduction to biocatalysis: Importance in green chemistry and chemical industry.

Recommended Text Books:

1. De, A. K. *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi, 2010.
2. Stocchi E., *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd.UK.
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut(1996).

Reference Books:

1. Felder R.M. and Rousseau R.W., *Elementary Principles of Chemical Processes*, Wiley Publishers, NewDelhi.
2. Dara S. S., *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.

3. Miller G.T., Environmental Science, 11th edition. Brooks/ Cole(2006).
4. Mishra, Environmental Studies, Selective and Scientific Books, New Delhi(2005).

Discipline Specific Elective Paper III LAB

1. Determination of Dissolved Oxygen (DO) inwater.
2. Determination of Chemical Oxygen Demand(COD)
3. Determination of Biological Oxygen Demand(BOD)
4. Percentage of available chlorine in bleachingpowder.
5. Measurement of chloride, sulphate and salinity of water samples by simpletitration method ($AgNO_3$ and potassiumchromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method.
7. Measurement of dissolvedCO_2.
8. Study of some of the common bio-indicators ofpollution.
9. Estimation of SPM in airsamples.
10. Preparation of borax/ boricacid.

Reference Books:

1. DaraS.S.,ATextbookonExperimentsandCalculationsinEngineering.
2. ChemistrySChand & Company; 9th Revised edition (2015).
3. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd.UK.
4. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, NewDelhi.
5. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, NewDelhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, NewDelhi.

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CO3	5	2	4	5	2	4	5	4	5	5
CO4	5	2	4	5	2	4	5	4	5	5
CO5	5	5	4	5	4	4	5	5	5	5

SEMESTER-VI

Alternative to DSE CORE PAPERIV

Discipline Specific Elective Paper-V

COURSE OUTCOMES:

After reading this paper, students will be able to

1. Choose the right source to review the literature.
2. Perform some basic research.
3. Compile and interpret the data.
4. Present the project finding in a publishable format.
5. Use of different Chemistry software and know the ethics research.

DISSERTATION

A project work is to be carried out by the student in consultation with the teachers of the department. The report of work (dissertation) in a standard format is to be submitted and presented for evaluation.

Distribution of marks

a) Project Report/Dissertation (Proper documentation of literature, data, discussion etc. and logical flow of work undertaken): 50Marks
b) Seminar/Presentation: 30marks
c) Viva voce: 20marks

A brief Guidelines to Project Work:

1. Studentsshallundertaketheprojectwork(experimental/theoretical)relatedtoanybranchofchemistry/Chemical science under the guidance of teacher(s) from the department or jointly with teachers/research personnel of other institutes.
2. The following activities have been outlined as guidelines (notexhaustive):

- Physiochemical studies (pH, conductivity, turbidity, etc.) of different wetlands (ponds, lakes, river etc.)
- Analysis of iron in pond / tube well / riverwater.
- Analysis of Hardness of water samples.
- Adulteration detection activities in food stuff and other edibleitems.
- Extraction and preliminary characterization of useful chemicals (as far as possible) from plants.
- Solubility, surface tension, and viscosity measurements of some solution of practical relevance, (cough syrup, soap solution, pesticides, fertilizers..etc.)
- Pollution related activities (Industrial/Agricultural/Municipaletc.)
- Nutrition related activities, (essential metal detection in food, cereals, pulses, fruitsetc.).
- Small synthetical work (inorganic/Organic/Polymericcompounds)

3. The UG level project work is a group activity, maximum number of students being limited to three. HOD to notify the name of teacher(s) for supervising the project work of

each group. A teacher can guide more than one group, if necessary.

4. No two groups in the same institution are permitted to do project work on the sameproblem.

5. Each student shall prepare and submit the project report separately for evaluation. Two copies of project report are required to be submitted in bound form(spiral/paperback).
6. The project report shall be dividedas:

Chapter I: Introduction (Introduction on the topic, review of literature, objective and scope of the work)
ChapterII: Materials andmethods
Chapter III: Results anddiscussion
Chapter IV: Conclusions and Scope of future studies
ChapterV: References

Reference Books:

1. M. A. Malati, An Investigative, Integrated Approach to Practical Project Work;Mid-Kent ollege of Higher/Further Education, UK (October 1999); Imprint: Woodhead Publishing; ISBN:978-1-898563-47-1.
2. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) Practical skills in chemistry. 2nd Ed., Prentice-Hall,Harlow.

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CO3	5	2	5	5	5	5	5	5	5	5
CO4	5	2	5	5	5	5	5	5	5	5
CO5	5	5	5	5	5	5	5	5	5	5

SEMESTER-VI

Alternative for Discipline Specific Elective (DSE) Papers

Discipline Specific Elective Paper-VI
ANALYTICAL METHODS IN CHEMISTRY

Course Objectives

1. To introduce the undergraduates about the different spectroscopic methods, qualitative and quantitative aspects of analysis and different separation techniques .

COURSE OUTCOME MISSING

Unit I

UV-Visible and IR Spectrometry

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles, instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Unit II

Qualitative and quantitative aspects of analysis

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

Flame Atomic Absorption Spectrometry

Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Unit III

Thermal and electro-analytical methods of analysis

Theory of thermo-gravimetry (TG), basic principle of instrumentation. Techniques forquantitative estimation of Ca and Mg from their mixture.

Classification of electro-analytical methods, basic principle of pH metric, potentiometric and

conductometric titrations. Techniques used for the determination of equivalence points.

Unit IV

Separation techniques

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions.

Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: TLC andHPLC.

Recommended text books:

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed., The English Language Book Society ofLongman.
2. Skoog, Holler and Crouch, Principles of Instrumental Analysis, Cengage Learning, 6th Indian Reprint(2017).
3. Christian, Gary D; Analytical Chemistry, 6th Ed., John Wiley & Sons, New York,2004.

Reference books

1. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W. H. Freeman,2001.
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed., Wardsworth Publishing Company, Belmont, California, USA,1988.
3. Mikes, O. &Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd.London.
4. Pavia, Lamman, Kriz and Vyvyan, Introduction to Spectroscopy, Cengage Learning, 3rd Indian Reprint(2017).
5. Dash U N , AnalyticalChemistry

Discipline Specific Elective Paper -V LAB

1. Paper chromatographic separation of Fe^{3+}, Al^{3+}, andCr^{3+}.
2. Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the $R_f$values.
3. Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their $R_f$values.
4. Chromatographic separation of the active ingredients of plants, flowers and juices by TLC
5. Determine the pH of the given aerated drinks fruit juices, shampoos andsoaps.
6. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
7. Analysis of soil: determination of pH of soil, total soluble salt, estimation of calcium, magnesium, phosphate,nitrate
8. Separation of metal ions from their binarymixture.
9. Separation of amino acids from organic acids by ion exchangechromatography.
10. Determination of dissolved oxygen inwater.

11. Determination of chemical oxygen demand(COD).

Reference Books:

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G. H. Jeffery and others) 5th Ed., The English Language Book Society ofLongman.
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed., Wardsworth Publishing Company, Belmont, California, USA,1988.
3. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher,2009.

Generic Elective Paper-I (GE-I)

ATOMICSTRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Section A: Inorganic Chemistry-I

Course Outcomes

CO1. Students will perform calculations with Fajan's rules, Born equation, Slater's rules.

CO2. Students will understand the organization of atoms and molecules.

CO3. Students will predict the shapes and geometries of molecules.

CO4. Students will synthesize different organic compounds with functional group attachment and analysis.

CO5. Students will able to study the preparation and properties of different organic compounds.

Unit-I

Atomic Structure

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, deBroglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Quantum mechanics: Time independent Schrodinger equation and meaning of various terms init. Significance of ψ and ψ2 , Schrödinger equation for hydrogen atom. Quantum numbers and the it significance.

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of halffilled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Unit-II

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics, energy considerations. Lattice energy and solvation

Energy and 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.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis

Of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, non bonding combination of orbitals, MO treatment of homo nuclear diatomic molecules (N_2,O_2).

Section B: Organic Chemistry-I

Unit-III

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive effect, Electromeric effect, Resonance and hyperconjugation. Cleavage of bonds: Homolysis and heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and freeradicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Hückel's rule.

AliphaticHydrocarbons

Alkanes: (Upto 5 Carbons).*Preparation:* Catalytic hydrogenation, Wurtzreaction,Kolbe's

synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); *Reactions:* cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis,

Alkynes: (Upto 5 Carbons) *Preparation:* by dehalogenation of tetrahalides and dehydrohalogenation of vicinal-dihalides Conversion into higher alkynes; .

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis.

Unit-IV

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration:Geo

Metrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). D and L; cis-trans nomenclature; CIP Rules:R/ S (for one chiral carbonatoms) and E/Z Nomenclature(for upto two C=C systems).

Generic Elective Paper I LAB (GE-I Lab) Section A: Inorganic Chemistry

Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogencarbonate present in a mixture.

2. Estimation of oxalic acid by titrating it with $KMnO_4$.

3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

4. Estimation of Fe(II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.

5. Estimation of Cu(II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl) in organic compounds (containing up to two Extra elements).

2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)

(a) Identify and separate the components of a given mixture of 2 amino acids

(glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography.

(b) Identify and separate the sugars present in the given mixture by paper chromatography.

MAPPING OF COURSE OUTCOMES WITH THE PROGRAMME OUTCOMES:

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CO2	5	5	4	5	4	4	5	4	5	4
CO3	4	2	5	4	5	5	4	5	5	4
CO4	5	2	4	5	4	5	5	4	4	5
CO5	5	5	5	5	5	5	5	5	5	5

SEMESTER-II

Generic Elective Paper II (Theory, GE-II)

CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY

Course Outcomes

CO1. Students will able to perform calculations with ideal and real gases; predict chemical equilibrium and spontaneity of reactions by using thermodynamic principles.

CO2. Students will able to apply the concepts of colloids and gels.

CO3. Students will able to learn depth knowledge about solid & liquid states.

CO4. Students will able to synthesize alkyl halides, aryl halides, alcohols, phenols etc.

CO5. Students will able to study basic concepts of organic chemistry of compounds containing carboxylic acid, ether, esters etc

Unit-I

Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics.

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 from thermochemical data.Variation of enthalpy of a reaction with temperature–Kirchhoff's equation.

Chemical Equilibrium

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

Unit- II

Ionic Equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. pH scale. Salt hydrolysis calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts–applications of solubility product principle.

Section-B: Organic Chemistry-II

Unit-III

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatichydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from benzene sulphonic acid. Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation

And sulphonation. Friedel Craft's reaction (alkylation and acylation) (upto4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto4 carbons on benzene).

Alkyl and Aryl Halides

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions.Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis:

Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by– OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).

Unit- IV

Alcohols, Phenols and Ethers (Upto 5 Carbons)

Alcohols: Preparation: Preparation of 1°,2° and 3°alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes and ketones, carboxylic acid and esters. Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Pinacol Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer Tiemann Reaction, Gattermann-Koch Reaction,

Aldehydes and ketones (aliphatic and aromatic): Formaldehyde, acetaldehyde, acetone

And benzaldehyde

Preparation: from acid chlorides and from nitriles.

Reactions–Reaction with HCN, ROH, $NaHSO_3$,NH2- G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Clemensen reduction.

Generic Elective Paper-II LAB (GE-II Lab) Section-A: Physical Chemistry

Thermo-chemistry any three)

1. Determination of heat capacity of calorimeter for different volumes.

2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

3. Determination of enthalpy of ionization of aceticacid.

4. Determination of integral enthalpy of solution of salts (KNO_3,NH_4Cl).

5. Determination of enthalpy of hydration of copper sulphate.

6. Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH meter.

b) Preparation of buffer solutions: Sodium acetate-acetic acid, Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section-B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water) and determination of melting.

2. Preparations, recrystallisation, determination of melting point and calculation of quantitative yields of the followings:

(a) Bromination of Phenol/Aniline

(b) Benzoylation of amines/phenols

(c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

b) Preparation of buffer solutions: Sodium acetate-acetic acid, Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section-B: Organic Chemistry

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(c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

1. Ahluwalia,V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).

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CO1	5	5	5	5	4	4	5	4	4	5
CO2	5	5	5	5	4	4	5	2	4	5
CO3	5	5	5	5	5	4	4	4	4	5
CO4	5	2	5	5	4	4	5	5	4	5
CO5	5	5	5	5	4	5	5	5	5	5

SEMESTER-III

Generic Elective Paper-III(GE-III)

CHEMISTRY OF S- AND P-BLOCK ELEMENTS, STATES OF MATTER & CHEMICAL KINETICS

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Section-A: Inorganic Chemistry-II

Course Outcomes

CO1. Students will gain an idea about general principles of metallurgy, acid-base concepts.

CO2. Students will gain a thorough knowledge about the s and p Block Elements.

CO3. Students will able to design experiment to measure the rate of a reaction.

CO4. Students will able to measure viscosity and surface tension of a liquid.

CO5. Students will able to study the concept of solids state chemistry.

UNIT-I

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.

Hydrometallurgy, Methods of purification of metals (Al, Pb, Fe, Cu, Ni): electrolytic, oxidative refining, Parting process,van Arkel-de Boer process and Mond'sprocess.

***s*-and *p*-BlockElements**

Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling & Mulliken scales). Allotropy in C, S, and P. Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

UNIT-II

Compounds of *s*- and *p*-Block Elements

Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of p- block elements. Concept of multicentre bonding (diborane). Structure, bonding and their important properties like oxidation/reduction, acidic/basic nature of the following compounds and their applications in industrial, organic and environmental chemistry.

Hydrides of nitrogen (NH_3,N_2H_4,N_3H,NH_2OH); Oxo acids of P, S and Cl; Halides and oxohalides: PCl_3,PCl_5,$SOCl_2$.

SectionB:PhysicalChemistry-III

UNIT-III

Kinetic Theory of Gases

Postulates of KineticTheory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor,causes of deviation. vander Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation–derivation not required) and their importance.

Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Liquids

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

UNIT-IV

Solids

Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography-Law of constancy of inter facial angles, Law of rational indices.

Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, and CsCl (qualitative treatment only).Defects in crystals.

Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

Generic Elective Paper-III LAB(GE-III Lab)

Section A: Inorganic Chemistry

Qualitative analysis of inorganic salt mixture using H_2S: not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations:NH_4 + , Pb2+ , Ag+ , Bi3+, Cu2+, Cd2+ , Sn2+, Fe3+, Al3+, Co2+, Cr3+, Ni2+, Mn2+, Zn2+ , Ba2+, Sr2+, Ca2+, K+

Anions: CO2–, S2– , SO2– , NO– , Cl– , Br– , I– , NO– , SO2- , PO3- , F-

(Spot tests should be carried out wherever feasible)

SectionB:PhysicalChemistry

Chemical Kinetics

1. Study the kinetics of the following reactions.

2. Initial rate method: Iodide-persulphate reaction

Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Saponification of ethyl acetate.

c. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate

MAPPING OF COURSE OUTCOMES WITH THE PROGRAMME OUTCOMES:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	5	5	4	4	5	4	4	5
CO2	5	5	5	5	4	4	5	2	4	5
CO3	5	5	5	5	5	4	4	4	4	5
CO4	5	2	5	5	4	4	5	5	4	5
CO5	5	5	5	5	4	5	5	5	5	5

SEMESTER-IV

Generic Elective Paper- IV (Theory, GE-IV)

ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLY NUCLEAR HYDROCARBONS AND UV, IR SPECTROSCOPY

Course Outcomes

CO1. Students will gain an idea about s and p-block elements, their properties and uses.

CO2. Students will gain a thorough knowledge of noble gases and their uses.

CO3. Students will able to study surface tension of liquids.

CO4. Students will able to study chemistry of s and p block elements, noble gases and inorganic polymers.

CO5. Students will able to introduce general principles of metallurgy.

UNIT-I

Chemistry of 3d metals

Oxidation states displayed by Cr, Fe, Co, Ni and Co.

A study of the following compounds (including preparation and important properties); Peroxocompounds of Cr, K2Cr2O7, KMnO4, K4[Fe(CN)6], sodiumnitroprusside, [Co(NH3)6]Cl3, Na3[Co(NO2)6].

Organometallic Compounds

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and

ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. π-acceptor behaviour of carbon monoxide. Synergic effects (VB approach).

UNIT-II

Bio-InorganicChemistry

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na+ , K+ and Mg2+ ions: Na/K pump; Role of Mg2+ ions in energy production and chlorophyll. Role of Ca2+ in blood clotting, and structural role (bones)

SectionB:OrganicChemistry-4

UNIT-III

Poly nuclear and hetero nuclear aromatic compounds

Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene, Furan, Pyrrole,Thiophene,and Pyridine.

Active methylene compounds

Preparation: Claisen ester condensation. Keto-enoltautomerism.

Reactions: Synthetic uses of ethyl acetoacetate (preparation of non-hetero molecules having upto 6 carbon).

UNIT-IV

Application of Spectroscopy (UV-Visible,IR) to Simple Organic

Molecules Electromagnetic radiations, electronic transitions, λ max & ε max, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Wood wardrules for calculating λ max of conjugated dienes and α,β– unsaturated compounds.

Infrared radiation and types of molecular vibrations, functional group and fingerprint region.

IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

Generic Elective Paper-IV LAB(GE-IV Lab)

Section-A: Inorganic Chemistry

1. Preparation of following compounds (Any two)

a. Cuprous oxide(Cu2O)

b. Cuprous chloride, Cu2Cl2

c. Manganese (III) phosphate, MnPO4.H2O

d. Lead chromate (PbCrO4)

2. Separation of mixtures by chromatography: Measure the *Rf* value in each case. (Combination of two ions to be given)

- Paper chromatographic separation of Fe3+, A13+ and Cr3+or
- Paper chromatographic separation of Ni2+, Co2+, Mn2+ and Zn2+

Section B: Organic Chemistry

Systematic qualitative organic analysis of organic compounds possessing mono-functional groups(- COOH, phenolic, aldehyde, ketone, amide, nitro, amines) and preparation of one derivative.

Reference Books

1. Mendham,J., A.I.Vogel's Quantitative Chemical Analysis 6th Edn, Pearson,2009

2. Mann, F.G. & Saunders, B.C.Practical Organic Chemistry, Pearson Education(2009).

3. Ahluwalia,V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).

4.Gulati Shikha, Sharma Gulati J L and Manocha Shagun, Practical Inorganic Chemistry,1st Edn., CBS Publishers & Distributors Pvt. Ltd.,(2017)

MAPPING OF COURSE OUTCOMES WITH THE PROGRAMME OUTCOMES:

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CO3	5	5	5	5	5	4	4	4	4	5
CO4	5	2	5	5	4	4	5	5	4	5
CO5	5	5	5	5	4	5	5	5	5	5

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