

RKDF UNIVERSITY

RANCHI



FYUGP

CHEMISTRY HONOURS/RESEARCH

FOR UNDER GRADUATE COURSES UNDER RKDF UNIVERSITY RANCHI

NEP 2020

Implemented from
Academic Session 2023-27

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B.Sc. Chemistry

PROGRAMME OVERVIEW/ SCHEME OF THE PROGRAMME

- The Full-time, Regular UG programme for a regular student shall be for a period of four years with multiple entry and multiple exit options.
- Undergraduate degree programmes of either 3 or 4-year duration, with multiple entries and exit points and re-entry options within this period, with appropriate certifications such as:
 - a Certificate after completing 1 year (2 semesters) of study in the chosen fields of study,
 - a Diploma after 2 years (4 semesters) of study,
 - a Bachelor after a 3-year (6 semesters) programme of study,
 - a Bachelor (with Hons. / Research) after a 4-year (8 semesters) programme of study

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AIMS OF BACHELOR'S DEGREE PROGRAMME IN CHEMISTRY

The broad aims of bachelor's degree programme in Chemistry are:

The aim of bachelor's degree programme in chemistry is intended to provide:

- (i) Broad and balance knowledge in chemistry in addition to understanding of key chemical concepts, principles, and theories.
- (ii) To develop students' ability and skill to acquire expertise over solving both theoretical and applied chemistry problems.
- (iii) To provide knowledge and skill to the students' thus enabling them to undertake further studies in chemistry in related areas or multidisciplinary areas that can be helpful for self- employment/entrepreneurship.
- (iv) To provide an environment that ensures cognitive development of students in a holistic manner. A complete dialogue about chemistry, chemical equations and its significance is fostered in this framework, rather than mere theoretical aspects
- (v) To provide the latest subject matter, both theoretical as well as practical, such a way to foster their core competency and discovery learning. A chemistry graduate as envisioned in this framework would be sufficiently competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.
- (vi) To mold a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking and communication.
- (vii) To enable the graduate, prepare for national as well as international competitive examinations, especially UGC-CSIR NET and UPSC Civil Services Examination.

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SEMESTER - I

Subject Code	Paper Name	Credit
MJ01CHE	Inorganic Chemistry - I	3

Unit 1: Atomic Structure:

Bohr's theory, its limitations and atomic spectrum of hydrogen atom Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2 . Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations.

Unit 2: Periodicity of Elements:

s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements

- Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
- Atomic radii (van der Waals)
- Ionic and crystal radii.
- Covalent radii (octahedral and tetrahedral)
- Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
- Electron gain enthalpy, trends of electron gain enthalpy.
- Electronegativity, Pauling, Mullikan, Allred Rachow scales, electronegativity and bond order, partial charge, hybridization, group electronegativity.

Unit 3: 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, expression for

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lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

(ii) Covalent bond:

Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone and bond pairs of electrons multiple bonding, sigma and pi-bond approach, Valence Bond theory, (Heitler-London approach). Hybridization containing s, p and s, p, d atomic orbitals, shapes of hybrid orbitals, Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules: N₂, O₂, C₂, B₂, F₂, CO, NO, and their ions. Covalent character in ionic compounds, polarizing power and polarizability. Fajan rules, polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Ionic character from dipole moment and electronegativities.

(iii) Metallic Bond:

Qualitative idea of free electron model, Semiconductors, Insulators.

(iv) Weak Chemical Forces:

Van'der Waals, ion-dipole, dipole-dipole, induced dipole dipole- induced dipole interactions, hydrogen bond, effects of hydrogen bonding on melting and boiling points, solubility, dissolution.

Unit 4: Oxidation-Reduction:

Redox equations, Standard Electrode Potential and its application to inorganic reactions.

Principles involved in volumetric analysis to be carried out in class.

Reference Books:

- Lee, J. D. Concise Inorganic Chemistry, Wiley, 5th Edn.
- Douglas, B.E., McDaniel, D.H., Alexander J.J., Concepts & Models of Inorganic Chemistry,(Third Edition) John Wiley & Sons,1999.
- Atkins, P. W. and DePaula, J. Physical Chemistry, Tenth Edition, Oxford University Press,2014.
- Rodger, G. E. Inorganic and Solid State Chemistry, Cengage Learning, 2002.
- Douglas, B.E, Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.

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Subject Code	Paper Name	Credit
MJL01CHE	Chemistry Lab- I	1

(A) Titrimetric Analysis

- (i) Calibration and use of apparatus.
- (ii) Preparation of solutions of different Molarity/Normality of titrants.
- (iii) Use of primary and secondary standard solutions.

(B) Acid-Base Titrations

- (i) Estimation of carbonate and hydroxide present together in mixture.
- (ii) Estimation of carbonate and bicarbonate present together in a mixture.
- (iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

- (i) Estimation of Fe(II) using standardized KMnO_4 solution.
- (ii) Estimation of oxalic acid using standardized KMnO_4 solution
- (iii) Estimation of oxalic acid and sodium oxalate in a given mixture.
- (iv) Estimation of Fe(II) with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Reference Books:

- Mendham, J., A. I. Vogel's Quantitative Chemical Analysis Sixth Edition, Pearson, 2009.
- Svehala G. and Sivasankar I. B, Vogel's Qualitative Inorganic Analysis, Pearson, India, 2012.
- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: N.Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003)

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B.Sc. Chemistry SEMESTER - II

Subject Code	Paper Name	Credit
MJ02CHE	Organic Chemistry - I	3

Unit 1: Basics of Organic Chemistry:

Organic Compounds: Classification and Nomenclature, Hybridization, shape of molecules, influence of hybridization on bond properties. Electron Displacement Effects: 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, formal charges, Electrophiles and Nucleophiles, Nucleophilicity and basicity, Types, shape and relative stability of reaction intermediates (Carbocations, Carbanions, Free radicals and Carbenes). Organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit 2: Stereochemistry:

Concept of asymmetry, Fischer Projection, Newmann and Sawhorse projection formulae and their interconversions, Geometrical isomerism: cis-trans & syn-anti isomerism and E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, Meso structures, Racemic mixtures, Relative and absolute configuration: D/L and R/S configurations.

Unit 3: Chemistry of Aliphatic Hydrocarbons:

(i) *Alkanes:*

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

(ii) *Alkenes & Alkynes:*

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-

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hydroxylation (oxidation). 1, 2- and 1, 4- addition reactions in conjugated dienes and, Diels- Alder reaction, Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions.

(iii) Cycloalkanes and Conformational Analysis:

Cycloalkanes and stability, Baeyer strain theory, Conformation analysis, Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms.

Unit 4: Aromatic Hydrocarbon:

Aromaticity: Huckel'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 substituent groups.

Reference Books:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, 6th Edn., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill, (2007)
- F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).
- J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), Oxford University Press.
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products),
- Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
- F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism, Kluwer Academic Publisher, (2000).

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJL02CHE	Chemistry Lab-II	3

1. Purification of organic compounds by crystallization using the following solvents:
 - a. Water
 - b. Alcohol
 - c. Alcohol-Water
2. Determination of the melting points of given organic compounds and unknown organic compounds (using Kjeldahl method and electrically heated melting point apparatus).
3. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds.
4. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100 °C by distillation and capillary method)
5. Chromatography
 - a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
 - b. Separation of a mixture of two sugars by ascending paper chromatography

Reference Books

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

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Subject Code	Paper Name	Credit
MJ03CHE	Physical Chemistry - I	3

Unit 1: Behaviour of Real Gases:

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

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, 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.

Unit 2: Liquid State:

Structure and physical properties of liquids, vapour pressure, surface tension, viscosity, and their dependence on temperature. Effect of addition of various solutes on surface tension, cleansing action of detergents.

Unit 3: Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, p H scale, common ion effect, dissociation constants of mono-, di- and tri-protic acids.

Salt hydrolysis, hydrolysis constants, degree of hydrolysis and pH of different salt solutions. Buffer solutions, Henderson equation, buffer capacity, buffer range, buffer action, applications of buffers in analytical chemistry, Solubility and solubility product.

Unit 4: 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,

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qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices, X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Various types of defects in crystals, Glasses and liquid crystals.

Reference Books:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press(2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).5 G. M. Barrow, Tata McGraw Hill (Fifth Edition) (2007)
- Roy, B. N. Fundamentals of Classical and Statistical Thermodynamics Wiley, 20016 Commonly Asked Questions in Thermodynamics. CRC Press, 2011.

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Subject Code	Paper Name	Credit
MJL03CHE	Chemistry Lab- III	1

1. Surface tension measurements.

- Determine the surface tension by (i) drop number (ii) drop weight method.
- Study the variation of surface tension of detergent solutions with concentration.

2. Viscosity measurements using Ostwald's viscometer.

- Determination of viscosity of aqueous solution of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
- Viscosity of sucrose solution with the concentration of solute.

3. pH metry

- Effect on pH of addition of HCl/ NaOH to solutions of acetic acid, sodium acetate and their mixtures.
- Preparation of buffer solutions of different pH
 - Sodium acetate-acetic acid
 - Ammonium chloride-ammonium hydroxide
- pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.

Reference Books

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

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B.Sc. Chemistry SEMESTER - III

Subject Code	Paper Name	Credit
MJ04CHE	Organic Chemistry - II	3

Unit 1: Chemistry of Halogenated Hydrocarbons:

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – SN1, SN2 and SN_i mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. Nucleophilic aromatic substitution; SN_{Ar}, Benzyne mechanism.

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

Unit 2: Alcohols, Phenols, Ethers and Epoxides:

- (i) Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3°- alcohols, Bouvaelt-Blanc Reduction, Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement.
- (ii) Phenols: Preparation and properties, Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism.
- (iii) Ethers and Epoxides: Preparation and reaction with acids. Reaction of epoxides with alcohols, ammonia derivatives and LiAlH₄

Unit 3: 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, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α -substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH₄, NaBH₄, MPV, PDC and PGC), Addition reactions of unsaturated carbonyl compounds: Michael addition.

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Unit 4: Carboxylic Acids and their Derivatives:

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids, Preparation and reactions of acid chlorides, anhydrides, esters and amides, Comparative study of nucleophilic substitution 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, thioethers and sulphonic acids.

Reference Books:

- P Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman, New Delhi.
- Morrison, R. T., Boyd, R. N., Bhattejee, S.K., Organic Chemistry, 7th Edn., Pearson.
- Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons(1976).
- Solomons, T.W., Fryhle Craig, Organic Chemistry, John Wiley & Sons, Inc (2009).
- McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
- Kalsi, P. S. Organic reactions and their mechanisms, New Age Science (2010).
- Clayden, J., Greeves, N., Warren, S., Wothers, P., Organic Chemistry, Oxford University Press Inc., New York (2001).

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Subject Code	Paper Name	Credit
MJL04CHE	Chemistry Lab- IV	1

1. Identification of elements (N, S, and halogen) and Functional group tests for alcohols, phenols, carbonyl, carboxylic acid and amine group of compounds.
2. Organic preparations:
 - (i) Acetylation of one of the following compounds: amines (aniline, o-, m-, p-toluidines and o-, m-, p-anisidine) and phenols (β -naphthol, vanillin, salicylic acid) by any one method: (Using conventional method and using green chemistry approach)
 - (ii) Benzoylation of one of the amines (aniline, o-, m-, p-toluidines and o-, m-, p-anisidine) and one of the phenols (β -naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction.
 - (iii) Nitration: (any one)
 - a. Acetanilide/nitrobenzene by conventional method
 - b. Salicylic acid by green approach (using ceric ammonium nitrate).
 - (iv) Hydrolysis of amides and esters.
 - (v) Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
3. Collected solid samples may be used for recrystallization, melting point and TLC.
4. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, nitro compounds, amines and amides).
5. Preparation of methyl orange.

Reference Books

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

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Subject Code	Paper Name	Credit
MJ05CHE	Physical Chemistry - II	3

Unit 1: Introduction to 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 adiabatic conditions.

Thermochemistry: Heat 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.

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 irreversible processes.

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

Unit 2 : 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.

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.

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Unit 3: 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. Coupling of exoergic and endoergic reactions. 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); equilibrium between ideal gases and a pure condensed phase.

Unit 4: Solutions and Colligative Properties:

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions.

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

Reference Books:

- Laideler K. J. and Meiser J. M. Physical Chemistry Third Edition (International) 1999
- Levine I. N., Physical Chemistry, Fourth Edition, McGraw-Hill (International), 1995.
- McQuarrie D. A. and Simon J. D. Physical Chemistry- A Molecular Approach, University Science Books, 1998.
- Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
- House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
- Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004)

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Subject Code	Paper Name	Credit
MJL05CHE	Chemistry Lab - V	1

1. Determination of water equivalent of calorimeter.
2. Determination of heat of neutralization of HCl and NaOH.
3. Determination of heat of neutralization of acetic acid and NaOH.
4. Determination of heat of solution of ammonium chloride.
5. Determination of critical solution temperature (CST of phenol-water system).
6. Determination of effect of impurity (NaCl) on critical solution temperature of phenol-water system.
7. Determination of molecular weight of volatile compound by Victor Meyer method.
8. Determination of enthalpy of hydration of copper sulphate.
9. Study of the solubility of benzoic acid in water and determination of ΔH .

Reference Books

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

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B.Sc. Chemistry SEMESTER - IV

Subject Code	Paper Name	Credit
MJ06CHE	Inorganic Chemistry - II	3

Unit 1: Chemistry of s and p Block Elements:

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification: ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

Structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, phosphorus and chlorine. Per-oxo acids of Sulphur inter-halogen compounds, poly- halide ions, pseudo-halogens.

Unit 2: Noble Gases:

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2 , XeF_4 and XeF_6 , Bonding in noble gas compounds (Valence bond and MO treatment for XeF_2), Shape of noble gas compounds (VSEPR theory).

Unit 3: 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 Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

Unit 4: Acids and Bases

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

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Reference Books:

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E, Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed. John Wiley Sons, N.Y. 1994.
- Greenwood, N.N., Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
- Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
- Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry Fourth Ed., Pearson, 2010
- Shriver & Atkins, Inorganic Chemistry 5th Ed..

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Subject Code	Paper Name	Credit
MJ06GEO	Chemistry Lab- VI	1

(A) Iodo / Iodimetric Titrations

- (i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).
- (ii) Estimation of available chlorine in bleaching powder iodometrically.

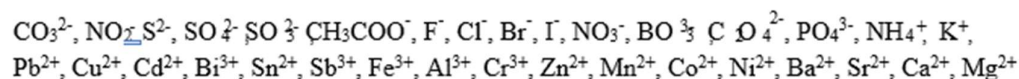
(B) Inorganic preparations

- (i) Cuprous Chloride, Cu_2Cl_2
- (ii) Preparation of Aluminium potassium sulphate (Potash alum) or Chrome alum.

(C) Qualitative semimicro analysis of mixtures

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given on the understanding of chemistry of different reactions.

Following radicals may be analyzed:



mixtures should preferably contain:

- (i) one interfering anion, or
- (ii) insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) or
- (iii) combination of anions e.g. CO_3^{2-} and SO_3^{2-} , NO_2^- and NO_3^- .

Note: Spot analyses/tests should be done wherever possible.

Reference Books

- Mendham, J., A. I. Vogel's Quantitative Chemical Analysis Sixth Edition Pearson, 2009.
- Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla. Pearson Education, 2002.
- Marr & Rockett Practical Inorganic Chemistry. John Wiley & Sons 1972.

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJ07CHE	Spectroscopy	3

Unit 1: UV Spectroscopy:

Types of electronic transitions, λ_{\max} , Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption, Application of Woodward - Fieser rules for calculation of λ_{\max} for the following systems: α , β -unsaturated aldehydes, ketones, carboxylic acids and esters, Conjugated dienes: alicyclic, homoannular and heteroannular and extended conjugated systems (aldehydes, ketones and dienes). Distinction between cis and trans isomers.

General principles Introduction to absorption and emission spectroscopy.

Unit 2: IR Spectroscopy:

Fundamental and non-fundamental molecular vibrations, Infrared radiation and types of molecular vibrations. 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). Effect of H-bonding, conjugation, resonance and ring size on IR absorptions, Fingerprint region and its significance, application in functional group analysis.

Unit 3: NMR Spectroscopy and Mass Spectroscopy:

- (i) **NMR Spectroscopy:** Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it, Spin-Spin coupling and coupling constant, Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds.
- (ii) **Mass Spectroscopy:** Application of fragmentation rule in characterization of organic compounds. Problems on structure elucidation of organic compounds based on spectral data. Applications of IR, UV, NMR and Mass spectra for identification of simple organic molecules.

Unit 4: Electronic Spectroscopy:

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

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Photophysical and Photochemical Processes: Laws of photochemistry, quantum yield. Jablonski diagrams: Law of photochemical equivalence, quantum efficiency, low and high quantum efficiency. kinetics of photochemical reactions ($\text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr}$, $2\text{HI} \rightarrow \text{H}_2 + \text{I}_2$), energy transfer in photochemical reactions (photosensitization and quenching), fluorescence, phosphorescence, chemiluminescence, Discussion of Electronic spectra and photochemistry (Lambert-Beer law and its applications).

Reference Books:

- Laideler K. J. and Meiser J. M. Physical Chemistry Third Edition (International) 1999
- Levine I. N., Physical Chemistry, Fourth Edition, McGraw-Hill (International), 1995.
- McQuarrie D. A. and Simon J. D. Physical Chemistry- A Molecular Approach, University Science Books, 1998
- Rohatgi-Mukherjee K. K. Fundamentals of Photochemistry, New age (revised second edition).
- Banwell C.N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw- Hill: New Delhi (2006).
- R.M. Silverstein, G.C. Bassler & T.C. Morrill: Spectroscopic Identification of Organic Compounds, John Wiley & Sons.
- John R. Dyer, Applications of absorption spectroscopy of organic compounds, Prentice Hall India (2012).

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJL07CHE	Chemistry Lab-VII	1

1. Purification method for liquid, solid organic substance (distillation, recrystallization, chromatography)
2. Determination of indicator constant - colorimetry. (instructor may vary indicators available in the lab).
3. Verification of Beer's Law - Determination of concentration of solution by colourimetry. (Instructor may explain the principle of using colourimeter, its handling drawing standard calibration curve, and its application in finding unknown concentration of dyes, concentration of metal solutions (e.g. Ni, Cu using appropriate reagent) from standard calibration curve.
4. Identification of functional groups of simple organic compounds by IR spectroscopy and NMR spectroscopy(Sample spectra may be provided for simple organic compounds like Ethanol, Aniline, Phenol, acetic acid, other simple aldehydes, carboxylic acid, etc., for identification of functional groups. References from standard spectroscopy books may also be taken for such purpose for enhancing students understanding and skill).
5. Project: Collect IR, NMR, UV-VIS spectra from available sources and make a Project on "Spectroscopic identification of Organic Compounds"

Reference Books

- Practicals in physical chemistry – a modern approach, P.S. Sindhu, Macmillan,
- Experiments in Physical Chemistry, J. M. Wilson, R.J. Newcomb, A.R. Denaro, 2nd Edn.,Elsevier.

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJ08CHE	Organic Chemistry - III	3

Unit 1: Nitrogen Containing Functional Groups:

Preparation and important reactions of nitro and compounds, nitriles and isonitriles 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.

Diazonium Salts: Preparation and their synthetic applications.

Unit 2: 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, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis,

Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction

Derivatives of furan: Furfural and furoic acid.

Unit 3: Polynuclear Hydrocarbons:

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

Unit 4: Alkaloids and Terpenes:

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.

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

Reference Books:

- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products),
Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).
- Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
- Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
- Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Parakashan (2010)

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJ08CHE	Chemistry Lab- VIII	1

1. Detection of extra elements.
2. Functional group test for nitro, amine and amide groups.
3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)

Reference Books:

- A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
- A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.
- Furniss, B.S., Hannaford, A.J., Rogers, V., Smith, P.W.G., Tatchell, A.R.
- Vogel's Textbook of Practical Organic Chemistry, ELBS.
- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000)

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B.Sc. Chemistry SEMESTER - V

Subject Code	Paper Name	Credit
MJ09CHE	Physical Chemistry - III	3

Unit 1: Chemical Kinetics:

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (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, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates

Unit 2: Phase Equilibria:

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. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems, water-chloroform-acetic acid system, triangular plots. Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

Unit 3: Surface Chemistry:

Surface Chemistry: Physical adsorption, chemisorption, adsorption isotherms (Freundlich, Temkin, derivation of Langmuir adsorption isotherms, surface area determination), BET theory of multilayer adsorption (no derivation), Adsorption in solution.

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Unit 4: 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.

Reference Books:

- Atkins P. and De Paula, J. Physical Chemistry Tenth Ed., OUP, 2014.
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa, 2004.
- Engel, T. and Reid, P. Physical Chemistry 3rd Ed., Prentice Hall, 2012.
- McQuarrie, D. A. and Simon, J. D. Molecular Thermodynamics Viva Books, 2004.
- Roy, B. N. Fundamentals of Classical and Statistical Thermodynamics Wiley, 2001
- Commonly Asked Questions in Thermodynamics. CRC Press, 2011.
- Levine, I. N. Physical Chemistry 6th Ed., Tata Mc Graw Hill, 2010.
- Metz, C.R. 2000 Solved Problems in Chemistry, Schaum Series, 2006.
- Zundhal, S.S. Chemistry concepts and applications Cengage India, 2011 6 Ball, D. W. Physical Chemistry Cengage India, 2012.
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP, 2009.
- Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill, 2011.

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJL09CHE	Chemistry Lab- IX	1

A. Kinetics

1. Study the kinetics of the following reactions.
 - a. Acid hydrolysis of methyl acetate with hydrochloric acid.
 - b. Saponification of ethyl acetate.
 - c. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
 - d. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:
 - a. simple eutectic and
 - b. congruently melting systems.

B. Adsorption

2. Verification of Freundlich and Langmuir isotherms for adsorption of acetic acid and selected organic dye(s) on activated charcoal.
3. Preparation of $\text{Fe}(\text{OH})_3$ sols.
4. Study of adsorption of acetic acid on charcoal.

C. Conductometry

5. Determination of cell constant
6. Equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
7. Conductometric titrations of: Strong acid Vs. strong base (ii) Weak acid vs. strong base, (iii) Mixture of strong acid and (iv) weak acid vs. strong base, Strong acid vs. weak base.

D. Potentiometry

8. Potentiometric titrations of: (i) Strong acid vs. strong base (ii) Weak acid vs. strong base (iii) Dibasic acid vs. strong base (iv) Potassium dichromate vs. Mohr's salt.

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Reference Books

- Khosla, B. D., Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand, N. Delhi, 2011.
- Garland, C. W., Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry, Eighth Edition, McGraw-Hill (2003).
- Halpern, A. M. and Mc Bane, G. C. Experimental Physical Chemistry, Third Edition, W, H.Freeman (2003).

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJ10CHE	Inorganic Chemistry-III	3

Unit 1: Bioinorganic Chemistry:

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium/ 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; Storage and transfer of iron.

Unit 2: Coordination Chemistry:

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of $10 Dq$ (Δ_o), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of $10 Dq$ (Δ_o , Δ_t). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds.

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

Unit 3: Transition Elements:

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, 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. Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy).

Unit 4: Lanthanoids and Actinoids:

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

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Reference Books

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E, Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed. John Wiley Sons, N.Y. 1994.
- Greenwood, N.N., Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
- Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
- Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry Fourth Ed., Pearson, 2010
- Atkins, P. W and Shriver D. N. Atkins' Inorganic Chemistry 5th Ed. Oxford University Press(2010).
- Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
- Basolo, F, and Pearson, R.C. Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJL10CHE	Chemistry Lab- X	1

A. Gravimetric Analysis:

1. Estimation of nickel (II) using Dimethylglyoxime (DMG).
2. Estimation of copper as CuSCN
3. Estimation of iron as Fe₂O₃ by precipitating iron as Fe(OH)₃.
4. Estimation of Al (III) by precipitating with oxine and weighing as Al(oxiMe)₃ (aluminium oxinate).

B. Inorganic Preparations:

1. Tetraamminecopper (II) sulphate, [Cu(NH₃)₄]SO₄.H₂O
2. Cis and trans K[Cr(C₂O₄)₂. (H₂O)₂] Potassium dioxalatodiaquachromate (III)
3. Tetraamminecarbonatocobalt (III) ion
4. Potassium tris(oxalate)ferrate(III)

C. Chromatography of Metal Ions:

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

1. Ni (II) and Co (II)
2. Fe (III) and Al (III)

Reference Books

- Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJ11CHE	Physical Chemistry-IV	3

Unit 1: Electrochemistry:

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

Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.

Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and $\text{SbO/Sb}_2\text{O}_3$ electrodes.

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).

Unit 2: Conductance:

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.

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods.

Unit 3: Applications of Conductance:

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.

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Unit 4: Electrical & Magnetic Properties of Atoms and Molecules:

Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements.

Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.

Reference Books

- Atkins, P.W & Paula, J.D. Physical Chemistry, 9th Ed., Oxford University Press (2011).
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
- Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Rogers, D. W. Concise Physical Chemistry Wiley (2010).
- Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005)

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJL11CHE	Chemistry Lab- XI	1

A. Conductometry:

1. Determination of cell constant
2. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
3. Perform the following conductometric titrations:
 - a. Strong acid vs. strong base
 - b. Weak acid vs. strong base
 - c. Mixture of strong acid and weak acid vs. strong base
 - d. Strong acid vs. weak base

B. Potentiometry:

1. Perform the following potentiometric titrations:
 - a. Strong acid vs. strong base
 - b. Weak acid vs. strong base
 - c. Dibasic acid vs. strong base
 - d. Potassium dichromate vs. Mohr's salt

Reference Books

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

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B.Sc. Chemistry SEMESTER – VI

Subject Code	Paper Name	Credit
MJ12CHE	Organic Chemistry-IV	3

Unit 1: Amino Acids, Peptides and Proteins:

Amino acids, Peptides and their classification.

α -Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis;

Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis

Unit 2: 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 stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

Unit 3: Lipids:

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

Unit 4: Pharmaceutical Compounds:

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).

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Reference Books

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.
- Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
- 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.

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Subject Code	Paper Name	Credit
MJL12CHE	Chemistry Lab- XII	1

1. Estimation of glycine by Sorenson's formalin method.
2. Study of the titration curve of glycine.
3. Estimation of proteins by Lowry's method.
4. Study of the action of salivary amylase on starch at optimum conditions.
5. Effect of temperature on the action of salivary amylase.
6. Saponification value of an oil or a fat.
7. Determination of Iodine number of an oil/ fat.

Reference Books:

- Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
- Arthur, I. V. Quantitative Organic Analysis, Pearson.

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJ13CHE	Inorganic Chemistry-IV	3

Unit 1: Organometallic Compounds:

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 back bonding.

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

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

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

Unit 2: Theoretical Principles in Qualitative Analysis (H₂S 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, borate, oxalate and phosphate) and need to remove them after Group II.

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Unit 3: Reaction Kinetics and Mechanism:

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

Unit 4: Catalysis by Organometallic Compounds:

Study of the following industrial processes and their mechanism: Alkene hydrogenation (Wilkinson's Catalyst), Hydroformylation (Co salts), Wacker Process, Synthetic gasoline (Fischer Tropsch reaction), synthesis gas by metal carbonyl complexes

Reference Books

- Vogel, A.I. Qualitative Inorganic Analysis, Longman, 1972 Svehla, G.
- Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall, 1996-03-07.
- Cotton, F.A. G.; Wilkinson & Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.; Wiley India,
- Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
- Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005
- Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry 3rd Ed., John Wiley and Sons, NY, 1994.
- Greenwood, N.N. & Earnshaw, A. Chemistry of the Elements, Elsevier 2nd Ed, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
- Lee, J.D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008.
- Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
- Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
- Basolo, F. & Person, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.
- Purcell, K.F. & Kotz, J.C., Inorganic Chemistry, W.B. Saunders Co. 1977
- Miessler, G. L. & Donald, A. Tarr, Inorganic Chemistry 4th Ed., Pearson, 2010.

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- Collman, James P. et al. Principles and Applications of Organotransition Metal Chemistry. Mill Valley, CA: University Science Books, 1987.

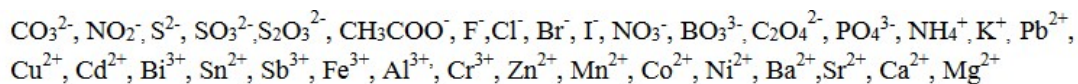
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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJL13CHE	Chemistry Lab- XIII	1

Qualitative semi micro analysis of mixtures containing 3 anions and 3 cations.

The following radicals are suggested:



Mixtures should preferably contain:

- one interfering anion, or
- insoluble component (BaSO_4 , SrSO_4 , PbSO_4 , CaF_2 or Al_2O_3) or
- combination of 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^- .

Spot tests should be done whenever possible.

- Measurement of 10 Dq by spectrophotometric method
- Verification of spectrochemical series.
- Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs thermodynamic factors.
- Preparation of acetylacetonato complexes of $\text{Cu}^{2+}/\text{Fe}^{3+}$. Find the λ_{max} of the complex.
- Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method

Reference Books:

- Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla.
- Marr & Rockett Inorganic Preparations

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Subject Code	Paper Name	Credit
MJ14	Quantum Chemistry and Photochemistry	3

Unit 1: Quantum Chemistry:

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and “particle-in-a-box” (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.

Unit 2: Simple Harmonic Oscillator:

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. 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. Spherical harmonics. Discussion of solution.

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression).

Average and most probable distances of electron from nucleus.

Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Unit 3: Valence Bond and Molecular Orbital Approaches:

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. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB).

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Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2 , H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

Unit 4: Photochemistry:

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

Reference Books

- Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw- Hill: New Delhi (2006).
- Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
- House, J. E. Fundamentals of Quantum Chemistry 2ndEd. Elsevier: USA (2004).
- Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
- Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015)

RKDF UNIVERSITY RANCHI

B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJL14	Chemistry Lab-XIV	1

Colourimetry

1. Verify Lambert-Beer's law and determine the concentration of $\text{CuSO}_4/\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ in a solution of unknown concentration.
2. Determine the concentrations of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ in a mixture..
3. Study the kinetics of iodination of propanone in acidic medium.
4. Determine the amount of iron present in a sample using 1,10-phenanthroline.
5. Determine the dissociation constant of an indicator (phenolphthalein).
6. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.
7. Analysis of the given vibration-rotation spectrum of $\text{HCl}(\text{g})$

Reference Books:

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

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJ15	Biomolecules and Macromolecules	3

Unit 1: 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 projections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation;

Disaccharides: Structure elucidation of maltose, lactose and sucrose.

Polysaccharides: Elementary treatment of starch, cellulose and glycogen.

Unit 2: Nucleic Acids:

Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides.

Unit 3: Polymers:

Introduction and classification including di-block, tri-block and amphiphilic polymers; Number average molecular weight, Weight average molecular weight, Degree of polymerization, Polydispersity Index.

Polymerisation reactions: Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene);

Fabrics: natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives; Introduction to liquid crystal polymers; Biodegradable and conducting polymers with examples.

Unit 4: 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).

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Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet;

Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes –structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.

Reference Books

- Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Billmeyer, F. W. Textbook of Polymer Science, John Wiley & Sons, Inc.
- Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. Polymer Science, New Age International (P) Ltd. Pub.
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products),
Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
- Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Prakashan (2010).

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJL15CHE	Chemistry Lab-XV	1

1. Extraction of caffeine from tea leaves.
2. Preparation of sodium polyacrylate.
3. Preparation of urea formaldehyde.
4. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.
5. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols etc.
6. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
7. Preparation of methyl orange.
8. Isolation and characterization of DNA from onion/ cauliflower/peas.

Reference Books

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

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B.Sc. Chemistry SEMESTER – VII

Subject Code	Paper Name	Credit
MJ16CHE	Analytical Chemistry	3

Unit 1: 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.

Unit 2: Thermal Methods of Analysis:

Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

Unit 3: Electroanalytical Methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points.

Techniques used for the determination of pKa values.

Unit 4: Optical Methods of Analysis:

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 of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;

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.

Flame Atomic Absorption and Emission 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.

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B.Sc. Chemistry

Reference Books

- Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .
- Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
- Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
- Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
- Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
- Ditts, R.V. Analytical Chemistry – Methods of separation.

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJL16CHE	Chemistry Lab-XVI	1

1. Determination of pKa values of indicator using spectrophotometry.
2. Structural characterization of compounds by infrared spectroscopy.
3. Determination of dissolved oxygen in water.
4. Determination of chemical oxygen demand (COD).
5. Determination of Biological oxygen demand (BOD).
6. Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method

Reference Books

- Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H Jeffery and others) 5th Ed. The English Language Book Society of Longman .
- Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
- Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
- Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJ17CHE	Polymer Chemistry	3

Unit 1: Introduction to Polymers:

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 2: Kinetics of Polymerization:

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.

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

Determination of molecular weight of polymers (M_n , M_w , etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Unit 3: Properties of Polymers:

Brief introduction to preparation, structure, properties (physical, thermal, Flow & mechanical properties) and application of the following polymers:

polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,

Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)]

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Unit 4: Polymer Solution:

Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

Determination of molecular weight of polymers (M_n , M_w , etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Glass transition temperature (T_g) and determination of T_g , Free volume theory, WLF equation, Factors affecting glass transition temperature (T_g).

Reference Books

- Seymour's Polymer Chemistry, Marcel Dekker, Inc.
- G. Odian: Principles of Polymerization, John Wiley.
- F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
- P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
- R.W. Lenz: Organic Chemistry of Synthetic High Polymers.

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJL17CHE	Chemistry Lab-XVII	1

A. Polymer Synthesis:

1. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutyronitrile (AIBN)
2. Preparation of nylon 66/6
3. Preparations of novalac resin/resold resin.
4. Microscale Emulsion Polymerization of Poly(methylacrylate).
5. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
6. Purification of monomer

B. Polymer Characterization:

1. Determination of molecular weight by viscometry:
 - i. Polyacrylamide-aq.NaNO₂ solution
 - ii. (Poly vinyl propylidene (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).

C. Polymer Analysis:

1. Instrumental Techniques
2. IR studies of polymers
3. DSC analysis of polymers

Reference Books

- Ditts, R.V. Analytical Chemistry – Methods of separation
- Malcohm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.
- Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003)
- Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)

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- Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)
- Petr Munk and Tejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002)
- L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005)
- Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005)
- Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013)

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJ18CHE	Green Chemistry	3

Unit 1: Introduction to Green Chemistry:

Definition of Green Chemistry, Need for Green Chemistry. Goals of Green Chemistry.

Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

Unit 2: Principles of Green Chemistry and Designing a Chemical Synthesis:

Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Unit 3: Examples of Green Synthesis/ Reactions:

Green Synthesis of the these compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to Strecker **synthesis**), **citral**, **ibuprofen**, **paracetamol**, **furfural**.

Microwave assisted reactions in Water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols).

Microwave assisted reactions in Organic Solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation.

Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes;

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anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2-dihydrotriazine derivatives; benzimidazoles.

Ultrasound assisted Reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.

Selective Methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of “Clayan”, a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.

Unit 4: Future Trends in Green Chemistry:

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development.

Reference Books

- V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
- P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
- A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
- M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
- M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

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Subject Code	Paper Name	Credit
MJL18CHE	Chemistry Lab-XVIII	1

1. *Use of enzymes as catalysts*: Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.
2. *Using renewable resources*: Preparation of biodiesel from vegetable oil.
3. *Diels Alder reaction in water*: Reaction between furan and maleic acid in water and at room temperature rather than in benzene and reflux.
4. Extraction of D-limonene from orange peel using liquid CO₂ prepared from dry ice
5. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of Copper(II).
6. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Reference Books

- Anastas, P.T & Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press (1998).
- Kirchoff, M. & Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC (2002).
- Ryan, M.A. Introduction to Green Chemistry, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
- Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore CISBN 978-93-81141-55-7 (2013).
- Cann, M.C. & Connelly, M. E. Real world cases in Green Chemistry, American Chemical Society (2008).
- Cann, M. C. & Thomas, P. Real world cases in Green Chemistry, American Chemical Society (2008).

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJ19CHE	Industrial and Environmental Chemistry	3

Unit1: Industrial Gases and Inorganic Chemicals:

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

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

Unit 2: Industrial Metallurgy:

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

Unit 3: Energy & Environment:

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion/ Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Unit 4: Environmental Pollution:

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 SO₂, CO₂, CO, NO_x, H₂S and other foul smelling gases. Methods of estimation of CO, NO_x, SO_x 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. Control of particulates.

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Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature 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, annery, dairy, petroleum and petrochemicals, agro, fertilizer, etc.

Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

Reference Books

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
- K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.
- S.E. Manahan, Environmental Chemistry, CRC Press (2005).
- G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
- A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005)

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJL19CHE	Chemistry Lab-XIX	1

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO_3 and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-} , HCO_3^-) using double titration method.
7. Measurement of dissolved CO_2 .
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid

Reference Books

- R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
- K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.

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B.Sc. Chemistry SEMESTER - VIII

Subject Code	Paper Name	Credit
MJ20CHE	Fuel Chemistry	3

Unit 1 : Review of Energy Sources:

Renewable and non-renewable Sources of Energy.

History of Fuels: Review of energy sources (renewable and non-renewable). History of solid, liquid and gaseous fuels, Definitions and properties of solid fuels, Definitions and properties of liquid and gaseous fuels, Production and Consumption pattern of fuels Various measurement techniques.

Classification of fuels and their calorific value.

Unit 2: Coal:

Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Unit 3: Petroleum and Petrochemical Industry:

Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.

Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives, Xylene.

Unit 4: Lubricants:

Classification of lubricants, lubricating oils (conducting and non-conducting)

Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

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Reference Books:

1. E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
3. B.K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut.

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
MJL20CHE	Chemistry Lab-XX	1

1. To determine the calorific value and water equivalent of a supplied sample by using
2. Bomb calorimeter (manually)
3. To determine the calorific value and water equivalent of a supplied sample by using
4. Bomb calorimeter (Automatically)
5. To determine the proximate analysis of coal sample
6. To determine the ultimate analysis of the coal sample

Reference Books:

1. P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
2. B.K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut.

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
AMJ01	Nanochemistry	3

Unit 1: Introduction to Nanoscience, Nanostructure and Nanotechnology:

Basic idea; Overview of nanostructures and nano-materials, classification, (cluster, colloid, nanoparticles, and nanostructures -Spheroid, Wire, Rod, Tube, and Quantum Dot), Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures, control of nano-architecture- one dimensional control. Carbon nanotubes and inorganic nanowires. Calculation of percentage of surface atom and surface to volume ratio of spherical, wire, rod and disc shapes nanoparticles.

Unit 2: Size Dependent Properties of Nanomaterials:

Basic idea with few examples only: Quantum confinement, Electrical, Optical (Surface Plasmon resonance), variation in colours (Blueshift & Red shift), Magnetic, thermal and catalytic properties.

Unit 3: Synthesis of Nanomaterials:

Brief introduction about Top-down and Bottom-up approaches & self-assembly techniques of nanoparticles synthesis, Solvothermal process, Examples of preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires.

Unit 4: Chemistry of Small Surfaces:

Curvature and neighboring-charge effects on chemical reactivity and equilibria (pKa's, redox potentials), Applications in structural materials, lighting, energy conversion (Solar Cells) and catalysis applications, Environmental, safety, and ethical aspects of nanotechnology.

Reference Books:

- Zhen Guo and Li Tan, Fundamentals and Applications of Nanomaterials.2009, Artech House,LondonPublication.
- C. N. R. Rao, A. Muller, A. K. Cheetam, The Chemistry of Nanomaterials: Synthesis,Properties and Applications, Willey-VCH Verlag, Germany, 2005.

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- G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, ImperialCollege Press, London, 2004
- R. W. Kelsall, I. W. Hameley, M. Geoghegan, Nanoscale Science and Technology, JohnWiley& Sons, England, 2005
- Charles P. Poole and Frank J Owens, Introduction to nano technology, Wiley Interscience, 2003.
- Pradeep, T., A text of book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
AMJL01	Advanced Chemistry Lab-I	1

1. Synthesis of ZnO nanoparticles.
2. Synthesis of nanoparticles.

Reference Books

- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.
- Garland, C. W., Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed., McGraw-Hill: New York (2003).

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
AMJ02CHE	Advanced Analytical Chemistry	3

Unit 1: Statistical methods in Chemical Analysis:

Theory of error and treatment of quantitative data, accuracy and precision, ways of expressing accuracy and precision, Normal error curve and its equation. Useful statistical tests with equation, test of significance, the F-test, Q-test, the students t-test, the Chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, regression analysis (least square method).

Unit 2: Separation Techniques:

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique. Paper, column and thin layer chromatography, Gas-liquid chromatography, HPLC.

Mechanism of Separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Stereoisomeric Separation and Analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis.

Unit 3: Polarography:

Current-voltage relationship, theory of polarographic waves, instrumentation, qualitative and quantitative applications.

Atomic Spectroscopy: Atomic absorption spectroscopy, theory and application (with some examples).

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Unit 4: Analysis of Fuel and Drugs:

Fuel Analysis: Solid, liquid and gaseous fuels, general properties of fuels, ultimate and proximate analysis of solid fuel, Determination of calorific value of solid, liquid and gaseous fuels, Flash point and fire point.

Drug Analysis: Classification of drugs, Analysis of some standard drug using various chromatographic techniques.

Reference Books

- Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
- Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. WardsworthPublishingCalifornia, USA, 1988.
- Christian, G.D, Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, D.C.: Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
- Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis
- Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, EllesHarwoodJohn Wiley 1979.
- Ditts, R.V. Analytical Chemistry, Methods of separation, van Nostrand, 1974.
- Khopkar, S. M., Basic Concepts of Analytical Chemistry, New Age (Second edition) 1998
- Ditts, R.V. Analytical Chemistry – Methods of separation.

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
AMJL02CHE	Advanced Chemistry Lab-II	1

1. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
2. Preparation of buffer solutions of different pH (i. Sodium acetate-acetic acid, ii. Ammonium chloride-ammonium hydroxide)
3. Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:
 - a. Ni (II) and Co (II)
 - b. Fe (III) and Al (III)
4. Chromatographic separation of the active ingredients of plants, flowers and juices by TLC.
5. Determination of flash point & fire point of given fuel sample.
6. Determination of viscosity index, cloud point, pour point of given fuel sample.
7. Determination of calorific value of given fuel sample/coal sample using bomb calorimeter.
10. Proximate analysis of given coal sample.
11. Determination of the iodine number of oil.
12. Determination of the saponification number of oil.

Reference Books

- Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
- Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009
- Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.
- Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. WardsworthPublishingCalifornia, USA, 1988.
- Christian, G.D, Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004. 4
Harris, D.C.: Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.5
Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis

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- Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, EllesHarwoodJohn Wiley 1979.
- Ditts, R.V. Analytical Chemistry, Methods of separation, van Nostrand, 1974.

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
AMJ03CHE	Organometallic and Bioinorganic Chemistry	3

Unit 1: Organometallic Compounds:

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.

Unit 2: Synergic Effects:

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)- (MO diagram of CO can be referred to for synergic effect to IR frequencies).

Unit 3: Metal Carbonyls:

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 back bonding.

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeise's salt and ferrocene. Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

Unit 4: 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, Schlenk equilibrium.

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Unit 5: Bioinorganic Chemistry:

A brief introduction to bio-inorganic chemistry. Geochemical effect on distribution of metals. Role of metal ions present in biological systems with special reference to Na^+ , K^+ and Mg^{2+} ions: Na/K pump, Role of Mg^{2+} ions in energy production and chlorophyll. Iron and its application in bio- systems, Haemoglobin, Storage and transfer of iron. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

Reference Books

- Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
- Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry Wiley-VCH, 1999
- Basolo, F, and Pearson, R.C. Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
- Greenwood, N.N. & Earnshaw A. Chemistry of the Elements, Butterworth-Heinemann, 1997

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B.Sc. Chemistry

Subject Code	Paper Name	Credit
AMJL03CHE	Advanced Major Chemistry Lab-III	3

1. Reaction of metal with halide – preparation of Grignard reagent. (only demonstration purpose)
2. Grignard preparation of dye (malachite green (using methylbenoate)/crystal violet (using diethylcarbonate) (starting material as p-bromo N, N-dimethyl aniline) (only demonstration purpose)
3. Preparation of various Schiff base-metal complexes and their identification using spectroscopy.
4. Preparation of any two of the following complexes and measurement of their conductivity measurement:
 - a) tetraamminecarbonatocobalt (III) nitrate
 - b) tetraamminecopper (II) sulphate
 - c) potassium trioxalatoferrate (III) trihydrate

Reference Books

- Synthesis of organometallic compounds: A practical guide, S. Komiya, Wiley.
- A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall,

Or

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Subject Code	Paper Name	Credit
RS-1	Research Methodology	4

Unit- I

- Research: Meaning, definition and objective of research.
- Types of Research- Descriptive vs. Analytical, applied vs. fundamental, Quantitative vs. Qualitative, Conceptual vs. empirical
- Significance of research
- Research Designs: Meaning, concept, Need, Designs for deferent types of research, Library, Laboratory, and Field research, Advantages of designing research,
- Research problems and developing research proposal: selection of research area and topic, statement of research problems, its scope, types involve in defining the problem
- Defining concept, objective, basic assumptions delimitation and limitations of the problems, statement of hypothesis.

Unit -II

- Variables: Independent and dependent variable, quantitative and qualitative variable, Discrete and continuous variables, confounding variables, methods of controlling variables, measurement of variables.
- Sampling: meaning, characteristic of good sample design, steep in sampling design, types, advantages.
- Techniques of primary data collection: Questionnaire, Schedule, Interview, Observation and other methods.
- Secondary Data Criterion: Reliability, suitability and adequacy of data.
- Report writing: types and format.

Unit - III

- Processing and analysis of data: Processing operation – Editing, Coding, Classification and tabulation of Data- Cartographic presentation of data, elements of data analysis, role of statistics in data analysis, statistical table.

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- Probability: Basic aspects, probability of combination of events, probability of random variables, distribution of random variables.
- Measures of central tendency- mean median and mode.
- Common distribution functions: binomial probability distribution and normal distribution curve.
- Measures of dispersion: range, mean deviation, variance, standard deviation, coefficient of variation.
- Regression and correlation: least square methods of fitting a regression line, curvilinear.

Recommended Books:

- Clifford, Nicholas and Valentine, Gill (2003): *Key Methods in Geography*, Sage Publications, London.
- Gerber, Rod and Chuan, G.K. eds. (2000): *Field workin Geography–Reflection, Perspective and Action*, Kluwer Academic Publishers, Dordrecht.
- Gomez, Basil and Jones, J.P.ed.s. (2010): *Research Methods in Geography*, Wiley-Black Well, Sussex.
- Kothari, C.R. and Garg, Gaurav (2019): *Research Methodology – Methods and Techniques*, 4th Multi Colour Edition, New Age International Publications, New Delhi.
- Misra, H.N. and Singh, V.P. (2019): *Research Methodology in Geography*, Rawat Publications, Jaipur.
- Murthy, K.L.N. (2014): *Research Methodology in Geography–A Textbook*, Concept Publishing Company, New Delhi.
- Sarma, Mukunda (2021):*Research Methodology*, EBH Publishers (India), Guwahati.
Stoddard, R.H. (2010): *Field Techniques and Research Methods in Geography*, National Council for Geographic Education and Digital Common @ University of Nebraska, Lingol, sNebraska.

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Subject Code	Paper Name	Credit
RS-2	Research Proposal	4

Process of writing a research proposal

That includes the following points:

1. TITLE.
2. INTRODUCTION
3. REVIEW OF LITERATURE (BACKGROUND AND RATIONALE)
4. RESEARCH QUESTION (S)/ HYPOTHESIS
5. AIMS & OBJECTIVES
6. RESEARCH METHODOLOGY.
7. WORK PLAN
8. Use of tools techniques for Research: methods to search required in formation effectively, MS Office, Software for detection of Plagiarism.
9. REFERENCE/ BIBLIOGRAPHY.

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Subject Code	Paper Name	Credit
RS-3	Research Proposal	4

Dissertation

Topic -

chapter 1 Introduction

chapter 2 review of literature

chapter 3. study area profile

chapter 4 profile of selected respondent

chapter 5 related with your topic

chapter 6 related with your topic

chapter 7 Conclusion and suggestions.

bibliography

appendix A important concept and formulas

appendix B abbreviation

appendix C local terms/ words

questionnaire

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Subject Code	Paper Name	Credit
MN01	Chemistry-I	3

Unit 1: Atomic Structure:

Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

Quantum mechanics: Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2 , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s . Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s).

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

Unit 2: Chemical Bonding and Molecular Structure:

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, 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, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

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.

Concept of resonance and resonating structures in various inorganic and organic compounds.

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, nonbonding combination

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of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO⁺. Comparison of VB and MO approaches.

Unit 3: 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 free radicals.

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

Unit 4: 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: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis – trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Unit 5: Aliphatic Hydrocarbons:

Alkanes: Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation

Alkenes: Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides

(Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans-alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO₄) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

Alkynes: Preparation: Acetylene from CaC₂ and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: Formation of metal acetylides, addition of bromine and alkaline KMnO₄, ozonolysis and oxidation with hot alk. KMnO₄.

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Reference Books:

- J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.
- F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
- Douglas, McDaniel and Alexander: Concepts and Models in Inorganic Chemistry, John Wiley.
- James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
- T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.
- I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
- Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chan.

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Subject Code	Paper Name	Credit
MNL01CHE	Chemistry-I Lab	1

A. Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate 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 $\text{K}_2\text{Cr}_2\text{O}_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $\text{Na}_2\text{S}_2\text{O}_3$.

B: Organic Chemistry

1. Separation of mixtures by Chromatography: Measure the R_f value in each case (combination of two compounds to be given).
2. 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.
3. Identify and separate the sugars present in the given mixture by paper chromatography.
4. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)

Reference Books

- Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
- Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
- Textbook of Practical Organic Chemistry, A.I. Vogel, Prentice Hall, 5th edition.
- Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

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B.Sc. Chemistry

Semester -III

Subject Code	Paper Name	Credit
MN03CHE	Chemistry-II	3

Unit 1: 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 and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchoff's equation.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Unit 2: Chemical Equilibrium:

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG_0 , Le Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases

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

Unit 3: Aromatic Hydrocarbons:

Preparation of Benzene: from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions of Benzene: Electrophilic substitution-nitration, halogenation and sulphonation.

Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes .

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Unit 4: Alkyl and Aryl Halides:

Alkyl Halides : Types of Nucleophilic Substitution (SN_1 , SN_2 and SN_i) reactions.

Preparation from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

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 $NaNH_2/NH_3$).

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Unit 5: Alcohols, Phenols, Ethers, Aldehydes and Ketones:

Alcohols: Preparation- Preparation of 1° , 2° and 3° alcohols using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3).

Oppeneauer oxidation Diols: oxidation of diols. Pinacol- Pinacolone rearrangement.

Phenols: Preparation- Cumene hydroperoxide method, from diazonium salts.

Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten – Baumann Reaction.

Ethers : Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde) Preparation- from acid chlorides and from nitriles.

Reactionns: Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Reference Books

- T. W. Graham Solomons: Organic Chemistry, John Wiley and Sons.
- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.

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- Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
- G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
- G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
- J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009). B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
- R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985)

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Subject Code	Paper Name	Credit
MNL03CHE	Chemistry-II Lab	1

A: Physical Chemistry

Thermochemistry:

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 acetic acid.
3. Determination of integral enthalpy of solution of salts (KNO₃, NH₄Cl).
4. Determination of enthalpy of hydration of copper sulphate.
5. Study of the solubility of benzoic acid in water and determination of ΔH .

Ionic equilibria & pH measurements:

1. 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.
2. Preparation of buffer solutions:
 - i. Sodium acetate-acetic acid
 - ii. Ammonium chloride-ammonium hydroxide
3. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed.
4. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
 - i. Bromination of Phenol/Aniline
 - ii. Benzoylation of amines/phenols
 - iii. Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

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Reference Books

- A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
- F. G. Mann• & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

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Semester -V

Subject Code	Paper Name	Credit
MN05CHE	Chemistry-III	3

Unit 1: 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, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process.

Unit 2: s- and p-Block Elements:

Periodicity in s- and p-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-Rochow 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.

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: (NH₃, N₂H₄, N₃H, NH₂OH)

Oxoacids of P, S and Cl. Halides and oxohalides: PCl₃, PCl₅, SOCl₂ and SO₂Cl₂

Unit 3: Kinetic Theory of Gases:

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO₂.

Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature

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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).

Unit 4 : Liquids and Solids:

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)

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 interfacial angles, Law of rational indices. Miller indices. X-Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Unit 5: 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).*

Reference Books

- G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
- G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
- J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
- B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
- R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
- J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.

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- F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley. D. F. Shriver and P. W. Atkins: Inorganic Chemistry, Oxford University Press.
- Gary Wulfsberg: Inorganic Chemistry, Viva Books Pvt. Ltd.

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Subject Code	Paper Name	Credit
MNL05	Chemistry-III Lab	3

A: Inorganic Chemistry

Semi-micro qualitative analysis using H₂S of mixtures- not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations :

NH₄⁺, Pb²⁺, Ag⁺, Bi³⁺, Cu²⁺, Cd²⁺, Sn²⁺, Fe³⁺, Al³⁺, Co²⁺, Cr³⁺, Ni²⁺, Mn²⁺, Zn²⁺, Ba²⁺, Sr²⁺, Ca²⁺, K⁺

Anions :

CO₃²⁻, S₂⁻, SO₂⁻, S₂O₃²⁻, NO₃⁻, CH₃COO⁻, Cl⁻, Br⁻, I⁻, NO₃⁻, SO₄²⁻, PO₄³⁻, BO₃³⁻, C₂O₄²⁻, F⁻

(Spot tests should be carried out wherever feasible) Section

B: Physical Chemistry

1. Surface tension measurement (use of organic solvents excluded).
 - a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
 - b) Study of the variation of surface tension of a detergent solution with concentration.
2. Viscosity measurement (use of organic solvents excluded).
 - a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.
 - b) Study of the variation of viscosity of an aqueous solution with concentration of solute.
3. Chemical Kinetics
Study the kinetics of the following reactions.
 - a. Initial rate method: Iodide-persulphate reaction
 - b. Integrated rate method:
 - c. Acid hydrolysis of methyl acetate with hydrochloric acid.
 - d. Saponification of ethyl acetate.
 - e. Compare the strengths of HCl and H₂SO₄ by studying kinetics of hydrolysis of methyl acetate

Reference Books:

- A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.

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- A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

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B.Sc. Chemistry Semester -VII

Subject Code	Paper Name	Credit
MN07	Chemistry-IV	3

Unit 1: Transition Elements (3d series):

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Unit 2: Coordination Chemistry and Crystal Field Theory

Coordination Chemistry: Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature.

Crystal Field Theory: Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

Unit 3: Carbohydrates:

Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

Unit 4: Amino Acids, Peptides and Proteins:

Classification of Amino Acids, Zwitterion structure and Isoelectric point Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C-terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t- butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis

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Unit 5: Enzymes and Lipids:

Enzymes: Enzymes and correlation with drug action Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (Including stereospecificity). Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Noncompetitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure –activity relationships of drug molecules, binding role of –OH group, –NH₂ group, double bond and aromatic ring,

Lipids: Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Reference Books:

2. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry, Cengage Learning India Pvt. Ltd., New Delhi (2009).*
3. B. H. Mahan: *University Chemistry 3rd Ed. Narosa (1998).*
4. R. H. Petrucci: *General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).* J. D. Lee: *A New Concise Inorganic Chemistry, E.L.B.S.*
5. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry, John Wiley.* Gary Wulfsberg: *Inorganic Chemistry, Viva Books Pvt. Ltd.*
6. Morrison, R. T. & Boyd, R. N. *Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
7. Finar, I. L. *Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
8. Finar, I. L. *Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).*
9. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.*
10. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed., W. H. Freeman.*

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Subject Code	Paper Name	Credit
MNL07	Chemistry-IV Lab	1

A: Inorganic Chemistry

1. Estimation of the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oxinate in a given solution gravimetrically.
2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
3. Estimation of total hardness of a given sample of water by complexometric titration.
4. To draw calibration curve (absorbance at λ_{max} vs. concentration) for various concentrations of a given coloured compound and estimate the concentration of the same in a given solution.
5. Determination of the composition of the Fe^{3+} salicylic acid complex/ Fe^{2+} phenanthroline complex in solution by Job's method.
6. Determination of concentration of Na^+ and K^+ using Flame Photometry.

B: Organic Chemistry

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. To determine the saponification value of an oil/fat.
5. To determine the iodine value of an oil/fat
6. Differentiate between a reducing/ nonreducing sugar.
7. To synthesise aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

Reference Books

- A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
- A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.
- Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R.
- Vogel's Textbook of Practical Organic Chemistry, ELBS.