

Course Structure for Under Graduate Papers in Chemistry (Paper Types: Major, Multidisciplinary (DSE), Minor SEC, VAC)

Semester-wise Distribution of Papers in Chemistry

Sem	Paper Code	Paper Title	Paper Type	Credits
I	24-CHE-C-101	Inorganic Chemistry-1 (3T+1P)	Major-1	4
	24-CHE-C-103	Physical Chemistry-1 (3T+1P)	Major-2	4
	24-CHE-T-102	Essential Food Nutrients (3T)	DSE-1	3
	24-CHE-M-101	GE-1: Inorganic Chemistry-1 (3T+1P)	Minor-1	4
	24-CHE-S-101	Analytical Methods & Lab Standards in Chemistry (3T)	SEC-1	3
	24-CHE-V-102	Medicines in Daily Life (2T)	VAC-1	2
II	24-CHE-C-152	Organic Chemistry-1 (3T+1P)	Major-3	4
	24-CHE-C-153	Physical Chemistry-2 (3T+1P)	Major-4	4
	24-CHE-T-151	Inorganic Materials of Industrial Importance (3T)	DSE-2	3
	24-CHE-M-153	GE-2: Physical Chemistry-1 (3T+1P)	Minor-2	4
	24-CHE-S-153	Mathematical Tools in Chemistry (3T)	SEC-2	3
	24-CHE-V-152	Green Methods in Chemistry (2T)	VAC-2	2
III	24-CHE-C-201	Inorganic Chemistry-2 (3T+1P)	Major-5	4
	24-CHE-C-202	Organic Chemistry-2 (3T+1P)	Major-6	4
	24-CHE-C-203	Physical Chemistry-3 (3T+1P)	Major-7	4
	24-CHE-T-213	Computational Methods in Chemistry (3T)	DSE-3	3
	24-CHE-M-202	GE-3: Organic Chemistry-1 (3T+1P)	Minor-3	4
	24-CHE-S-203	Applied Mathematics in Chemistry (3T)	SEC-3	3
	24-CHE-V-202	Chemistry of Cosmetics & Toiletries (2T)	VAC-3	2
IV	24-CHE-C-251	Inorganic Chemistry-3 (3T+1P)	Major-8	4
	24-CHE-C-252	Organic Chemistry-3 (3T+1P)	Major-9	4
	24-CHE-C-253	Physical Chemistry-4 (3T+1P)	Major-10	4
	24-CHE-M-251	GE-4: Inorganic Chemistry-2 (3T+1P)	Minor-4	4
	24-CHE-V-251	Environmental Chemistry (2T)	VAC-4	2
V	24-CHE-C-301	Inorganic Chemistry-4 (3T+1P)	Major-11	4
	24-CHE-C-302	Organic Chemistry-4 (3T+1P)	Major-12	4
	24-CHE-C-303	Physical Chemistry-5 (3T+1P)	Major-13	4
	24-CHE-M-302	GE-5: Organic Chemistry-2 (3T+1P)	Minor-5	4
VI	24-CHE-C-351	Inorganic Chemistry-5 (3T+1P)	Major-14	4
	24-CHE-C-352	Organic Chemistry-5 (3T+1P)	Major-15	4
	24-CHE-C-353	Physical Chemistry-6 (3T+1P)	Major-16	4
	24-CHE-M-352	GE-6: Physical Chemistry-2 (3T+1P)	Minor-6	4
VII	24-CHE-C-401	Inorganic Chemistry-6 (3T+1P)	Major-17	4
	24-CHE-C-402	Organic Chemistry-6 (3T+1P)	Major-18	4
	24-CHE-C-403	Physical Chemistry-7 (3T+1P)	Major-19	4
	24-CHE-C-411	Inorganic Chemistry-7 (3T+1P)	Major-20	4
	24-CHE-M-401	GE-7: Inorganic Chemistry-3 (3T+1P)	Minor-7	4
VIII	24-CHE-C-451	Inorganic Chemistry-8 (3T+1P)	Major-21	4

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Sem	Paper Code	Paper Title	Paper Type	Credits
<i>A/B*</i>	24-CHE-C-452	Organic Chemistry-7 (3T+1P)	Major-22	4
	24-CHE-C-453	Physical Chemistry-8 (3T+1P)	Major-23	4
	24-CHE-C-462	Organic Chemistry-8 (3T+1P)	Major-24	4
	24-CHE-M-452	GE-8: Organic Chemistry-3 (3T+1P)	Minor-8	4
Chemistry Credits in: Major=96, DSE=9, Minor=32, SEC=9 & VAC=8				

Notes

- T & P denote Theory and Practical credits, respectively. For courses with Practical credits, an 'L' factor is appended to the paper code. The mark distribution for the University Exam (UE) and Internal Assessment (IA) for both theory and practical are provided in the respective detailed syllabus.
- Majors and Minors shall be treated as Honors-Subsidiary in the erstwhile system.
- Two courses of 2 credits each, viz. Compulsory Qualifying - I & II, are to be taken during I-IV Semesters. Compulsory Qualifying - I shall be General Urdu, and Compulsory Qualifying - II shall be any one of Islamiyat, Hindu Religion Studies, or Indian Religions & Culture.
- VAC: Students will choose from a pool of VAC courses offered by the Faculties of Humanities & Languages, Social Sciences, Sciences, Life Sciences, Management, and Fine Arts, subject to the prescribed prerequisites and other specific requirements.
- Multidisciplinary (MD): Students of the Faculty of Life Sciences will choose Multidisciplinary courses from a pool of such courses offered by the Faculty of Life Sciences. Students of the Faculties of Humanities & Languages, Social Sciences, Sciences, Management, and Fine Arts may choose Multidisciplinary courses from a pool of such courses offered by these five faculties.
- *B**: If students opt for research, then they will opt for one paper according to their research specialization as Internship/Apprenticeship/Project/Community Outreach (IAPC).

Undergraduate Papers in Chemistry

EFFECTIVE FROM JULY 2024

MAJOR PAPERS IN CHEMISTRY UNDER NEW EDUCATION POLICY (NEP-2020)



Department of Chemistry
Faculty of Sciences
Jamia Millia Islamia
(A Central University by Act of Parliament)
Jamia Nagar, New Delhi-110025

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	24-CHE-M-153	GE-2: Physical Chemistry-1 (3T+1P)	Minor-2	4
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- *B**: If students opt for research, then they will opt for one paper according to their research specialization as Internship/Apprenticeship/Project/Community Outreach (IAPC).

Major-1: Inorganic Chemistry-1

Semester	Paper Code	Credits	Total Marks	Paper Type
I	24-CHE-C-101	3	100 (UE=60, IA=40)	Theory

Unit I: Atomic Structure and Periodic Table (20L)

- Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle. Schrödinger's wave equation, significance of ψ and ψ^2 . Quantum numbers and their significance. Sign of wave functions. Radial and angular distribution curves; Shapes of s, p, and d orbitals. Contour boundary and probability diagrams
- The long form of periodic table; Discussion of following properties with reference to s and p-block elements: Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.; Atomic radii (van der Waals), Ionic radii (crystal), Covalent radii (octahedral and tetrahedral); Ionization enthalpy and factors affecting ionization energy; Applications of ionization enthalpy, trends of ionization enthalpy. Electronegativity; Pauling's/ Allred Rachow's and Mulliken electronegativity scales; Variation of electronegativity with bond order

Unit II: Chemical Bonding and Molecular Structure-I (15L)

- Ionic bond: General characteristics, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation, Madelung constant, Born-Haber cycle and its application
- Covalent bond: Lewis structure, Valence Bond theory, hybridization, Energetics of hybridization, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules; VSEPR theory, covalent character in ionic compounds, polarizing power and polarizability
- Metallic Bond: Qualitative idea of valence bond and band theories, defects in solid state.

Unit III: Oxidation-Reduction

- Redox reactions, Standard Electrode Potential, Electro-chemical series and its application to inorganic reactions, Oxidation state, rules for the determination of oxidation states, electrochemical series, applications of electrochemical series and Galvanic cell.

Reference Books:

1. Lee, J.D., *Concise Inorganic Chemistry*, 5th edn., Blackwell Science.
2. Douglas, B.E. and McDaniel, D.H., *Concepts & Models of Inorganic Chemistry*, Oxford.
3. Atkins, P.W. & Paula, J., *Physical Chemistry*, 10th Ed., Oxford University Press.

Major-1: Inorganic Chemistry Lab-1

Semester	Paper Code	Credits	Total Marks	Paper Type
I	24-CHE-C-101L	1	50 (UE=25, IA=25)	Practical

Titrimetric Analysis

1. Titrimetric Analysis
2. Calibration and use of apparatus
3. Preparation of solutions of different Molarity/Normality of titrants

Acid-Base Titrations

1. Estimation of carbonate and hydroxide present together in mixture
2. Estimation of carbonate and bicarbonate present together in a mixture.
3. Estimation of free alkali present in different soaps/detergents

Oxidation-Reduction Titrimetry

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

Reference Books:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis*, 6th Ed., Pearson, 2009.
2. Svehla, G., *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.

Major-2: Physical Chemistry-1

Semester	Paper Code	Credits	Total Marks	Paper Type
I	24-CHE-C-103	3	100 (UE=60, IA=40)	Theory

- **Unit-I: Gaseous State (15 Lectures)**

Gas laws, Ideal gas equation, Dalton's law of partial pressure, Graham's law of diffusion, Postulates of kinetic theory of gases, Kinetic gas equation. Deviation from ideal behavior: Effect of temperature and pressure. Maxwell's distribution of molecular velocities: Root mean square, Average, and Most probable velocities. Collision properties: Collision number, Mean free path, Collision diameter, and Collision frequency. Liquefaction of gases. Critical Phenomena: PV isotherms of real gases, Continuity of states, van der Waals equation, Isotherms of van der Waals equation, Relationship between critical constants and van der Waals constants, Law of corresponding states, Reduced equation of state.

- **Unit-II: Liquid State (15 Lectures)**

Structural differences between solids, liquids, and gases. Intermolecular forces. Variation of vapour pressure of liquids with temperature and Trouton's rule. Liquid Crystals: Vapour pressure-Temperature diagram, Classification of liquid crystals. Structure of Smectic, Nematic, and Cholestric liquid crystals.

- **Unit-III: Solid State (15 Lectures)**

Crystalline and Amorphous solid, Symmetry of crystal systems, Space lattice, and Unit cell. Summary of crystal systems, Applications of crystallographic studies, Packing fraction, Density of crystalline solid, Coordination number, Number of atoms in unit cell. X-ray diffraction, Bragg's equation. Powder method for determining the crystal structure of NaCl.

Reference Books:

1. Essentials of Physical Chemistry, B.S. Bahl, G.D. Tuli, and Arun Bahl, S. Chand & Company Ltd.
2. A Text Book of Physical Chemistry, A.S. Negi and S.C. Anand, New Age International Publishers.
3. Physical Chemistry, G. M. Barrow, McGraw Hill International Student Edition.
4. Physical Chemistry through Problems, S. K. Dogra and S. Dogra, Wiley Eastern Ltd.
5. Physical Chemistry, P. W. Atkins and J. de Paula, Oxford University Press (2014).

Major-2: Physical Chemistry Lab-1

Semester	Paper Code	Credits	Total Marks	Paper Type
I	24-CHE-C-103L	1	50 (UE=25, IA=25)	Practical

1. Surface tension measurements:

- (a) Determine surface tension of a solution using the drop number method.
- (b) Study variation of surface tension with concentration for detergent solutions.

2. Viscosity measurement using Ostwald's viscometer for

- (a) ethanol
- (b) amyl alcohol
- (c) aqueous solution of sugar at room temperature.

3. Indexing of powder diffraction patterns for a cubic crystalline system.
4. Indexing of a given powder diffraction pattern of a tetragonal crystalline system.
5. Indexing of a given powder diffraction pattern of an orthorhombic crystalline system.
6. Any other experiment carried out in the class.

Recommended Books

- O.P. Pandey, D.N. Bajpai & S. Giri, Practical Chemistry, S. Chand & Company Ltd.
- B. D. Khosla, V. C. Garg & A. Gulati, Senior Practical Physical Chemistry, S. Chand & Co.: New Delhi (2011).
- C. W. Garland, J.W. Nibler, & D.P. Shoemaker, Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).

Major-3: Organic Chemistry-1

Semester	Paper Code	Credits	Total Marks	Paper Type
II	24-CHE-C-152	3	100 (UE=60, IA=40)	Theory

- **Unit-I: Basics of Organic Chemistry (15 Lectures)**

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

Electronic Displacements: Inductive, Electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength, Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radical, carbene & nitrene. Introduction to types of organic reactions.

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples

- **Unit-II: Stereochemistry (15 Lectures)**

Fischer Projection, Newmann and Sawhorse Projection formulae and their inter-conversions; Geometrical isomerism: cis-trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Diastereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations. Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms.

- **Unit-III: Chemistry of Aliphatic Hydrocarbons (15 Lectures)**

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation-relative reactivity and selectivity. Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g., propene, 1-butene, toluene, ethyl benzene.

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Reference Books

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

3. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
4. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
5. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

Major-3: Organic Chemistry Lab-1

Semester	Paper Code	Credits	Total Marks	Paper Type
II	24-CHE-C-152L	1	50 (UE=25, IA=25)	Practical

1. Checking the calibration of the thermometer.
2. Purification of organic compounds by crystallization using the following solvents:
 - (a) Water
 - (b) Alcohol
 - (c) Alcohol-water
3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus).
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds.
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100° by distillation and capillary method).
6. 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.
 - (c) Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC).

Reference Books

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

Major-4: Physical Chemistry-2

Semester	Paper Code	Credits	Total Marks	Paper Type
II	24-CHE-C-153	3	100 (UE=60, IA=40)	Theory

- **Unit-I: Chemical Equilibrium (15 Lectures)**

Reversible and irreversible reactions, Characteristics of chemical equilibrium, Formulation of equilibrium law, equilibrium law for ideal gases, relation between K_p , K_c , and K_x . Reaction quotient, factors affecting the equilibrium constant. Equilibrium between gases and solids, equilibrium constant for a system of real gases, equilibrium constant of reactions in solution. Thermodynamic treatment of equilibrium constant. Variation of equilibrium constant with temperature, pressure and concentration, effect of inert gas on reaction equilibrium, Le – Chatelier’s principle

- **Unit-II: Ionic Equilibria (15 Lectures)**

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization. Acid-base concept. Dissociation constants of weak acids and weak bases. Ionization constant and Ionic product of water. The pH scale, Buffer solutions, Calculations of pH values of buffer mixtures, Derivation of Henderson equation and its applications, buffer capacity and buffer action. Salt hydrolysis, Determination of hydrolysis constant, degree of hydrolysis and pH for different salts. Relation between K_h , K_a , and K_b . Solubility and solubility product of sparingly soluble salts – Applications of solubility product principle and Common ion effect

- **Unit-III: Chemical Kinetics (15 Lectures)**

Chemical Kinetics and its Scope, Rate of a Reaction, Rate Laws, Factors Influencing the Rate of Reaction: Concentration, Temperature, Pressure, Catalyst. Rate Constant, Elementary and Complex Reactions, Molecularity, Order of Reactions, Concentration and Temperature Dependence of Rates, Mathematical Characteristics of Simple Chemical Reactions - Zero Order, First Order, Second Order, Pseudo Order, and their Half-life Expressions. Determination of Order of Reaction - Differential Method, Method of Integration, Half-life Method and Isolation Method. Kinetics of Parallel and Consecutive Reactions. Catalysts: Classification, Homogeneous Catalysis, Heterogeneous Catalysis, Enzyme Catalysis, Michaelis- Menten Mechanism.

Reference Books

1. Essentials of Physical Chemistry, B.S. Bahl, G.D. Tuli, and Arun Bahl, S. Chand & Company Ltd.
2. A Text Book of Physical Chemistry, A.S. Negi and S.C. Anand, New Age International Publishers.
3. Physical Chemistry, G. M. Barrow, McGraw Hill International Student Edition.

Major-4: Physical Chemistry Lab-2

Semester	Paper Code	Credits	Total Marks	Paper Type
II	24-CHE-C-153L	3	50 (UE=25, IA=25)	Practical

1. Ionic Equilibria

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

2. Chemical Kinetics

- To determine the order of the reaction between thiosulphate and HCl with respect to thiosulphate.
- To determine the order of the reaction between thiosulphate and HCl with respect to HCl.
- To study the kinetics of the reaction between thiosulphate and HCl at moderate concentration of $[H^+]$ by using initial rate method.
- To determine the order of reaction for acid hydrolysis of methyl acetate at room temperature.
- To determine the kinetics of the hydrolysis of ethyl acetate catalyzed by hydrogen ions at room temperature.
- To study the effect of acid strength on the hydrolysis of an ester.
- To study the kinetics of alkaline hydrolysis of M/40 methyl acetate by providing M/40 HCl and M/40 NaOH.
- To study the kinetics of the saponification of ethyl acetate by integrated rate method.

3. Any other experiment carried out in the class.**Reference Books**

- O.P. Pandey, D.N. Bajpai & S. Giri, Practical Chemistry, S. Chand & Company Ltd.
- B. D. Khosla, V. C. Garg & A. Gulati, Senior Practical Physical Chemistry, S. Chand & Co.: New Delhi (2011).
- C. W. Garland, J.W. Nibler, & D.P. Shoemaker, Experiments in Physical Chemistry 8th Ed.; McGraw Hill: New York (2003).
- R.C. Das and B. Behra, Experiments in Physical Chemistry,; Tata McGraw Hill.

Major-5: Inorganic Chemistry-2

Semester	Paper Code	Credits	Total Marks	Paper Type
III	24-CHE-C-201	3	100 (UE=60, IA=40)	Theory

- **Unit-I: Group I and Group II Elements (15 Lectures)**
Hydrogen: Isotopes (separation method not needed). Ortho and Para hydrogen, Hydrides and their classification. Alkali metals: Chemical properties of the metals: reaction with water, air, nitrogen; uses of s-block metals and their compounds, Compounds of s-block metals: oxides, hydroxides, peroxides, superoxides - preparation and properties; bicarbonates, nitrates; halides and polyhalides; anomalous behavior of Li. Alkaline earth metals: Comparative study of these elements with special reference to their hydrides, oxides, hydroxide and halides. Diagonal relationship, salvation and complexes of s-block metals including their applications in bio-systems.
- **Unit-II: Group III Elements (15 Lectures)**
Comparative study of physical and chemical properties of these elements with special reference to their oxides, hydrides, halides and nitrides. Preparation and properties of boric acids (ortho and meta boric acids) and borax, borax bead test. Study of hydrides formed by boron, structure and bonding in diboranes; an idea of three-center two-electron bond in the light of molecular orbital theory. Borazine and borohydrides.
- **Unit-III: Group III Elements (15 Lectures)**
Comparative study of physical and chemicals properties of these elements with special references to their oxides, hydrides, nitrides, sulphides and carbides, fluorocarbons, study of silicates (structural aspects only), silicones, allotropy, Inert pair effect, metallic and nonmetallic character, catenation and heterocatenation.

Reference Books

1. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, Blackwell Science, Oxford, UK, 1996.
2. F.A. Cotton, G. Wilkinson, C.A. Murillo, and M. Bochmann, *Advanced Inorganic Chemistry*, 6th Edition, Wiley-Interscience, New York, 1999.
3. D.F. Shriver and P.W. Atkins, *Inorganic Chemistry*, 3rd Edition, Oxford University Press, Oxford, UK, 1999.
4. G.L. Miessler and D.A. Tarr, *Inorganic Chemistry*, 4th Edition, Pearson Education, Upper Saddle River, New Jersey, 2011.
5. A.G. Sharpe, *Inorganic Chemistry*, 3rd Edition, Pearson Education, Harlow, England, 2001.

Major-5: Inorganic Chemistry Lab-2

Semester	Paper Code	Credits	Total Marks	Paper Type
III	24-CHE-C-201L	3	50 (UE=25, IA=25)	Practical

1. Iodo/Iodimetric Titrations

- Estimation of Cu(II) and $\text{K}_2\text{Cr}_2\text{O}_7$ using sodium thiosulphate solution (iodimetrically).
- Estimation of (i) arsenite and (ii) antimony iodimetrically.
- Estimation of available chlorine in bleaching powder iodometrically.

2. Water Analysis (Complexometric Titrations)**3. Inorganic Preparations**

- Cuprous chloride, Cu_2Cl_2
- Manganese(III) phosphate, $\text{MnPO}_4 \cdot \text{H}_2\text{O}$
- Aluminium potassium sulphate, $\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$ (Potash alum or Chrome alum)

Reference Books

1. G.H. Jeffery, J. Bassett, J. Mendham, and R.C. Denney, *Vogel's Quantitative Chemical Analysis*, 6th Edition, Pearson Education, New Delhi, 2009.

Major-6: Organic Chemistry-2

Semester	Paper Code	Credits	Total Marks	Paper Type
III	24-CHE-C-202	3	100 (UE=60, IA=40)	Theory

- **Unit-I: Chemistry of Carbonyl Compounds – Aldehydes & Ketones (15 Lectures)**

Structure, reactivity and preparation: Nucleophilic additions; nucleophilic addition-elimination reactions with ammonia derivatives with mechanism. Mechanisms of Aldol condensation, Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt reaction, Perkin reaction, Cannizzaro reaction, and Wittig reaction; Beckmann and Benzil-Benzilic acid rearrangements; Haloform reaction.

Oxidation and reduction of carbonyls: Baeyer-Villiger oxidation, Clemmensen and Wolff-Kishner reductions. Use of reducing reagents: LiAlH_4 , NaBH_4 , MPV (Meerwein-Ponndorf-Verley), PDC (Pyridinium Dichromate), and PGC (Pyridinium Chlorochromate).

Addition reactions of unsaturated carbonyl compounds: Michael addition.

Active methylene compounds: Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

- **Unit-II: Carboxylic Acids and Their Derivatives (15 Lectures)**

Preparation, physical properties, and reactions of monocarboxylic acids. Typical reactions of dicarboxylic acids, hydroxy acids, and unsaturated acids such as 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 the acyl group. Mechanism of acidic and alkaline hydrolysis of esters.

Named reactions: Claisen condensation, Dieckmann condensation, Reformatsky reaction, Hofmann bromamide degradation, and Curtius rearrangement.

- **Unit-III: Organometallic Compounds (15 Lectures)**

Definition and classification of organometallic compounds. Concepts of hapticity, the 18-electron rule, and Wade's rules. Discussion on sandwich compounds and fluxional molecules.

Grignard reagents: Formation, structure, and chemical reactions.

Organozinc compounds: Formation, structure, and chemical reactions.

Organolithium compounds: Formation, structure, and chemical reactions.

Reaction types: Oxidative addition, reductive elimination, insertion reactions at M-C and M-H bonds, transmetallation, and cyclization reactions.

Industrial and synthetic applications: Hydroformylation using cobalt octacarbonyl, Monsanto acetic acid process, hydrogenation using Wilkinson's catalyst, Tebbe reagent, Ziegler-Natta polymerization, and Zeise's salt.

Reference Books

1. Morrison, R.T. & Boyd, R.N., *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
2. Finar, I.L., *Organic Chemistry*, Volume 2: Stereochemistry and the Chemistry of Natural Products, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.

3. Solomons, T.W. Graham, *Organic Chemistry*, John Wiley & Sons, Inc.
4. Kalsi, P.S., *Textbook of Organic Chemistry*, 1st Edition, New Age International (P) Ltd. Publishers.
5. Clayden, J., Greeves, N., Warren, S., Wothers, P., *Organic Chemistry*, Oxford University Press.

Major-6: Organic Chemistry Lab-2

Semester	Paper Code	Credits	Total Marks	Paper Type
III	24-CHE-C-202L	1	50 (UE=25, IA=25)	Practical

1. Detection of extra elements: Presence of nitrogen (N), sulphur (S), and halogens (X = Cl, Br, I); When both nitrogen and sulphur are present, perform test for thiourea and amino sulphonic acid.
2. Functional group tests:
 - Nitro group
 - Amine group: Detection of primary, secondary, tertiary, aliphatic and aromatic amines
 - Amide and anilide groups
3. Selective reduction of *m*-dinitrobenzene to *m*-nitroaniline.
4. Reduction of *p*-nitrobenzaldehyde using sodium borohydride.
5. Nitration of acetanilide, nitrobenzene, and salicylic acid.
6. Preparation of *m*-dinitrobenzene by nitration of nitrobenzene.
7. Aldol condensation of benzaldehyde and acetone to form dibenzalacetone.
8. Aldol condensation of benzaldehyde and acetophenone to form a chalcone.

Reference Books

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

Major-7: Physical Chemistry-3

Semester	Paper Code	Credits	Total Marks	Paper Type
III	24-CHE-C-203	3	100 (UE=60, IA=40)	Theory

- **Unit-I: Phase Equilibria (15 Lectures)**

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-vapor and solid-vapor equilibria, phase diagram for one component systems, with application. Phase diagram for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points. Three component systems, water-chloroform-acetic acid system, triangular plots. Critical solution temperature, Distribution law.

- **Unit-II: Thermochemistry (15 Lectures)**

Exothermic and endothermic reactions; Heats of reactions and standard states; Relation between heat of reaction at constant volume (q_v) and at constant pressure (q_p); Heat capacity and the relation between C_p and C_v ; Laws of thermochemistry; Enthalpy of formation; Heat of solution and dilution; Heat of neutralization; Heat of combustion; Heat of transition; Bond dissociation energy, bond energy and its calculation; Concept of lattice energy; Effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.

- **Unit-III: Thermodynamics (15 Lectures)**

Introduction: System, surroundings, intensive and extensive properties, isolated, closed and open systems; thermodynamic processes, state and path functions. First law of thermodynamics: Concept of heat (q), work (w), internal energy (U), and statement of the first law; concept of Carnot cycle, calculations of q , w , U and H for reversible, irreversible and free expansion of gases under isothermal and adiabatic conditions. Second law of thermodynamics: Spontaneous processes, criteria of spontaneity, concept of entropy and statements of the second law of thermodynamics, calculation of entropy change for reversible and irreversible processes. Entropy changes for isolated systems and entropy change in phase transitions. Gibbs free energy and spontaneity; free energy and work function, variation of free energy with temperature and pressure. Gibbs-Helmholtz equation, Clausius-Clapeyron equation and Maxwell relations.

Reference Books

1. *Essentials of Physical Chemistry*, B.S. Bahl, G.D. Tuli and Arun Bahl, S. Chand & Company Ltd.
2. *A Text Book of Physical Chemistry*, A.S. Negi and S.C. Anand, New Age International Publishers.
3. *Physical Chemistry*, G.M. Barrow, International Student Edition, McGraw Hill.
4. *Physical Chemistry through Problems*, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.
5. *Physical Chemistry*, P.W. Atkins & J. de Paula, 10th Ed., Oxford University Press (2014).
6. *Chemical Thermodynamics*, Rastogi & Mishra.

Major-7: Physical Chemistry Lab-3

Semester	Paper Code	Credits	Total Marks	Paper Type
III	24-CHE-C-203L	3	50 (UE=25, IA=25)	Practical

1. Determine the critical solution of phenol-water system.
2. Determine the concentration of NaCl in an unknown solution by critical solution temperature method.
3. Determine the distribution coefficient of iodine in carbon tetrachloride-water system.
4. Determine the distribution coefficient of benzoic acid between toluene and water.
5. Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) of solution of salts.
6. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.
7. To determine the enthalpy of hydration of CuSO_4 .
8. To study the solubility of benzoic acid in water and determination of ΔH .
9. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber Cycle.
10. Verification of Hess's law by utilizing the enthalpy of neutralization of:
 - HCl (aq) ,
 - $\text{NaOH(s)} + \text{HCl(aq)}$, and
 - Enthalpy of solution of NaOH(s) in water.
11. Determination of basicity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
12. Any other experiment carried out in the class.

Reference Books

1. O.P. Pandey, D.N. Bajpai & S. Giri, *Practical Chemistry*, S. Chand & Company Ltd.
2. B.D. Khosla, V.C. Garg & A. Gulati, *Senior Practical Physical Chemistry*, S. Chand & Co.: New Delhi (2011).
3. C.W. Garland, J.W. Nibler & D.P. Shoemaker, *Experiments in Physical Chemistry*, 8th Ed., McGraw-Hill: New York (2003).
4. A.M. Halpern & G.C. McBane, *Experimental Physical Chemistry*, 3rd Ed., W.H. Freeman & Co.: New York (2003).

Major-8: Inorganic Chemistry-3

Semester	Paper Code	Credits	Total Marks	Paper Type
IV	24-CHE-C-251	3	100 (UE=60, IA=40)	Theory

- **Unit-I: Group V and Group VI Elements (15 Lectures)**

Comparative study of the physical and chemical properties of these elements with special reference to their hydrides, oxides, halides, oxyhalides and sulphides. Oxoacids of nitrogen: nitrous acid, nitric acid, hyponitrous acid, hydrazoic acid, pernitric acid. Oxoacids of phosphorus: orthophosphorous acid, metaphosphorous acid, hypophosphorous acid; orthophosphoric acid, di-, tri-, and tetra-polyphosphoric acids. Comparative study of physical and chemical properties of these elements with special reference to their hydrides, oxides, halides and oxyhalides. Detailed study of oxyacids, peroxyacids and thio-oxyacids of sulphur with special emphasis on their structures.

- **Unit-II: Organometallic Compounds (15 Lectures)**

Definition and classification 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 the 3d series. General methods of preparation of mono- and binuclear carbonyls of the 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using Valence Bond Theory (VBT). π -acceptor behaviour of CO, synergic effect and extent of back bonding. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

- **Unit-III: Inorganic Polymers (15 Lectures)**

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

Reference Books

1. F.A. Cotton, G. Wilkinson and P.L. Gaus, *Basic Inorganic Chemistry*, 3rd Edition, Wiley India.
2. J.E. Huheey, E.A. Keiter and R.L. Keiter, *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th Edition, Harper Collins, 1993; Pearson Education, 2006.
3. A.G. Sharpe, *Inorganic Chemistry*, 4th Indian Reprint, Pearson Education, 2005.
4. N.N. Greenwood and A. Earnshaw, *Chemistry of the Elements*, 2nd Edition, Elsevier, 1997.
(Includes: Ziegler-Natta Catalysts and Equilibria in Grignard Solution.)
5. P. Powell, *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.

Major-8: Inorganic Chemistry Lab-3

Semester	Paper Code	Credits	Total Marks	Paper Type
IV	24-CHE-C-251L	3	50 (UE=25, IA=25)	Practical

1. Gravimetric Analysis

- Estimation of Ni(II) using Dimethylglyoxime (DMG).
- Estimation of copper as copper as CuSCN.
- Estimation of iron as Fe₂O₃ by precipitating iron as Fe(OH)₃.
- Estimation of Al(III) by precipitating with oxine.

2. Inorganic Complex Preparations

- *cis*- and *trans*-K[Cr(C₂O₄)₂(H₂O)₂] (Potassium dioxalato diaquachromate(III))
- Tetraamminecarbonatocobalt(III) ion
- Potassium tris(oxalato)ferrate(III)

3. Chromatography of Metal Ions

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

- Ni(II) and Co(II)
- Fe(III) and Al(III)

Reference Books

1. G.H. Jeffery, J. Bassett, J. Mendham, and R.C. Denney, *Vogel's Quantitative Chemical Analysis*, 6th Edition, Pearson Education, New Delhi, 2009.

Major-9: Organic Chemistry-3

Semester	Paper Code	Credits	Total Marks	Paper Type
IV	24-CHE-C-252	3	100 (UE=60, IA=40)	Theory

- **Unit-I: Nitrogen Containing Functional Groups (15 Lectures)**

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

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

Diazonium salts: Preparation and their synthetic applications.

- **Unit-II: Heterocyclic Compounds (15 Lectures)**

Classification and nomenclature. Structure and aromaticity in five- and six-membered rings containing one heteroatom. Synthesis, reactions and mechanisms 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, Madelung synthesis)
- Quinoline and Isoquinoline (Skraup synthesis, Friedländer synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction)

Derivatives of furan: Furfural and furoic acid.

- **Unit-III: Dyes (15 Lectures)**

Classification and constitution of dyes. Mordant and vat dyes. Chemistry of dyeing.

Synthesis and applications of:

- Azo dyes: Methyl Orange and Congo Red (mechanism of diazo coupling)
- Triphenylmethane dyes: Malachite Green, Rosaniline, Crystal Violet
- Phthalein dyes: Phenolphthalein and Fluorescein
- Natural dyes: Structure elucidation and synthesis of Alizarin and Indigotin
- Edible dyes with examples

Reference Books

1. F.A. Cotton, G. Wilkinson and P.L. Gaus, *Basic Inorganic Chemistry*, 3rd Edition, Wiley India.

2. J.E. Huheey, E.A. Keiter and R.L. Keiter, *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th Edition, Harper Collins, 1993; Pearson Education, 2006.
3. A.G. Sharpe, *Inorganic Chemistry*, 4th Indian Reprint, Pearson Education, 2005.
4. N.N. Greenwood and A. Earnshaw, *Chemistry of the Elements*, 2nd Edition, Elsevier, 1997.
(Includes: Ziegler-Natta Catalysts and Equilibria in Grignard Solution.)
5. P. Powell, *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.

Major-9: Organic Chemistry Lab-3

Semester	Paper Code	Credits	Total Marks	Paper Type
IV	24-CHE-C-252L	3	50 (UE=25, IA=25)	Practical

1. To estimate the strength of phenol using hypo and potassium dichromate by titration method.
2. To estimate the strength of aniline using hypo and potassium dichromate by titration method.
3. Estimation of phenol/aniline using brominating mixture (bromate-bromide method).
4. Preparation of oximes of aldehydes/ketones (e.g., benzaldehyde, ethyl methyl ketone, cyclohexanone, etc.).
5. Preparation of semicarbazone derivatives for aldehydes/ketones (e.g., benzaldehyde, ethyl methyl ketone, cyclohexanone, etc.).
6. Preparation of S-benzylisothiuronium salts for water-soluble (ethanoic acid) and water-insoluble (benzoic acid) carboxylic acids.
7. Acid hydrolysis of benzamide / ethyl benzoate / methyl salicylate.
8. Alkaline hydrolysis of benzamide / ethyl benzoate / methyl salicylate.
9. Preparation of quinoline from aniline (Skraup synthesis).
10. Preparation of 2-phenylindole from hydrazine (Fischer indole synthesis).

Reference Books

1. A.I. Vogel, *Quantitative Organic Analysis*, Part 3, Pearson Education, 2012.
2. F.G. Mann and B.C. Saunders, *Practical Organic Chemistry*, Pearson Education, 2009.
3. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, and A.R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edition, Pearson, 2012.
4. V.K. Ahluwalia and S. Dhingra, *Comprehensive Practical Organic Chemistry: Qualitative Analysis*, University Press, 2004.
5. V.K. Ahluwalia and R. Aggarwal, *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis*, University Press, 2004.

Major-10: Physical Chemistry-4

Semester	Paper Code	Credits	Total Marks	Paper Type
IV	24-CHE-C-253	3	100 (UE=60, IA=40)	Theory

• Unit-I: Conductance (15 Lectures)

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water, (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

• Unit-II: Electrochemistry (15 Lectures)

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 electrodes. Difference between chemical cells and concentration cells, liquid junction potential, its derivation, Electrode concentration cells without liquid junction potential, electrolyte concentration cells without liquid junction potential, concentration cells with liquid junction potential.

• Unit-III: Solutions and Colligative Properties (15 Lectures)

Methods of expressing concentrations of solutions, Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, Experimental method for measuring the lowering of vapour pressure, molecular weight determination. Osmosis, Law of osmotic pressure, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Abnormal molar mass, degree of dissociation and association of solutes.

Reference Books

1. *Essentials of Physical Chemistry*, B.S. Bahl, G.D. Tuli and Arun Bahl, S. Chand & Company Ltd.
2. *A Text Book of Physical Chemistry*, A.S. Negi and S.C. Anand, New Age International Publishers.
3. *Physical Chemistry*, G.M. Barrow, International Student Edition, McGraw Hill.
4. *Physical Chemistry through Problems*, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.
5. *Physical Chemistry*, P.W. Atkins & J. de Paula, 10th Ed., Oxford University Press (2014).

Major-10: Physical Chemistry Lab-4

Semester	Paper Code	Credits	Total Marks	Paper Type
IV	24-CHE-C-253L	3	50 (UE=25, IA=25)	Practical

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:
 - Strong acid vs. strong base
 - Weak acid vs. strong base
 - Mixture of strong acid and weak acid vs. strong base
 - Strong acid vs. weak base
4. Perform the following potentiometric titrations:
 - Strong acid vs. strong base
 - Weak acid vs. strong base
 - Dibasic acid vs. strong base
 - Potassium dichromate vs. Mohr's salt
5. Determination of the molar mass of the given solute by using Rast method.
6. Any other experiment carried out in the class.

Reference Books

1. O.P. Pandey, D.N. Bajpai & S. Giri, *Practical Chemistry*, S. Chand & Company Ltd.
2. B.D. Khosla, V.C. Garg & A. Gulati, *Senior Practical Physical Chemistry*, S. Chand & Co.: New Delhi (2011).
3. C.W. Garland, J.W. Nibler & D.P. Shoemaker, *Experiments in Physical Chemistry*, 8th Ed., McGraw-Hill: New York (2003).
4. A.M. Halpern & G.C. McBane, *Experimental Physical Chemistry*, 3rd Ed., W.H. Freeman & Co.: New York (2003).

Undergraduate Papers in Chemistry

EFFECTIVE FROM JULY 2024

MINOR PAPERS IN CHEMISTRY UNDER NEW EDUCATION POLICY (NEP-2020)



Department of Chemistry
Faculty of Sciences
Jamia Millia Islamia
(A Central University by Act of Parliament)
Jamia Nagar, New Delhi-110025

Course Structure for Under Graduate Papers in Chemistry (Paper Types: Major, Multidisciplinary (DSE), Minor SEC, VAC)

Semester-wise Distribution of Papers in Chemistry

Sem	Paper Code	Paper Title	Paper Type	Credits
I	24-CHE-C-101	Inorganic Chemistry-1 (3T+1P)	Major-1	4
	24-CHE-C-103	Physical Chemistry-1 (3T+1P)	Major-2	4
	24-CHE-T-102	Essential Food Nutrients (3T)	DSE-1	3
	24-CHE-M-101	GE-1: Inorganic Chemistry-1 (3T+1P)	Minor-1	4
	24-CHE-S-101	Analytical Methods & Lab Standards in Chemistry (3T)	SEC-1	3
	24-CHE-V-102	Medicines in Daily Life (2T)	VAC-1	2
II	24-CHE-C-152	Organic Chemistry-1 (3T+1P)	Major-3	4
	24-CHE-C-153	Physical Chemistry-2 (3T+1P)	Major-4	4
	24-CHE-T-151	Inorganic Materials of Industrial Importance (3T)	DSE-2	3
	24-CHE-M-153	GE-2: Physical Chemistry-1 (3T+1P)	Minor-2	4
	24-CHE-S-153	Mathematical Tools in Chemistry (3T)	SEC-2	3
	24-CHE-V-152	Green Methods in Chemistry (2T)	VAC-2	2
III	24-CHE-C-201	Inorganic Chemistry-2 (3T+1P)	Major-5	4
	24-CHE-C-202	Organic Chemistry-2 (3T+1P)	Major-6	4
	24-CHE-C-203	Physical Chemistry-3 (3T+1P)	Major-7	4
	24-CHE-T-213	Computational Methods in Chemistry (3T)	DSE-3	3
	24-CHE-M-202	GE-3: Organic Chemistry-1 (3T+1P)	Minor-3	4
	24-CHE-S-203	Applied Mathematics in Chemistry (3T)	SEC-3	3
	24-CHE-V-202	Chemistry of Cosmetics & Toiletries (2T)	VAC-3	2
IV	24-CHE-C-251	Inorganic Chemistry-3 (3T+1P)	Major-8	4
	24-CHE-C-252	Organic Chemistry-3 (3T+1P)	Major-9	4
	24-CHE-C-253	Physical Chemistry-4 (3T+1P)	Major-10	4
	24-CHE-M-251	GE-4: Inorganic Chemistry-2 (3T+1P)	Minor-4	4
	24-CHE-V-251	Environmental Chemistry (2T)	VAC-4	2
V	24-CHE-C-301	Inorganic Chemistry-4 (3T+1P)	Major-11	4
	24-CHE-C-302	Organic Chemistry-4 (3T+1P)	Major-12	4
	24-CHE-C-303	Physical Chemistry-5 (3T+1P)	Major-13	4
	24-CHE-M-302	GE-5: Organic Chemistry-2 (3T+1P)	Minor-5	4
VI	24-CHE-C-351	Inorganic Chemistry-5 (3T+1P)	Major-14	4
	24-CHE-C-352	Organic Chemistry-5 (3T+1P)	Major-15	4
	24-CHE-C-353	Physical Chemistry-6 (3T+1P)	Major-16	4
	24-CHE-M-352	GE-6: Physical Chemistry-2 (3T+1P)	Minor-6	4
VII	24-CHE-C-401	Inorganic Chemistry-6 (3T+1P)	Major-17	4
	24-CHE-C-402	Organic Chemistry-6 (3T+1P)	Major-18	4
	24-CHE-C-403	Physical Chemistry-7 (3T+1P)	Major-19	4
	24-CHE-C-411	Inorganic Chemistry-7 (3T+1P)	Major-20	4
	24-CHE-M-401	GE-7: Inorganic Chemistry-3 (3T+1P)	Minor-7	4
VIII	24-CHE-C-451	Inorganic Chemistry-8 (3T+1P)	Major-21	4

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Sem	Paper Code	Paper Title	Paper Type	Credits
<i>A/B*</i>	24-CHE-C-452	Organic Chemistry-7 (3T+1P)	Major-22	4
	24-CHE-C-453	Physical Chemistry-8 (3T+1P)	Major-23	4
	24-CHE-C-462	Organic Chemistry-8 (3T+1P)	Major-24	4
	24-CHE-M-452	GE-8: Organic Chemistry-3 (3T+1P)	Minor-8	4
Chemistry Credits in: Major=96, DSE=9, Minor=32, SEC=9 & VAC=8				

Notes

- T & P denote Theory and Practical credits, respectively. For courses with Practical credits, an 'L' factor is appended to the paper code. The mark distribution for the University Exam (UE) and Internal Assessment (IA) for both theory and practical are provided in the respective detailed syllabus.
- Majors and Minors shall be treated as Honors-Subsidiary in the erstwhile system.
- Two courses of 2 credits each, viz. Compulsory Qualifying - I & II, are to be taken during I-IV Semesters. Compulsory Qualifying - I shall be General Urdu, and Compulsory Qualifying - II shall be any one of Islamiyat, Hindu Religion Studies, or Indian Religions & Culture.
- VAC: Students will choose from a pool of VAC courses offered by the Faculties of Humanities & Languages, Social Sciences, Sciences, Life Sciences, Management, and Fine Arts, subject to the prescribed prerequisites and other specific requirements.
- Multidisciplinary (MD): Students of the Faculty of Life Sciences will choose Multidisciplinary courses from a pool of such courses offered by the Faculty of Life Sciences. Students of the Faculties of Humanities & Languages, Social Sciences, Sciences, Management, and Fine Arts may choose Multidisciplinary courses from a pool of such courses offered by these five faculties.
- *B**: If students opt for research, then they will opt for one paper according to their research specialization as Internship/Apprenticeship/Project/Community Outreach (IAPC).

Minor-1: Inorganic Chemistry-1

Semester	Paper Code	Credits	Total Marks	Paper Type
I	24-CHE-M-101	3	100 (UE=60, IA=40)	Theory

Unit I: Chemical Bonding and Molecular Structure

Chemical Bonding Overlapping of orbital, homo and heterodiatomic molecules, types of bonds: ionic, covalent, coordinate, Metallic and hydrogen bonding, Valence bond theory of covalent bonding and its limitations, Hybridization and hybrid orbitals, resonance, Born- Haber cycle and lattice energy.

Unit II: Concept of Acid and Bases

Concept of acid base, Arrhenius concept, Bronsted-Lowry concept, Leveling solvents, Solvent concept, Lewis concept, Lux-Flood Concept, Effect of substituent on acidity of an acid, Usanovich concept

Unit III: Coordination Chemistry

Double salts and coordination compounds; structures of coordination compounds; Werner's work; ligands and their classification; IUPAC nomenclature; isomerism: structural and stereo (with special reference to coordination number 4 & 6),

- Redox reactions, Standard Electrode Potential, Electro-chemical series and its application to inorganic reactions, Oxidation state, rules for the determination of oxidation states, electrochemical series, applications of electrochemical series and Galvanic cell.

Reference Books:

1. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity, 4th Ed., Harper Collins 1993, Pearson,2006.
2. Sharpe, A.G., Inorganic Chemistry, 4th Indian Reprint (Pearson Education)2005.
3. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press,1994.
4. Powell, P. Principles of Organometallic Chemistry, Chapman and Hall,1988.

Minor-1: Inorganic Chemistry Lab-1

Semester	Paper Code	Credits	Total Marks	Paper Type
I	24-CHE-M-101L	1	50 (UE=25, IA=25)	Practical

Titrimetric Analysis

1. To prepare standard solution of sodium carbonate and determine the percentage of given NaOH and KOH mixture solution (2.5 g/liter) by using HCl solution.
2. To prepare standard solution of potassium dichromate and find out the strength of given potassium dichromate solution using sodium thiosulphate (hypo solution) as an intermediate.
3. To prepare standard solution of potassium permanganate and find out the strength of given potassium permanganate solution using sodium thiosulphate (hypo solution) as an intermediate.
4. To prepare standard solution of copper(II) sulphate and find out the strength of given copper(II) sulphate solution using sodium thiosulphate (hypo solution) as an intermediate.
5. To determine the viscosity of pure liquids and binary mixtures by Ostwald viscometer.
6. Determination of the surface tension of pure liquids and binary mixtures.
7. Determination of partition coefficient of iodine between water and carbon tetrachloride or toluene or chloroform.
8. Determination of partition coefficient of Benzoic acid between water and toluene.

Reference Books:

1. Practical Chemistry, OP Pandey, DN Bajpai, S. Giri, S. Chand & Company Ltd., 2008.
2. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.

Minor-2: Physical Chemistry-1

Semester	Paper Code	Credits	Total Marks	Paper Type
II	24-CHE-M-153	3	100 (UE=60, IA=40)	Theory

Unit I. Gaseous State

Gas laws, Ideal gas equation, Dalton's law of partial pressure, Graham's law of diffusion, Postulates of kinetic theory of gases, Kinetic gas equation. Deviation from ideal behavior: Effect of temperature and pressure. Maxwell's distribution of molecular velocities: Root mean square, Average and Most probable velocities. Collision properties: Collision number, Mean free path, Collision diameter and Collision frequency. Liquefaction of gases. Critical Phenomena: PV isotherms of real gases, Continuity of states, van der Waals equation, Isotherms of van der Waals equation, Relationship between critical constants and van der Waals constants, Law of corresponding states, Reduced equation of state.

Unit II. Liquid State

Description of liquids, Structural differences between solids, liquids and gases, Intermolecular forces. Variation of vapour pressure of liquids with temperature and Trouton's rule. Liquid Crystals, Vapour pressure-Temperature diagram, Classification of liquid crystals, Difference between liquid crystals. Structure of Smectic, Nematic and Cholesteric liquid crystals.

Unit III. Chemical Kinetics

Chemical Kinetics and its Scope, Rate of a Reaction, Rate Laws, Factors Influencing the Rate of Reaction: Concentration, Temperature, Pressure, Catalyst. Rate Constant, Elementary and Complex Reactions, Molecularity, Order of Reactions, Concentration and Temperature Dependence of Rates, Mathematical Characteristics of Simple Chemical Reactions - Zero Order, First Order, Second Order, Pseudo Order, and their Half-life Expressions. Determination of Order of Reaction - Differential Method, Method of Integration, Half-life Method and Isolation Method.

Reference Books

1. Essentials of Physical Chemistry, B.S. Bahl, G.D. Tuli and Arun Bahl, S. Chand & Company Ltd.
2. A Text Book of Physical Chemistry, A.S. Negi and S.C. Anand, New Age International Publishers.
3. Physical Chemistry, G. M. Barrow, International Student Edition, McGraw Hill.
4. Physical Chemistry through Problems, S. K. Dogra and S. Dogra Wiley Eastern Ltd.
5. Physical Chemistry, P. W. Atkins, & J. de Paula, 10th Ed., Oxford University Press(2014).

Minor-2: Physical Chemistry Lab-1

Semester	Paper Code	Credits	Total Marks	Paper Type
II	24-CHE-M-153L	1	50 (UE=25, IA=25)	Practical

1. Surface tension measurements:

- (a) Determine surface tension of a solution using the drop number method.
- (b) Study variation of surface tension with concentration for detergent solutions.

2. Viscosity measurement using Ostwald's viscometer for

- (a) ethanol
- (b) amyl alcohol
- (c) aqueous solution of sugar at room temperature.

- 3. To study the kinetics of the saponification of ethyl acetate by integrated rate method.
- 4. To determine the order of the reaction between thiosulphate and HCl with respect to thiosulphate.
- 5. To determine the order of the reaction between thiosulphate and HCl with respect to HCl.

Minor-3: Organic Chemistry-1

Semester	Paper Code	Credits	Total Marks	Paper Type
III	24-CHE-M-202	3	100 (UE=60, IA=40)	Theory

Unit I: Basics of Organic Chemistry

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, Electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Homolytic and Heterolytic fission with suitable examples; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radical. Introduction to types of organic reactions. Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples

Unit II: Stereochemistry

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis-trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations. Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms.

Unit III: Chemistry of Aliphatic Hydrocarbons

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation-relative reactivity and selectivity. Preparation of alkenes by elimination reactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). Preparations & Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Reference Books:

1. Morrison, R.N. & Boyd, R.N., *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I.L., *Organic Chemistry*, Volume 1, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Eliel, E.L. & Wilen, S.H., *Stereochemistry of Organic Compounds*, Wiley, London, 1994.
4. Kalsi, P.S., *Stereochemistry: Conformation and Mechanism*, New Age International, 2005.

5. McMurry, J.E., *Fundamentals of Organic Chemistry*, 7th Edition, Cengage Learning India Edition, 2013.

Minor-3: Organic Chemistry Lab-1

Semester	Paper Code	Credits	Total Marks	Paper Type
III	24-CHE-M-202L	1	50 (UE=25, IA=25)	Practical

Qualitative and Separation Techniques

1. **Purification of organic compounds by crystallization** using the following solvents:
 - Water
 - Alcohol
 - Alcohol–Water mixture
2. **Determination of melting points** of the above compounds and unknown organic compounds using Kjeldahl method and electrically heated melting point apparatus.
3. **Chromatography**
 - Separation of a mixture of two amino acids by ascending and horizontal paper chromatography.
 - Separation of a mixture of two sugars by ascending paper chromatography.
 - Separation of a mixture of *o*- and *p*-nitrophenol or *o*- and *p*-aminophenol by thin layer chromatography (TLC).
4. **Preliminary examination and functional group tests** for alcohols, phenols, and carboxylic acid groups.

Reference Books:

1. F.G. Mann and B.C. Saunders, *Practical Organic Chemistry*, Pearson Education, 2009.
2. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, and A. R. Tatchell, *Practical Organic Chemistry*, 5th Edition, Pearson, 2012.

Minor-4: Inorganic Chemistry-2

Semester	Paper Code	Credits	Total Marks	Paper Type
IV	24-CHE-M-251	3	100 (UE=60, IA=40)	Theory

Unit I: 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 and Bsworth diagrams). Difference between the first, second and third transition series. Chemistry of first transition series elements (Ti, V, Cr, Mn, Fe and Co in various oxidation states, excluding their metallurgy).

Unit II: Lanthanoids and Actinoids

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

Unit III: Noble Gases

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF₂, XeF₄ and XeF₆; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF₂). Molecular shapes of noble gas compounds (VSEPR theory).

Reference Books:

1. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th Ed., Harper Collins, 1993; Pearson, 2006.
2. Sharpe, A.G., *Inorganic Chemistry*, 4th Indian Reprint, Pearson Education, 2005.
3. Powell, P., *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
4. Shriver, D.D. & Atkins, P., *Inorganic Chemistry*, 2nd Ed., Oxford University Press, 1994.
5. Miessler, G. L. & Tarr, D.A., *Inorganic Chemistry*, 4th Ed., Pearson, 2010.

Minor-4: Inorganic Chemistry Lab-2

Semester	Paper Code	Credits	Total Marks	Paper Type
IV	24-CHE-M-251L	1	50 (UE=25, IA=25)	Practical

(A) Qualitative Analysis

Qualitative analysis of inorganic mixtures containing three anions and three cations, including interfering radicals.

(B) Inorganic Synthesis

- a) Preparation of Potash alum and Chrome alum.
- b) Synthesis of Tetraamminecopper(II) sulphate monohydrate, $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \cdot \text{H}_2\text{O}$.
- c) Synthesis of Potassium tris(oxalato)ferrate(III), $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$.

(C) Conductometric Analysis

- a) To study changes in conductance during titration with a strong alkali in the following systems:
 - (i) Strong acid
 - (ii) Weak acid
 - (iii) Mixture of strong acid and weak acid
- b) To determine the ionization constant of a weak acid conductometrically.

Reference Books:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis*, 6th Ed., Pearson, 2009.
2. Svehla, G., *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.

Undergraduate Papers in Chemistry

EFFECTIVE FROM JULY 2024

MULTIDISCIPLINARY (DSE) PAPERS IN CHEMISTRY

UNDER NEW EDUCATION POLICY (NEP-2020)



Department of Chemistry
Faculty of Sciences
Jamia Millia Islamia
(A Central University by Act of Parliament)
Jamia Nagar, New Delhi-110025

Course Structure for Under Graduate Papers in Chemistry (Paper Types: Major, Multidisciplinary (DSE), Minor SEC, VAC)

Semester-wise Distribution of Papers in Chemistry

Sem	Paper Code	Paper Title	Paper Type	Credits
I	24-CHE-C-101	Inorganic Chemistry-1 (3T+1P)	Major-1	4
	24-CHE-C-103	Physical Chemistry-1 (3T+1P)	Major-2	4
	24-CHE-T-102	Essential Food Nutrients (3T)	DSE-1	3
	24-CHE-M-101	GE-1: Inorganic Chemistry-1 (3T+1P)	Minor-1	4
	24-CHE-S-101	Analytical Methods & Lab Standards in Chemistry (3T)	SEC-1	3
	24-CHE-V-102	Medicines in Daily Life (2T)	VAC-1	2
II	24-CHE-C-152	Organic Chemistry-1 (3T+1P)	Major-3	4
	24-CHE-C-153	Physical Chemistry-2 (3T+1P)	Major-4	4
	24-CHE-T-151	Inorganic Materials of Industrial Importance (3T)	DSE-2	3
	24-CHE-M-153	GE-2: Physical Chemistry-1 (3T+1P)	Minor-2	4
	24-CHE-S-153	Mathematical Tools in Chemistry (3T)	SEC-2	3
	24-CHE-V-152	Green Methods in Chemistry (2T)	VAC-2	2
III	24-CHE-C-201	Inorganic Chemistry-2 (3T+1P)	Major-5	4
	24-CHE-C-202	Organic Chemistry-2 (3T+1P)	Major-6	4
	24-CHE-C-203	Physical Chemistry-3 (3T+1P)	Major-7	4
	24-CHE-T-213	Computational Methods in Chemistry (3T)	DSE-3	3
	24-CHE-M-202	GE-3: Organic Chemistry-1 (3T+1P)	Minor-3	4
	24-CHE-S-203	Applied Mathematics in Chemistry (3T)	SEC-3	3
	24-CHE-V-202	Chemistry of Cosmetics & Toiletries (2T)	VAC-3	2
IV	24-CHE-C-251	Inorganic Chemistry-3 (3T+1P)	Major-8	4
	24-CHE-C-252	Organic Chemistry-3 (3T+1P)	Major-9	4
	24-CHE-C-253	Physical Chemistry-4 (3T+1P)	Major-10	4
	24-CHE-M-251	GE-4: Inorganic Chemistry-2 (3T+1P)	Minor-4	4
	24-CHE-V-251	Environmental Chemistry (2T)	VAC-4	2
V	24-CHE-C-301	Inorganic Chemistry-4 (3T+1P)	Major-11	4
	24-CHE-C-302	Organic Chemistry-4 (3T+1P)	Major-12	4
	24-CHE-C-303	Physical Chemistry-5 (3T+1P)	Major-13	4
	24-CHE-M-302	GE-5: Organic Chemistry-2 (3T+1P)	Minor-5	4
VI	24-CHE-C-351	Inorganic Chemistry-5 (3T+1P)	Major-14	4
	24-CHE-C-352	Organic Chemistry-5 (3T+1P)	Major-15	4
	24-CHE-C-353	Physical Chemistry-6 (3T+1P)	Major-16	4
	24-CHE-M-352	GE-6: Physical Chemistry-2 (3T+1P)	Minor-6	4
VII	24-CHE-C-401	Inorganic Chemistry-6 (3T+1P)	Major-17	4
	24-CHE-C-402	Organic Chemistry-6 (3T+1P)	Major-18	4
	24-CHE-C-403	Physical Chemistry-7 (3T+1P)	Major-19	4
	24-CHE-C-411	Inorganic Chemistry-7 (3T+1P)	Major-20	4
	24-CHE-M-401	GE-7: Inorganic Chemistry-3 (3T+1P)	Minor-7	4
VIII	24-CHE-C-451	Inorganic Chemistry-8 (3T+1P)	Major-21	4

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Sem	Paper Code	Paper Title	Paper Type	Credits
<i>A/B*</i>	24-CHE-C-452	Organic Chemistry-7 (3T+1P)	Major-22	4
	24-CHE-C-453	Physical Chemistry-8 (3T+1P)	Major-23	4
	24-CHE-C-462	Organic Chemistry-8 (3T+1P)	Major-24	4
	24-CHE-M-452	GE-8: Organic Chemistry-3 (3T+1P)	Minor-8	4
Chemistry Credits in: Major=96, DSE=9, Minor=32, SEC=9 & VAC=8				

Notes

- T & P denote Theory and Practical credits, respectively. For courses with Practical credits, an 'L' factor is appended to the paper code. The mark distribution for the University Exam (UE) and Internal Assessment (IA) for both theory and practical are provided in the respective detailed syllabus.
- Majors and Minors shall be treated as Honors-Subsidiary in the erstwhile system.
- Two courses of 2 credits each, viz. Compulsory Qualifying - I & II, are to be taken during I-IV Semesters. Compulsory Qualifying - I shall be General Urdu, and Compulsory Qualifying - II shall be any one of Islamiyat, Hindu Religion Studies, or Indian Religions & Culture.
- VAC: Students will choose from a pool of VAC courses offered by the Faculties of Humanities & Languages, Social Sciences, Sciences, Life Sciences, Management, and Fine Arts, subject to the prescribed prerequisites and other specific requirements.
- Multidisciplinary (MD): Students of the Faculty of Life Sciences will choose Multidisciplinary courses from a pool of such courses offered by the Faculty of Life Sciences. Students of the Faculties of Humanities & Languages, Social Sciences, Sciences, Management, and Fine Arts may choose Multidisciplinary courses from a pool of such courses offered by these five faculties.
- *B**: If students opt for research, then they will opt for one paper according to their research specialization as Internship/Apprenticeship/Project/Community Outreach (IAPC).

DSE-1: Essential Food Nutrients

Semester	Paper Code	Credits	Total Marks	Paper Type
I	24-CHE-T-102	3	100 (UE=60, IA=40)	Theory

Unit I: Carbohydrate

Introduction; brief descriptions (structure and properties) of: (i) Monosaccharides: glucose, fructose, and galactose, (ii) Disaccharides: sucrose, lactose, and maltose, and (iii) Polysaccharides: starch, cellulose, and glycogen.

Concept of reducing and non-reducing sugars, analysis of carbohydrates (Molisch test, Benedict's test, and Barfoed's test); carbohydrate metabolism, glycaemic index, common diseases related to carbohydrate metabolism (diabetes, galactosemia, lactose intolerance, etc.).

Unit II: Lipids and Proteins

Lipids: Introduction; classification (simple and complex lipids, essential and non-essential lipids, fats, oils, and waxes); brief description of common lipids: triglycerides, phospholipids, cholesterol (LDL and HDL), and lipoproteins.

Chemical properties of lipids: iodine value, saponification value, degradation and control (auto-oxidation, lipolysis, rancidity); common diseases related to lipids (atherosclerosis, hyperlipidemia, and lipid metabolism disorders).

Proteins: Introduction; classification; protein structure (primary, secondary, and tertiary); sources; physical and chemical properties; common diseases related to proteins.

Unit III: Vitamins, Minerals, and Balanced Diet

Vitamins: Introduction and classification; sources and importance of vitamins (A, B complex, C, D, E, and K) and associated diseases.

Minerals: Introduction and classification; sources and importance of microminerals (Fe, Zn, Cu, Mn, Cr, Co, I, and Se), macrominerals (Ca, Mg, Na, K, and P) and associated diseases.

Balanced Diet: Introduction and importance; components of a balanced diet; general description of diet plans based on body mass index (BMI) and conditions like diabetes.

Reference Books

1. Coultate, T. *Food: The Chemistry of its Components*, 2023, Royal Society of Chemistry.
2. deMan, J. M., Finley, J. W., Hurst, W. J., Lee, C. Y. *Principles of Food Chemistry*, 2018, 4th Edition, Springer.

DSE-2: Inorganic Materials of Industrial Importance

Semester	Paper Code	Credits	Total Marks	Paper Type
II	24-CHE-T-151	3	100 (UE=60, IA=40)	Theory

Unit I: Industrial Chemicals and Fertilizers

Glass: Properties, manufacture, processing, and types (soda lime, lead, armored, safety, borosilicate, fluorosilicate, colored, photosensitive).

Ceramics: Clays, feldspar, types, manufacture, high-tech ceramics, applications, superconducting & semiconducting oxides, fullerenes, nanotubes, carbon fiber. Cements: Classification, ingredients, manufacture, setting process, quick-setting cement.

Fertilizers: Types, manufacture of urea, ammonium & calcium ammonium nitrates, phosphates, superphosphates, mixed fertilizers, KCl, K_2SO_4 .

Unit II: Protective Coatings

Introduction, Metallic Coatings, Electroplating, Electroless Plating, Chemical Conversion Coatings, Organic coatings, Paints, Analysis of oils, Formulation of paints, Varnishes, Enamels.

Metallic coatings—electrolytic, electroless, spraying, anodizing.

Unit III: Alloys and Explosives

Classification of alloys, ferrous and non-ferrous types, and properties of alloying elements. Steel manufacturing (impurity removal, surface treatments). Composition and properties of steels.

Chemical Explosives: Origin of explosive properties, preparation, and characteristics of lead azide, PETN, RDX. Introduction to rocket propellants.

Reference Books:

1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
5. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
6. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

DSE-3: Computational Methods in Chemistry

Semester	Paper Code	Credits	Total Marks	Paper Type
III	24-CHE-T-213	3	100 (UE=60, IA=40)	Theory

Unit I: Introduction to C Programming and Basic Syntax

- Introduction to C language and structure of a program.
- Data types, variables, constants, and operators.
- Arithmetic expressions and precedence of operators.
- Input and Output using `scanf()` and `printf()`.
- Control structures: `if`, `else`, `switch`, `while`, `do-while`, `for`.
- User-defined functions: declaration, definition, and calling.
- Use of standard math library functions: `abs()`, `pow()`, `sqrt()`, `log()`, `exp()`, `fabs()`, `sin()`, `cos()`, `tan()`.
- One-dimensional and two-dimensional arrays.
- Use of `#define` and constants.
- Simple chemistry-based programs (e.g., mole-mass conversion, temperature conversion).

Unit II: Matrix Operations and Data Handling

- Declaration and manipulation of matrices using 2D arrays.
- Programs for matrix addition, subtraction, and multiplication.
- Nested loops and modular programming with functions.
- Introduction to file handling: reading and writing data files.
- String handling functions: `strlen()`, `strcpy()`, `strcat()`, `strcmp()`.
- `struct` in C for handling molecular or atomic datasets.
- Sorting and searching techniques for datasets.
- Chemical data processing using user-defined structures and arrays.

Unit III: Numerical Methods in Chemistry

- Solving equations:
 - Quadratic equation
 - Polynomial roots using Bisection, Newton-Raphson, Iteration
- Numerical differentiation and integration:
 - Trapezoidal rule, Simpson's rule
 - Application to entropy, heat, PV-curves
- Statistical analysis:
 - Mean, variance, standard deviation, error
 - Linear regression (least squares method)
- Plotting (text-based output) of:
 - Trigonometric functions (particle in a box)
 - Exponential decay functions
 - Ideal and van der Waals gas isotherms (using cubic equation solvers)

Reference Books:

1. Yashavant Kanetkar, *Let Us C*, BPB Publications.
2. E. Balagurusamy, *Programming in ANSI C*, McGraw-Hill.
3. T.R. Chetia, *Introduction to Computer Programming (with Applications in Chemistry)*.
4. S.N. Ghoshal, *Computational Chemistry*.
5. M. Venugopal, *C Programming for Beginners*, Universities Press.

Undergraduate Papers in Chemistry

EFFECTIVE FROM JULY 2024

SEC PAPERS IN CHEMISTRY

UNDER NEW EDUCATION POLICY (NEP-2020)



Department of Chemistry

Faculty of Sciences

Jamia Millia Islamia

(A Central University by Act of Parliament)

Jamia Nagar, New Delhi-110025

Course Structure for Under Graduate Papers in Chemistry (Paper Types: Major, Multidisciplinary (DSE), Minor SEC, VAC)

Semester-wise Distribution of Papers in Chemistry

Sem	Paper Code	Paper Title	Paper Type	Credits
I	24-CHE-C-101	Inorganic Chemistry-1 (3T+1P)	Major-1	4
	24-CHE-C-103	Physical Chemistry-1 (3T+1P)	Major-2	4
	24-CHE-T-102	Essential Food Nutrients (3T)	DSE-1	3
	24-CHE-M-101	GE-1: Inorganic Chemistry-1 (3T+1P)	Minor-1	4
	24-CHE-S-101	Analytical Methods & Lab Standards in Chemistry (3T)	SEC-1	3
	24-CHE-V-102	Medicines in Daily Life (2T)	VAC-1	2
II	24-CHE-C-152	Organic Chemistry-1 (3T+1P)	Major-3	4
	24-CHE-C-153	Physical Chemistry-2 (3T+1P)	Major-4	4
	24-CHE-T-151	Inorganic Materials of Industrial Importance (3T)	DSE-2	3
	24-CHE-M-153	GE-2: Physical Chemistry-1 (3T+1P)	Minor-2	4
	24-CHE-S-153	Mathematical Tools in Chemistry (3T)	SEC-2	3
	24-CHE-V-152	Green Methods in Chemistry (2T)	VAC-2	2
III	24-CHE-C-201	Inorganic Chemistry-2 (3T+1P)	Major-5	4
	24-CHE-C-202	Organic Chemistry-2 (3T+1P)	Major-6	4
	24-CHE-C-203	Physical Chemistry-3 (3T+1P)	Major-7	4
	24-CHE-T-213	Computational Methods in Chemistry (3T)	DSE-3	3
	24-CHE-M-202	GE-3: Organic Chemistry-1 (3T+1P)	Minor-3	4
	24-CHE-S-203	Applied Mathematics in Chemistry (3T)	SEC-3	3
	24-CHE-V-202	Chemistry of Cosmetics & Toiletries (2T)	VAC-3	2
IV	24-CHE-C-251	Inorganic Chemistry-3 (3T+1P)	Major-8	4
	24-CHE-C-252	Organic Chemistry-3 (3T+1P)	Major-9	4
	24-CHE-C-253	Physical Chemistry-4 (3T+1P)	Major-10	4
	24-CHE-M-251	GE-4: Inorganic Chemistry-2 (3T+1P)	Minor-4	4
	24-CHE-V-251	Environmental Chemistry (2T)	VAC-4	2
V	24-CHE-C-301	Inorganic Chemistry-4 (3T+1P)	Major-11	4
	24-CHE-C-302	Organic Chemistry-4 (3T+1P)	Major-12	4
	24-CHE-C-303	Physical Chemistry-5 (3T+1P)	Major-13	4
	24-CHE-M-302	GE-5: Organic Chemistry-2 (3T+1P)	Minor-5	4
VI	24-CHE-C-351	Inorganic Chemistry-5 (3T+1P)	Major-14	4
	24-CHE-C-352	Organic Chemistry-5 (3T+1P)	Major-15	4
	24-CHE-C-353	Physical Chemistry-6 (3T+1P)	Major-16	4
	24-CHE-M-352	GE-6: Physical Chemistry-2 (3T+1P)	Minor-6	4
VII	24-CHE-C-401	Inorganic Chemistry-6 (3T+1P)	Major-17	4
	24-CHE-C-402	Organic Chemistry-6 (3T+1P)	Major-18	4
	24-CHE-C-403	Physical Chemistry-7 (3T+1P)	Major-19	4
	24-CHE-C-411	Inorganic Chemistry-7 (3T+1P)	Major-20	4
	24-CHE-M-401	GE-7: Inorganic Chemistry-3 (3T+1P)	Minor-7	4
VIII	24-CHE-C-451	Inorganic Chemistry-8 (3T+1P)	Major-21	4

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Sem	Paper Code	Paper Title	Paper Type	Credits
<i>A/B*</i>	24-CHE-C-452	Organic Chemistry-7 (3T+1P)	Major-22	4
	24-CHE-C-453	Physical Chemistry-8 (3T+1P)	Major-23	4
	24-CHE-C-462	Organic Chemistry-8 (3T+1P)	Major-24	4
	24-CHE-M-452	GE-8: Organic Chemistry-3 (3T+1P)	Minor-8	4
Chemistry Credits in: Major=96, DSE=9, Minor=32, SEC=9 & VAC=8				

Notes

- T & P denote Theory and Practical credits, respectively. For courses with Practical credits, an 'L' factor is appended to the paper code. The mark distribution for the University Exam (UE) and Internal Assessment (IA) for both theory and practical are provided in the respective detailed syllabus.
- Majors and Minors shall be treated as Honors-Subsidiary in the erstwhile system.
- Two courses of 2 credits each, viz. Compulsory Qualifying - I & II, are to be taken during I-IV Semesters. Compulsory Qualifying - I shall be General Urdu, and Compulsory Qualifying - II shall be any one of Islamiyat, Hindu Religion Studies, or Indian Religions & Culture.
- VAC: Students will choose from a pool of VAC courses offered by the Faculties of Humanities & Languages, Social Sciences, Sciences, Life Sciences, Management, and Fine Arts, subject to the prescribed prerequisites and other specific requirements.
- Multidisciplinary (MD): Students of the Faculty of Life Sciences will choose Multidisciplinary courses from a pool of such courses offered by the Faculty of Life Sciences. Students of the Faculties of Humanities & Languages, Social Sciences, Sciences, Management, and Fine Arts may choose Multidisciplinary courses from a pool of such courses offered by these five faculties.
- *B**: If students opt for research, then they will opt for one paper according to their research specialization as Internship/Apprenticeship/Project/Community Outreach (IAPC).

SEC-1: Analytical Methods & Lab Standards in Chemistry

Semester	Paper Code	Credits	Total Marks	Paper Type
I	24-CHE-S-101	3	100 (UE=60, IA=40)	Theory

Unit I: Introduction to Lab Operations

General guidelines, Handling of glassware, Handling of equipment, Equipment protection, Handling of chemicals, Receipt and labeling of chemicals, Precautions in handling, Chemical spills, Storage and Disposal of chemicals and glassware, Mercury and Bio-hazardous clean up and disposal procedure.

Unit II: Safety measures

Safety rules, Hygiene, Knowledge about personal safety, Use of personal safety equipment, Respiratory protective equipment, Electrical safety, Fire extinguisher, Laboratory injuries and treatment, Accident management.

Unit III: Separation techniques

Solvent extraction: Classification, principle and efficiency of the technique.

Mechanism of extraction: extraction by solvation and chelation, Technique of extraction: batch, continuous and counter current extractions, Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.

Reference Books:

1. Hazards in Chemical Laboratory - G. D. Muir
2. Research Methodology-C. R. Kothari, New Age International Publishers, New Delhi (2004).
3. Manufacture, Storage and Import of Hazardous Chemicals Rules -1989.
4. Laboratory safety for chemistry students — R. H. Hill, D. C. Finster, Wiley (2016).
5. Harper, C. A., *Introduction to Mathematical Physics*, Prentice Hall, Englewood Cliffs, New Jersey, 1976. ISBN: 0-13-487538-9.

SEC-2: Mathematical Tools in Chemistry

Semester	Paper Code	Credits	Total Marks	Paper Type
II	24-CHE-S-153	3	100 (UE=60, IA=40)	Theory

Unit I: Algebra

Basic concepts of algebra relevant to chemical sciences. Rules of operations, identities, and simplification of expressions.

- Linear and quadratic equations: solution methods and applications in chemical problems.
- Simultaneous linear equations and their application in chemical equilibrium.
- Exponential and logarithmic functions: laws, series expansion, and their use in pH calculations and kinetics.
- Permutations and combinations

Unit II: Vectors and Vector Algebra

- Concept of scalar and vector quantities.
- Vector addition, subtraction, dot product, cross product and their geometrical interpretations.
- Applications of vectors in molecular geometry, force fields, and crystal structure.
- Direction cosines, scalar and vector triple products.
- Gradient, divergence, and curl – physical significance and application in chemical thermodynamics and fluid dynamics.

Unit-III: Matrices and Determinants

- Basic operations on matrices: addition, subtraction, multiplication, transpose, and inverse.
- Types of matrices: diagonal, unit, symmetric, skew-symmetric, singular, orthogonal.
- Determinants and their properties; evaluation of determinants up to order 3.
- Solving systems of linear equations using matrix methods (Cramer's rule, Gaussian elimination).
- Application of matrices in quantum chemistry, symmetry operations, and molecular orbital theory.

Reference Books:

1. M. R. Spiegel, *Schaum's Outline of Theory and Problems of Vector Analysis*, McGraw-Hill Education.

2. H. F. Mathews, *Mathematics for Physical Chemistry*, 3rd Edition, University Science Books, 2004.
3. D. A. McQuarrie, *Mathematics for Physical Chemistry*, University Science Books, 2008.
4. G. Doggett, *Mathematics for Chemists*, Royal Society of Chemistry, 1998.
5. K. F. Riley, M. P. Hobson, and S. J. Bence, *Mathematical Methods for Physics and Engineering*, 3rd Edition, Cambridge University Press, 2006.
6. E. Steiner, *The Chemistry Maths Book*, Oxford University Press, 2008.

SEC-3: Applied Mathematics in Chemistry

Semester	Paper Code	Credits	Total Marks	Paper Type
III	24-CHE-S-203	3	100 (UE=60, IA=40)	Theory

Unit I: Differential and Integral Calculus

- Review of functions, limits, continuity and differentiability.
- Differentiation: rules, higher-order derivatives, applications in chemical kinetics and rate laws.
- Integration: definite and indefinite integrals, techniques of integration (substitution, partial fractions, by parts).
- Applications of integration in physical chemistry – calculation of work, thermodynamic quantities, and probability distributions.

Unit II: Fourier and Laplace Transforms

- Introduction to periodic functions and Fourier series.
- Fourier transform: definition, properties, and applications in vibrational spectroscopy and quantum mechanics.
- Laplace transform: definition, properties, inverse Laplace transforms.
- Application of Laplace transforms to solve differential equations in chemical kinetics and relaxation phenomena.
- Convolution theorem and Heaviside function.

Unit-III: Special Functions and Special Integrals

- Gamma and Beta functions: definitions, properties, and applications in statistical mechanics and spectroscopy.
- Error function, exponential integral, sine and cosine integrals: relevance in reaction-diffusion models.
- Legendre polynomials, Hermite polynomials, and Bessel functions: introduction and role in quantum chemistry and molecular vibrations.
- Orthogonality and recurrence relations of special functions.

Reference Books:

1. D.A. McQuarrie, *Mathematics for Physical Chemistry*, University Science Books, 2008.
2. H. Margenau and G.H. Murphy, *The Mathematics of Physics and Chemistry*, D. Van Nostrand Company, 1943.

3. Mary L. Boas, *Mathematical Methods in the Physical Sciences*, Wiley, 3rd Edition, 2005.
4. K.F. Riley, M.P. Hobson, S.J. Bence, *Mathematical Methods for Physics and Engineering*, Cambridge University Press, 3rd Edition, 2006.
5. E. Butkov, *Mathematical Physics*, Addison-Wesley, 1968.
6. E. Steiner, *The Chemistry Maths Book*, Oxford University Press, 2008.
7. Harper, C. A., *Introduction to Mathematical Physics*, Prentice Hall, Englewood Cliffs, New Jersey, 1976. ISBN: 0-13-487538-9.

Undergraduate Papers in Chemistry

EFFECTIVE FROM JULY 2024

VAC PAPERS IN CHEMISTRY UNDER NEW EDUCATION POLICY (NEP-2020)



Department of Chemistry
Faculty of Sciences
Jamia Millia Islamia
(A Central University by Act of Parliament)
Jamia Nagar, New Delhi-110025

Course Structure for Under Graduate Papers in Chemistry (Paper Types: Major, Multidisciplinary (DSE), Minor SEC, VAC)

Semester-wise Distribution of Papers in Chemistry

Sem	Paper Code	Paper Title	Paper Type	Credits
I	24-CHE-C-101	Inorganic Chemistry-1 (3T+1P)	Major-1	4
	24-CHE-C-103	Physical Chemistry-1 (3T+1P)	Major-2	4
	24-CHE-T-102	Essential Food Nutrients (3T)	DSE-1	3
	24-CHE-M-101	GE-1: Inorganic Chemistry-1 (3T+1P)	Minor-1	4
	24-CHE-S-101	Analytical Methods & Lab Standards in Chemistry (3T)	SEC-1	3
	24-CHE-V-102	Medicines in Daily Life (2T)	VAC-1	2
II	24-CHE-C-152	Organic Chemistry-1 (3T+1P)	Major-3	4
	24-CHE-C-153	Physical Chemistry-2 (3T+1P)	Major-4	4
	24-CHE-T-151	Inorganic Materials of Industrial Importance (3T)	DSE-2	3
	24-CHE-M-153	GE-2: Physical Chemistry-1 (3T+1P)	Minor-2	4
	24-CHE-S-153	Mathematical Tools in Chemistry (3T)	SEC-2	3
	24-CHE-V-152	Green Methods in Chemistry (2T)	VAC-2	2
III	24-CHE-C-201	Inorganic Chemistry-2 (3T+1P)	Major-5	4
	24-CHE-C-202	Organic Chemistry-2 (3T+1P)	Major-6	4
	24-CHE-C-203	Physical Chemistry-3 (3T+1P)	Major-7	4
	24-CHE-T-213	Computational Methods in Chemistry (3T)	DSE-3	3
	24-CHE-M-202	GE-3: Organic Chemistry-1 (3T+1P)	Minor-3	4
	24-CHE-S-203	Applied Mathematics in Chemistry (3T)	SEC-3	3
	24-CHE-V-202	Chemistry of Cosmetics & Toiletries (2T)	VAC-3	2
IV	24-CHE-C-251	Inorganic Chemistry-3 (3T+1P)	Major-8	4
	24-CHE-C-252	Organic Chemistry-3 (3T+1P)	Major-9	4
	24-CHE-C-253	Physical Chemistry-4 (3T+1P)	Major-10	4
	24-CHE-M-251	GE-4: Inorganic Chemistry-2 (3T+1P)	Minor-4	4
	24-CHE-V-251	Environmental Chemistry (2T)	VAC-4	2
V	24-CHE-C-301	Inorganic Chemistry-4 (3T+1P)	Major-11	4
	24-CHE-C-302	Organic Chemistry-4 (3T+1P)	Major-12	4
	24-CHE-C-303	Physical Chemistry-5 (3T+1P)	Major-13	4
	24-CHE-M-302	GE-5: Organic Chemistry-2 (3T+1P)	Minor-5	4
VI	24-CHE-C-351	Inorganic Chemistry-5 (3T+1P)	Major-14	4
	24-CHE-C-352	Organic Chemistry-5 (3T+1P)	Major-15	4
	24-CHE-C-353	Physical Chemistry-6 (3T+1P)	Major-16	4
	24-CHE-M-352	GE-6: Physical Chemistry-2 (3T+1P)	Minor-6	4
VII	24-CHE-C-401	Inorganic Chemistry-6 (3T+1P)	Major-17	4
	24-CHE-C-402	Organic Chemistry-6 (3T+1P)	Major-18	4
	24-CHE-C-403	Physical Chemistry-7 (3T+1P)	Major-19	4
	24-CHE-C-411	Inorganic Chemistry-7 (3T+1P)	Major-20	4
	24-CHE-M-401	GE-7: Inorganic Chemistry-3 (3T+1P)	Minor-7	4
VIII	24-CHE-C-451	Inorganic Chemistry-8 (3T+1P)	Major-21	4

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<i>A/B*</i>	24-CHE-C-452	Organic Chemistry-7 (3T+1P)	Major-22	4
	24-CHE-C-453	Physical Chemistry-8 (3T+1P)	Major-23	4
	24-CHE-C-462	Organic Chemistry-8 (3T+1P)	Major-24	4
	24-CHE-M-452	GE-8: Organic Chemistry-3 (3T+1P)	Minor-8	4
Chemistry Credits in: Major=96, DSE=9, Minor=32, SEC=9 & VAC=8				

Notes

- T & P denote Theory and Practical credits, respectively. For courses with Practical credits, an 'L' factor is appended to the paper code. The mark distribution for the University Exam (UE) and Internal Assessment (IA) for both theory and practical are provided in the respective detailed syllabus.
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- *B**: If students opt for research, then they will opt for one paper according to their research specialization as Internship/Apprenticeship/Project/Community Outreach (IAPC).

VAC-1: Medicines in Daily Life

Semester	Paper Code	Credits	Total Marks	Paper Type
I	24-CHE-V-102	3	100 (UE=60, IA=40)	Theory

Unit I: General Introduction

Introduction-Health, disease, drugs, chemotherapy, approaches in drug designing, classification of drugs and their origin. Structure of active ingredients, uses, dosage, side effects and their natural remedies

Unit II: Different class of medicines

Analgesics and Antipyretics: Aspirin, paracetamol, ibuprofen, morphine, codeine.

Antibiotics: Amoxicillin, norfloxacin, ciprofloxacin.

Antihistamines/Antiallergics: Cetirizine and levocetirizine (with emphasis on the role of stereoisomers).

Antiparasitic: Albendazole.

Antidiabetics: Insulin, glipizide, and metformin.

Antihypertensive: Amlodipine and its natural remedies – Rauwolfia.

Diuretics: Lasix.

Antidepressants: Zoloft and its natural treatment.

Antacids: Ideal properties of antacids; combinations of antacids; sodium bicarbonate, ranitidine, milk of magnesia, aluminium hydroxide gel.

Anesthetics: Introduction and types with examples.

Reference Books:

1. G.L. Patrick, *Introduction to Medicinal Chemistry*, Oxford University Press, 2001.
2. T.L. Lemke and D.A. Williams, *Foye's Principles of Medicinal Chemistry*, 5th Edition, USA, 2002.
3. H. Singh and V.K. Kapoor, *Medicinal and Pharmaceutical Chemistry*, Vallabh Prakashan, 1996.
4. G.R. Chatwal, *Pharmaceutical Chemistry, Inorganic (Vol. 1)*, Himalayan Publishing House, 2010.
5. <https://go.drugbank.com>

VAC-2: Green Chemistry

Semester	Paper Code	Credits	Total Marks	Paper Type
II	24-CHE-V-152	3	100 (UE=60, IA=40)	Theory

Unit I: Fundamentals and Principles of Green Chemistry

Introduction to Green Chemistry; Need for Green Chemistry; Goals of Green Chemistry; Limitations and obstacles in the pursuit of the goals of Green Chemistry.

Twelve Principles of Green Chemistry: Designing a green synthesis using these principles. Prevention of waste and byproducts; Maximum incorporation of materials used in the process into the final products.

Green solvents: Supercritical fluids, water as a solvent for organic reactions, ionic liquids. Energy requirements for reactions: Alternative sources of energy such as microwaves and ultrasonic energy. Careful use of blocking/protecting groups. Catalysis and green chemistry: comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis, and photocatalysis.

Strengthening and development of analytical techniques to prevent the generation of hazardous substances in chemical processes.

Unit II: Green Synthesis, Real-World Applications, and Future Trends

- Green synthesis of adipic acid, catechol, and disodium iminodiacetate (alternative to Strecker synthesis)
- Microwave-assisted reactions in water: Hofmann elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols
- Microwave-assisted reactions in organic solvents: Diels–Alder reaction and decarboxylation reaction
- Ultrasound-assisted reactions: Sonochemical Simmons–Smith reaction
- Surfactants for carbon dioxide: Replacing smog-producing and ozone-depleting solvents with CO₂
- Enzymatic inter-esterification for production of no trans-fats and oils
- Development of fully recyclable carpet: Cradle-to-cradle carpeting
- Future Trends in Green Chemistry: Oxidation reagents and catalysts; biomimetic and multifunctional reagents; combinatorial green chemistry; proliferation of solventless reactions; co-crystal controlled solid-state synthesis. Role of green chemistry in sustainable development.

Reference Books:

1. V.K. Ahluwalia and M.R. Kidwai, *New Trends in Green Chemistry*, Anamalaya Publishers, 2005.

2. P.T. Anastas and J.K. Warner, *Green Chemistry: Theory and Practice*, Oxford University Press, 1998.
3. A.S. Matlack, *Introduction to Green Chemistry*, Marcel Dekker, 2001.
4. M.C. Cann and M.E. Connely, *Real-World Cases in Green Chemistry*, American Chemical Society, Washington, 2000.
5. M.A. Ryan and M. Tinnesand, *Introduction to Green Chemistry*, American Chemical Society, Washington, 2002.
6. M. Lancaster, *Green Chemistry: An Introductory Text*, 2nd Edition, RSC Publishing, 2010.

VAC-3: Chemistry of Cosmetics & Toiletries

Semester	Paper Code	Credits	Total Marks	Paper Type
III	24-CHE-V-202	3	100 (UE=60, IA=40)	Theory

Unit I: Synthesis of Cosmetics

A general study including preparation and uses of the following cosmetic products: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold cream, vanishing cream, and shaving cream), antiperspirants, and artificial flavours.

Unit II: Essential Oils and Applications

Essential oils and their importance in the cosmetic industry with reference to the following compounds: Eugenol, Geraniol, Sandalwood oil, Eucalyptus oil, Rose oil, 2-Phenyl ethyl alcohol, Jasmone, Civetone, and Muscone.

Reference Books:

1. R. Cremlyn, *Pesticides: Preparation and Modes of Action*, John Wiley & Sons, New York, 1978.
2. E. Stocchi, *Industrial Chemistry*, Vol. I, Ellis Horwood Ltd., UK, 1990.
3. *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
4. *Industrial Chemistry*, Goel Publishing House, Meerut, 1996.

VAC-4: Environmental chemistry

Semester	Paper Code	Credits	Total Marks	Paper Type
IV	24-CHE-V-251	3	100 (UE=60, IA=40)	Theory

Unit I: Air Pollution

Major regions of the atmosphere; chemical and photochemical reactions in the atmosphere.

Air pollutants: Types, sources, particle size and chemical nature. Major sources of air pollution. Pollution caused by SO₂, CO₂, CO, NO_x, H₂S, and other foul-smelling gases. Methods of estimation of CO, NO_x, and SO_x and corresponding control procedures.

Chemistry and environmental impact of: Photochemical smog, greenhouse effect, ozone depletion.

Air pollution control devices: Settling chambers, Venturi scrubbers, Electrostatic Precipitators (ESPs).

Unit II: Water Pollution

Hydrological cycle, water resources, aquatic ecosystems.

Sources and nature of water pollutants. Techniques for measuring water pollution. Impacts of water pollution on the hydrological cycle and aquatic ecosystems.

Water purification methods: Effluent treatment plants (ETPs) — primary, secondary, and tertiary treatments. Sludge disposal.

Industrial waste management: Incineration of waste. Water treatment and purification methods: reverse osmosis, electrodialysis, ion-exchange.

Water quality parameters for wastewater, industrial water, and domestic water.

Reference Books:

1. Stanley E. Manahan, *Environmental Chemistry*, 10th Edition, CRC Press, Taylor and Francis Group, USA, 2017.
2. C. Baird and M. Cann, *Environmental Chemistry*, 5th Edition, W.H. Freeman & Company, New York, USA, 2012.
3. G.W. VanLoon and J.S. Duffy, *Environmental Chemistry: A Global Perspective*, 4th Edition, Oxford University Press, 2018.
4. M.L. Brusseau, I.L. Pepper and C. Gerba, *Environmental and Pollution Science*, 3rd Edition, Academic Press, 2019.