

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

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	Chemistry Lab Standard (2T+1P)	SEC-1	3
	24-CHE-V-102	Food Flavors and Colourants (1T+1P)	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-151	Analytical Methods in Chemistry (2T+1P)	SEC-2	3
	24-CHE-V-151	Green Methods in Chemistry (1T+1P)	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 & Molecular modelling (3T)	DSE-3	3
	24-CHE-M-202	GE-3: Organic Chemistry-1 (3T+1P)	Minor-3	4
	24-CHE-S-203	IT Skills and Data Analysis for Chemists (2T+1P)	SEC-3	3
	24-CHE-V-202	Chemistry of Cosmetics & Toiletries (1T+1P)	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-253	Artificial Intelligence and Machine Learning in Chemistry (1T+1P)	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

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Sem	Paper Code	Paper Title	Paper Type	Credits
	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 <i>A/B*</i>	24-CHE-C-451	Inorganic Chemistry-8 (3T+1P)	Major-21	4
	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).

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.

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	24-CHE-C-453	Physical Chemistry-8 (3T+1P)	Major-23	4
	24-CHE-C-462	Organic Chemistry-8 (3T+1P)	Major-24	4
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- 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.
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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
I	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
I	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.

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	Chemistry Lab Standard (2T+1P)	SEC-1	3
	24-CHE-V-102	Food Flavors and Colourants (1T+1P)	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-151	Analytical Methods in Chemistry (2T+1P)	SEC-2	3
	24-CHE-V-151	Green Methods in Chemistry (1T+1P)	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 & Molecular modelling (3T)	DSE-3	3
	24-CHE-M-202	GE-3: Organic Chemistry-1 (3T+1P)	Minor-3	4
	24-CHE-S-203	IT Skills and Data Analysis for Chemists (2T+1P)	SEC-3	3
	24-CHE-V-202	Chemistry of Cosmetics & Toiletries (1T+1P)	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-253	Artificial Intelligence and Machine Learning in Chemistry (1T+1P)	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

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Sem	Paper Code	Paper Title	Paper Type	Credits
	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 <i>A/B*</i>	24-CHE-C-451	Inorganic Chemistry-8 (3T+1P)	Major-21	4
	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).

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	Chemistry Lab Standard (2T+1P)	SEC-1	3
	24-CHE-V-102	Food Flavors and Colourants (1T+1P)	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-151	Analytical Methods in Chemistry (2T+1P)	SEC-2	3
	24-CHE-V-151	Green Methods in Chemistry (1T+1P)	VAC-2	2
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	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 & Molecular modelling (3T)	DSE-3	3
	24-CHE-M-202	GE-3: Organic Chemistry-1 (3T+1P)	Minor-3	4
	24-CHE-S-203	IT Skills and Data Analysis for Chemists (2T+1P)	SEC-3	3
	24-CHE-V-202	Chemistry of Cosmetics & Toiletries (1T+1P)	VAC-3	2
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	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-253	Artificial Intelligence and Machine Learning in Chemistry (1T+1P)	VAC-4	2
V	24-CHE-C-301	Inorganic Chemistry-4 (3T+1P)	Major-11	4
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VI	24-CHE-C-351	Inorganic Chemistry-5 (3T+1P)	Major-14	4
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	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
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	24-CHE-C-403	Physical Chemistry-7 (3T+1P)	Major-19	4

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Sem	Paper Code	Paper Title	Paper Type	Credits
	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 <i>A/B*</i>	24-CHE-C-451	Inorganic Chemistry-8 (3T+1P)	Major-21	4
	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				

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- 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.
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- 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: Chemistry Lab Standard Operations and Safety Measures

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

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: Practicals (Minimum 6 Practicals, to be performed)

1. Demonstration and handling of fire-extinguisher.
2. Calibration and handling of burette and pipette.
3. Handling, precautions and calibration of weighing machine.
4. Storage and disposal of chemicals: demonstration and handling.
5. Preparation technique of standard solutions.
6. Laboratory preparation of standard soap.
7. Laboratory preparation of liquid soap.
8. Laboratory preparation of detergent.

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).

SEC-2: Analytical Methods in Chemistry

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

Unit I

The nature and scope of analytical chemistry. Analytical chemistry, its functions and applications Analytical problems and procedures Analytical techniques and methods Sampling and sample handling Calibration and standards Quality in analytical laboratories

Unit II

Assessment of data Errors in analytical measurements Assessment of accuracy and precision Significance testing, Calibration and linear regression Quality control and Chemometrics.

Unit-III

Tools of Analytical Chemistry Chemicals, Apparatus, and Unit Operations of Analytical Chemistry Selecting and Handling Reagents and Other Chemicals. Cleaning and Marking of Laboratory Ware Evaporating Liquids, Measuring Mass, Equipment and Manipulations associated with Weighing, Filtration and Ignition of Solids, Measuring Volume, Calibrating Volumetric Glassware, The Laboratory Notebook, Safety in the Laboratory.

Unit IV: Practicals (Minimum 6 Practicals, to be performed)

1. To determine the strength of NaOH and Na_2CO_3 present together in a solution
2. To determine the strength of a silver nitrate solution by Mohr's & method.
3. To estimate Calcium with EDTA.
4. To estimate Magnesium with EDTA.
5. To determine the total, permanent and temporary hardness of water by complexometric method using EDTA.
6. Estimation of Barium as barium sulphate, Sulphate as BaSO_4 , Silver as AgCl and Copper as Cupric Oxide using Gravimetric Analysis.
7. Separation of a mixture of two amino acids by ascending paper chromatography.
8. Separation of a mixture of two sugars by ascending paper chromatography

Reference Books:

1. Seamus P.J. Higson: Analytical Chemistry, OUP Oxford; Standard Edition (11 December 2003); CBS PUBLISHERS AND DISTRIBUTORS PVT. LTD.
2. Donald West, Douglas Skoog and F. Holler, Fundamentals of Analytical Chemistry, Brooks/Cole; 9th edition (1 January 2013).

3. Adion A. Gordus: Schaum's Outline of Analytical Chemistry, Tata McGraw-Hill.
4. Gary D. Christian : Analytical Chemistry .
5. Freifelder and Kealy: Analytical Chemistry .
6. Daniel C Harris: Exploring Chemical Analysis.
7. Daniel C Harris: Quantitative Chemical Analysis.