# Department of Chemistry

## PROGRAMME M.Sc. (Chemistry)

## (Session: 2024-2025 Onwards)

➢ **Programme Structure**

➢ **Programme Outcomes (POs)**

➢ **Course Outcomes (COs)**

➢ **Detailed Syllabus (Course Contents)**

### COURSE STRUCTURE WITH CREDITS DISTRIBUTION

**(Subject: M.Sc. Chemistry)**
**(2024-2025 onwards)**
**UG SEMESTER-VII/PG SEMESTER-I**

| Course Code | | Course Name | Maximum Credits (20) | CIE | ETE |
|---|---|---|---|---|---|
| B020701T | Core | Inorganic Chemistry-I | 3 Credits | 25 | 75 |
| B020702P | Core | Chemistry Laboratory -I | 1 Credits | 25 | 75 |
| B020703T | Core | Organic Chemistry -I | 3 Credits | 25 | 75 |
| B020704P | Core | Chemistry Laboratory -II | 1 Credits | 25 | 75 |
| B020705T | Core | Research Methodology | 4 Credits | 25 | 75 |
| B020706T | Discipline Centric Elective (Select any one) | Physical Chemistry | 4 Credits | 25 | 75 |
| B020707T | | Polymer Chemistry | | | |
| B020708T | Discipline Centric Elective (Select any one) | Techniques of Chemistry -I | 4 Credits | 25 | 75 |
| B020709T | | Medicinal Chemistry | | | |

## UG SEMESTER-VIII (for Four Year Undergraduate Programme who obtained above 75% Marks)/ PG SEMESTER- II (for Two Year Post Graduate Programme- lateral entry)

| Course Code | | Course Name | Maximum Credits (20) | CIE | ETE |
|---|---|---|---|---|---|
| B020801T | Core | Inorganic Chemistry-II | 03 Credits | 25 | 75 |
| B020802P | Core | Chemistry Laboratory -III | 01 Credits | 25 | 75 |
| B020803T | Core | Organic Chemistry -II | 03 Credits | 25 | 75 |
| B020804P | Core | Chemistry Laboratory -IV | 01 Credits | 25 | 75 |
| B020805R | Research Project | Research Project | 12 Credits | -- | 100 |

***OR***

## UG SEMESTER-VIII (for Four Year Undergraduate Programme who obtained below 75% Marks)/ PG SEMESTER- II (for Two Year Post Graduate Programme- lateral entry)

| Course Code | | Course Name | Maximum Credits (20) | CIE | ETE |
|---|---|---|---|---|---|
| B020801T | Core | Inorganic Chemistry-II | 3 Credits | 25 | 75 |
| B020802P | Core | Chemistry Laboratory -III | 1 Credits | 25 | 75 |
| B020803T | Core | Organic Chemistry -II | 3 Credits | 25 | 75 |
| B020804P | Core | Chemistry Laboratory -IV | 1 Credits | 25 | 75 |
| B020805T | Discipline Centric Elective (select any one) | Chemistry of Natural Products | 4 Credits | 25 | 75 |
| B020806T | | Techniques of Chemistry -I I | | | |
| B020807T | Discipline Centric Elective (select any one) | Supra-molecular Chemistry and Strategy in Chemical Synthesis | 4 Credits | 25 | 75 |
| B020808T | | Heterocyclic Chemistry | | | |
| B020809T | Ability Enhancement Course (select any one) | Reagents in Organic Synthesis | 4 Credits | 25 | 75 |
| B020810T | | Analytical Chemistry | | | |

***Note: The Core Course will be same in the both of UG Semester-VIII and PG Semester-II.***

| PG SEMESTER-III/PG SEMESTER-I (One Year PG Programme-Lateral Entry) | | | | | |
|---|---|---|---|---|---|
| Course Code | | Course Name | Maximum Credits (20) | CIE | ETE |
| B020901T | Core | Organic Spectroscopy | 3 Credits | 25 | 75 |
| B020902P | Core | Chemistry Laboratory -V | 1 Credits | 25 | 75 |
| B020903T | Core | Organometallic Chemistry | 3 Credits | 25 | 75 |
| B020904P | Core | Chemistry Laboratory - VI | 1 Credits | 25 | 75 |
| B020905T | Discipline Centric Elective (select any one) | Inorganic Spectroscopy | 4 Credits | 25 | 75 |
| B020906T | | Nano Materials & Solid State Chemistry | | | |
| B020907T | Discipline Centric Elective (select any one) | Photochemistry | 4 Credits | 25 | 75 |
| B020908T | | Quantum Chemistry | | | |
| B020909T | Ability Enhancement Course (select any one) | Name reactions & Rearrangements in Organic Synthesis | 4 Credits | 25 | 75 |
| B020910T | | Molecular Spectroscopy | | | |

## PG SEMESTER-IV/PG SEMESTER-II (One Year PG Programme)

| Course Code | | Course Name | Maximum Credits (20) |
|---|---|---|---|
| B021001D | MRP | MASTER DISSERTATION | 20 Credits |

**Instrumental Methods of Analysis**

## M.Sc. Chemistry -Semester-I

**Paper Name:** Inorganic Chemistry -I (Paper-I)

**Paper CODE:** B020701T **Marks:** 100 (ETE 75 & CIE 25)

I. **Stereochemistry and Bonding in main group compounds:**

VSEPR, Walsh diagrams (tri-and penta-atomic molecules), dπ-pπ bonds, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules.

II. **Metal-Ligand Bonding in Transition Metal Complexes**

Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes, $\pi$-bonding and molecular orbital theory and Jahn-Teller distortion.

III. **Molecular symmetry and character tables**

Symmetry elements and symmetry operations, symmetry groups, defining properties of a group, character tables and its applications.

Symmetry considerations in simple inorganic and coordination compounds.

IV. **Chemistry of f-Block Elements**

Comparative study of lanthanides and actinides. Electronic configuration, Oxidation state, Ionic radii (lanthanide contraction), complex formation, Structure of complexes, spectral properties and magnetic properties. General chemistry of actinides including E.M.F. diagrams, Extraction and metallurgy of thorium and uranium. Separation of transamericium elements.

V. **Metal ligand equilibria in solution:**

Stepwise and overall formation constant, trends in stepwise constant, factors affecting the stability of metal complex with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin.

## M.Sc. Chemistry (Practical)-Semester-I

**Paper Name:** Chemistry Laboratory -I

**Paper CODE:** B020702P **Marks:** 100 (ETE 75 & CIE 25)

**Inorganic :**

a) **Qualitative Analysis :**
Qualitative mixture analysis for seven radicals including two rare elements (Mo, W, Ti, Zr, Th, Ce, V) in cationic and anionic forms.

b) Quantitative separation and determination of the following pairs of metal ions using gravimetric & volumetric methods.

(i) $Ni^{++}$ and $Cu^{++}$
(ii) $Cu^{++}$ and $Zn^{++}$
(iii) $Ag^{+}$ and $Cu^{++}$
(iv) $Ag^{+}$ and $Ca^{++}$

**Organic**

a) Separation and identification of organic compounds using chemical methods from binary mixture.

b) Isolation of
(i) Caffeine from tea leaves
(ii) Eugenol from cloves
(iii) Casein from milk
(iv) Lycopene from Tomatoes

## M.Sc. Chemistry -Semester-I

**Paper Name:** Organic Chemistry -I (Paper-II)

**Paper CODE:** B020703T **Marks:** 100 (ETE 75 & CIE 25)

**I- Nature pf bonding in organic molecules:**

Delocalised chemical bonding-conjugation, crossonjugation, resonance, hyper-conjugation, Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy of pi-molecular orbitals, annulenes, anti-aromaticity, homo-aromaticity. Bonding in fullerenes.

**II - Reaction Mechanism: Structure and Reactivity:**

Generation, structure stability and fate of reaction intermediates: carbocation(including nonclassical carbocation, phenonium ion, and norbornyl system), carbanion (including enolate ions), carbene, nitrenes, free radicals(allylic halogenation) and arynes. Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates. Methods of determining mechanism-isotope effects, product analysis. Kinetic and stereochemical studies.

**III. Stereochemistry**

Conformational analysis of cycloakanes-disubstitutedcyclohexanes, decalins, effect of conformation on reactivity.

Elements of symmetry, chirality, molecules with more than one chiral centre, threo and erythro isomers, optical purity, enantiotopic and diastereotopic atoms, group and faces, regiospecific, stereospecific and stereoslective synthesis, Asymmetric synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape. R/S nomenclature, chiral centres and chiral molecules.

**IV Aliphatic Nucleophilic Substitution**

The $S_N1$,$S_N2$,mixed $S_N1'$, $S_N2'$,$S_Ni$ and SET mechanisms.

neighbouring group participation by pi and sigma bonds, anchimeric assistance. Nucleophilic substitution at allylic, aliphatic trigonal and vinylic carbon. Effects of substrate structure, attacking nucleophile, leaving group and reaction medium on reactivity. Phase transfer catalysis, ambident nucleophile and regioselectivity. Stereochemistry of $S_N1$ and $S_N2$ reactions.

**V. Aromatic Electrophilic Substitution**

The arenium ion mechanism, orientation and reactivity, energy-profile diagrams. The ortho/para ratio, ipso attack. Diazonium coupling,Vilsmeier reaction, Gatterman-Koch reaction..

**VI. Aromatic Nucleophile Substitution**

The $ArSN^1$, $ArSN^2$& $ArSN^i$ via benzyne mechanisms. Effect of substrate structure, leaving group and attacking nucleophile on reactivity. The Von Richter, Sommelet-Hauser and Smiles rearrangements.

## M.Sc. Chemistry (Practical)-Semester-I

**Paper Name:** Chemistry Laboratory -II

**Paper CODE:** B020704P **Marks:** 100 (ETE 75 & CIE 25)

### Physical

**Chemical Kinetics :**

1. Kinetic studies of a reaction between acetone and iodine catalyzed by $H^+$ ions.
2. Kinetics of oxidation of reducing sugars by potassium ferricyanide in presence of ammonium hydroxide or sodium hydroxide.
3. Determination of rate constant and order of reaction between $H_2O_2$ and HI
4. Determination of velocity constant of hydrolysis of an ester/ionic reaction in micellar media.
5. Determination of the effect of a) change of temperature, b) ionic strength of media, c) change of concentration of reactants and catalysts on the velocity constant of hydrolysis of an ester/ionic reaction.

### Thermodynamics

1. Determination of partial molar volume of solute (e.g. KCl) and solvent in a binary mixture.
2. Determination of the temperature dependence of the solubility of a compound in two solvents having similar inter molecular interactions and to calculate the partial molar heat of solution.

**M.Sc. Chemistry-Semester-I**

**Paper Name:** RESEARCH METHODOLOGY

**Paper CODE:** B020705T

**Marks:** 100 (ETE 75 & CIE 25)

**Research Methodology**

An Introduction, Meaning of Research, objective of research, motivation in research, types of research, research approaches, importance of knowing how research is done. Research processes - scientific research, formation of the topic, hypothesis, conceptual definitions, operational definition, gathering of data, analysis of data, revising of hypothesis, Conclusion. Literature survey - Journals, books and resources. Presentation and publication of research output.

**Defining the research problems**

What is the research problems, selecting the problems, necessity of defining the problem, technique involved in defining the problems, bring clarity and focus to your research problem, procedure for reviewing the literature existing literature. search for

**Method of data collection**

Collection of primary data, observation method, interview method, collection of data through questionnaires, collection of data through schedules, some other method of data collection, study design based on the nature of the investigation - experimental study, theoretical study, comparison.

**The computer-its role in research**

Introduction, the computer and computer technology, the computer system. General awareness of computer hardware, CPU, input and output devices, memory, other peripheral devices, auxiliary storage devices. Basic knowledge of computer systems, softwares - System softwares and application software's Programming languages: machine language, assembly language and high-level languages. Interpreter and compiler. Flow charts and Algorithms. General awareness of operating systems: Disk operating system, Windows, Macintosh, Linux. Applications and uses of common softwares in chemistry, Origin, Chemsketch, Chemdraw. Basic ideas on the use of Internet in Chemistry education.

**M.Sc. Chemistry-Semester-I**

**Paper Name: Physical Chemistry**

**Paper CODE:** B020706T **Marks:** 100 (ETE 75 & CIE 25)

I **Partial Molar Properties, Nernst Heat Theorem (NHT) and Third Law of Thermodynamics:**

Partial molar properties, Chemical potential and other thermodynamic functions, Fugacity of real gases, Nernst Heat Theorem and its application to non-condensed systems. Statement of the third law of thermodynamics. Derivation of unattainability of absolute zero. The relationship between entropy constant and Nernst chemical constant. Determination of entropy from the Third Law using the correction due to gas imperfections.

II **Chemical Kinetics:** Thermodynamic formulation of rate constant. Comparison of collision and absolute reaction rate theories. Calculation of transmission coefficient. Transition State theory in solution. Primary and secondary salt effects in the light of mechanistic tests. The theory of Absolute reaction rates - for reactions between atoms and reactions between molecules in terms of partition function. Influence of ionic strength and dielectric constant. Explosive reactions.

III **Electrolytes:** Limitation of Arrhenius theory of electrolytic dissociation. Role of solvent and inter-ionic forces. Activity and activity coefficients, determination of activity coefficients, Debye- Huckel Theory of the structure of dilute ionic solution, charge density and electrical potential. Properties of ionic cloud, activity coefficients from Debye-Huckel theory. Limiting law and its verification. Debye-Huckel theory to more concentrated solutions. Partial molar quantities of electrolytic solutions, determination of partial molar volume.

IV **Statistical Thermodynamics:**

Quantum states and complexions. The combinatory rule, system with definite total energy. Degeneracy of energy levels, probability and most probable distribution, in distinguishability, Maxwell-Boltzmann statistics, partition function, translational, rotational, vibrational, nuclear and electronic partition functions. Internal energy and heat capacity in terms of partition function.

V **Chemistry of Macromolecules:**

Introduction, type of polymers. Step polymerization, kinetics of step polymerization. Statistical approach to Gelation, Molecular weight distribution in linear poly condensation (Derivation of size distribution), Molecular weight averages. Methods of determining molecular weight by osmotic pressure, light scattering, sedimentation and viscosity methods.

VI **Solid State:** Crystal structures, Bragg's law and applications. Band structure of solid.

**M.Sc. Chemistry-Semester-I**

**Paper Name: Polymer Chemistry**

**Paper CODE:** B020707T **Marks:** 100 (ETE 75 & CIE 25)

**I. Basics**

Importance of polymers, basic concepts :monomers, degree of polymerization. Linear branched and network polymers. Classification of polymers. Polymerization: condensation, addition/radical chain-ionic and co-ordination and copolymerization. Polymerization conditions and polymer reactions.Polymerization in homogeneous and heterogeneous systems.

**II. Polymer Characterization**

Polydispersion-average molecular weight concept. Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution. The practical significance of molecular weight. Measurement of molecular-weights. Endgroup, viscosity, light scattering, osmotic and ultracentrifugation methods.

**III. Analysis and testing of polymers**

Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study. Thermal analysis and physical testing-tensile strength. Fatigue, impact tear resistance, hardness and abrasion resistance.

**IV. Inorganic Polymers**

A general survey and scope of inorganic polymers special characteristics, classification, homo and hetero atomic polymers. Structure, properties and applications of (1) Polymers based on boron-borazines, boranes and carboranes. (2) Polymers based on silicon, silicones, polymetalloxanes and polymetallosiloxanes, silazanes.

**V. Structure, Properties and Application of**

a. Polymers based on Phosphorous-Phosphazenes, Polyphosphates.

b. Polymers based on Sulphur-tetrasulphurtetranitride and related compounds.

c. Co-ordination and metal chelate polymers.

**M.Sc. Chemistry-Semester-I**

**Paper Name: Techniques of Chemistry -I**

**Paper CODE: B020708T** **Marks:** 100 (ETE 75 & CIE 25)

1. **Data handling in Analysis:**

   Accuracy and precision. Errors, determinate and indeterminate errors, significant figures. Rounding off figures, standard deviation, regression analysis.

2. **Separation Techniques:**

   Principles and applications of solvent extraction. Quantitative treatments of extraction equilibria. Solvent extraction of metals. Solid phase extraction.

3. **Chromatography:**

   Introduction, principle, and experimental setup of chromatography. Partition and Adsorption chromatography: Principle of partition and adsorption chromatography. Mobile and stationary phases. liquid-liquid, gas-liquid, gas-solid and liquid-solid chromatography. Reversed phase partition chromatography, paper and thin layer chromatography Applications of partition and adsorption chromatography., HPLC.

4. **Ion Exchange resins:**

   Mechanism of ion exchange. Factors affecting the selection of ion exchange resins. Techniques in ion exchange methods and analytical applications.

5. **Spot tests:**

   Spot tests for metal ions, spot tests for identification of functional groups-hydroxyl, carboxylic, nitro, nitroso, azo and amino.

6. **Thermal Methods of Analysis:**

   Principle, methodology and applications: Thermogravimetric and differential thermal Analysis, thermometric titrations. Thermal stability of polymers. Decomposition Pattern and decomposition reactions- examples.

**M.Sc. Chemistry-Semester-I**

**Paper Name: Medicinal Chemistry**

**Paper CODE: B020709T** **Marks:** 100 (ETE 75 & CIE 25)

I. **Drug Design**

Development of new drugs, procedures followed in drug design, concept of lead compound and end modification, concepts of prodrugs and soft drugs, structure-activity relationship (SAR). Factors affecting bioactivity: Theories of drugs activity- occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship. History and development of QSAR. Concepts of drugs receptors and drug receptors. Elementary treatment of drug interactions. Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton surface activity parameter and redox potentials. LD-50, ED-50 (Mathematical derivations of equations excluded). Basic ideas about Pharmacokinetics and Pharmacodynamics.

II. **Antineoplastic Agents**

Introduction, cancer chemotherapy. Role of alkylating agents and antimetabolites in treatmentof cancer. Mention of carcinolytic antibiotics and mitoptic inhibitors. Synthesis of mechlorethamine, mustards and 6- mercaptopurine. Recent developments in cancer chemotherapy.

III. **Cardiovascular Drugs**

Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathetic function. Central intervention of cardiovascular output. Direct acting arteriolar dilators. Synthesis of amyl nitrate, hydrolaxine methyldopa and diazoxide propanol.

IV. **Local Anti-infective Drugs**

Anti-tubercular drugs and Anti-malerial drugs: Introduction and general mode of action. Synthesis of sulphonamides, norfloxacin, dapsone, chloroquin and primaquin.

V. **Psychoactive Drugs-The Chemotherapy of mind**

CNS depressants, general anesthetics, mode of action, hypnotics, sedatives, anti-anxiety drugs, benzodiazepines, antipsychotic drugs. Synthesis of diazepam, alprazolam and barbiturates.

VI. **Antibiotics**

General introduction, structure and synthesis of penicillin G & chloramphenicol.

VI. **Metals in Medicines**

Metal deficiency and diseases, toxic effects of metals, metals for diagnosis and chemotherapy.