

M.Sc. DEGREE PROGRAMME

IN

CHEMISTRY

(CBCSSUG 2019)

**UNDER CHOICE BASED CREDIT AND
SEMESTER SYSTEM**

PROGRAMME SPECIFIC OUTCOMES

&

COURSE OUTCOMES

2019 ADMISSION ONWARDS

Programme Objective

This post-graduate programme in Chemistry aims to strengthen the knowledge and skills, both in theory and practical, in major areas in Chemistry to students and thereby producing confident graduates capable of working independently and tackling challenging problems in teaching and research.

Programme Specific Outcomes

On successful completion of M. Sc. Chemistry programme, students will be able to

P.O.1: Demonstrate comprehensive knowledge and systematic understanding of the fundamental concepts of Chemistry

P.O.2: Design and perform the chemical synthesis and characterise the products.

P.O.3: Design and execute experimental routines for detection and quantification of chemical entities and to write formal reports.

P.O.4: Analyse the kinetics and energetics of chemical processes and infer the mechanism.

P.O.5: Demonstrate the basic principles of instrumental methods of analysis and display proficiency in the operation of advanced instruments for chemical analysis

P.O.6 Display the skills in computational methods and related soft-wares to execute in-depth analysis of chemical problems.

P.O.7: Work and communicate effectively in teams and uphold the ethical and cultural values.

SEMESTER 1

CHE1C01- QUANTUM MECHANICS AND COMPUTATIONAL CHEMISTRY

Objective:

1. Introduce basic and advanced concepts of quantum mechanics
2. Enable the students to solve Schrodinger equation for translational, vibrational, rotational motions and hydrogen like atoms.
3. Introduce various approximation methods in quantum mechanics and computational quantum chemistry methods and to familiarize the students with different computational methods and programmes

Course Outcome	Cognitive level
After completion of the entire course, the student should be able to	
C.O.1: Describe the basic principles and concepts of quantum mechanics.	Understand
C.O.2: Apply the postulates of quantum mechanics to simple and complex systems, the particle-in-a-box, rotational and vibrational motion, harmonic oscillator, hydrogenic atoms.	Apply
C.O.3: Derive the variational principle and perturbation principle and use them to calculate properties for simple systems of chemical interest.	Analyse
C.O.4: Differentiate the main similarities and differences between theoretical approaches	Apply
C.O.5: Correlate the size dependent electronic properties with energy of three-dimensional box with varying length.	Evaluate

SEMESTER 1

CHE1C 02- ELEMENTARY INORGANIC CHEMISTRY (4 Credits, 54h)

Objectives:

1. Enable the students to understand the chemistry of the main group elements.
2. To make the students aware of chemistry transition and inner transition elements.
3. Introduce the concepts of nuclear, radiation chemistry and chemistry of nanomaterials.

Course Outcome	Cognitive
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After completion of the entire course, the student should be able to	level
C.O.1: Apply various concepts of acids and bases – Arrhenius, Bronsted-Lowry, Solvent system, Lux-Flood, Lewis and Usanovich concepts HSAB concept	Analyze
C.O.2: Predict the periodic anomalies of non-metals and post-transitional metals. Study the properties of various allotropes of C, Si, P, As, Sb, Bi, O, and Se. Predict the stability and topology of different polyhedral boranes and related compounds.	Analyze
C.O.3: Describe the properties and applications of various silicates and amino silicates	Understand
C.O.4: Study the chemistry of transition metals and inner transition metals	Understand
C.O.5: Explain modern materials- nanomaterials, synthetic procedures and application of various nanomaterials	Understand

SEMESTER 1

CHE1C03- STRUCTURE AND REACTIVITY OF ORGANIC COMPOUNDS (4 Credits, 54h)

Objective:

1. To introduce the concept of aromaticity and effect of structure on reactivity of organic compounds
2. To understand the basic concepts in the study of organic reaction mechanism.
3. To learn the prochirality and chirality at centers, planes and helices and determine the absolute configuration

Course Outcome	Cognitive level
After completion of the entire course, the student should be able to	
C.O.1: Study various interactions present in organic molecules and also delivers concept based on aromaticity.	Analyze
C.O.2: Recognize the mechanistic aspects of substitution, addition and elimination reactions, considering various influencing factors	Analyze
C.O.3: Analyse the concepts of conformation and configuration in organic chemistry.	Apply
C.O.4: Demonstrate strategies for the stereospecific / stereoselective organic transformations towards chiral target molecules.	Apply
C.O.5: Determine configuration of compounds with chiral centres (R and S), biphenyls, allenes, spiranes (E and Z) and draw the configurations in dash and wedge formula, or zig –zag configurations.	Evaluate

SEMESTER 1

CHE1C04- THERMODYNAMICS, KINETICS AND CATALYSIS
(4 Credits, 54h)

Objective:

1. To make the student familiar with the concepts of thermodynamics and chemical equilibrium.
2. To make the students conversant with the basic concepts of chemical kinetics and catalysis.
3. Enable the students to understand surface chemistry and various adsorption isotherms.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Apply the concepts of thermodynamics to derive relations between molecular properties and to predict spontaneity of processes.	Analyze
C.O.2: Interpret dependence of chemical equilibrium on pressure, temperature and concentration.	Evaluate
C.O.3: Apply the laws of chemical kinetics to calculate rate / rate constants of different types of reactions	Apply
C.O.4: Calculate thermodynamic parameters from kinetic data and use adsorption isotherms as a tool for obtaining the surface area and rate constants in heterogeneous catalysis	Apply
C.O.5: Apply the principles of acid and enzyme catalysis to solve any given kinetic data.	Apply

SEMESTER II

CHE2C05- GROUP THEORY and CHEMICAL BONDING (3 Credits, 54h)

Objective:

1. Introduce basic concepts of symmetry and group theory.
2. Familiarize the students with different areas of character table and applications of group theory for bonding and spectroscopy.
3. Enable students to understand bonding in polyatomic molecules and to compare MO theory and VB theory.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Analyze the symmetrical aspects of any given molecule.	Analyze
C.O.2: Apply symmetry and Group Theory in Quantum mechanics and spectroscopy.	Apply
C.O.3: Apply group theory to study the bonding in compounds	Apply
C.O.4: Describe the principles of chemical bonding in diatomic molecules and in polyatomic molecules	Understand

C.O.5: Construct character table of the molecule and predict the spectral properties.	Create and evaluate
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SEMESTER II

CHE2C06-- CO-ORDINATION CHEMISTRY (3Credits, 54h)

Objective:

1. To generate the significance of coordination chemistry, which remains as one of the primary components of Inorganic chemistry
2. To understand the various characterization techniques used to analyze co-ordination compounds and the formation and stability of complexes
3. To realize the critical comparison between V.B, C.F.T, M.O theories and understand the reaction mechanisms of coordination compounds

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Understand the stereochemistry of coordination compounds and their stability	Understand
C.O.2: Describe and explain the structure and bonding in metal complexes	Analyze
C.O.3: Identify various d-d transitions and interpret the electronic spectra of any given transition metal complex.	Evaluate
C.O.4: Interpret the given transition metal complex with the aid of various spectroscopic techniques	Evaluate
C.O.5: Explain the various reaction mechanisms of coordination complexes and various photochemical reactions associated with complexes	Evaluate

SEMESTER II

CHE2C07-- REACTION MECHANISM IN ORGANIC CHEMISTRY (3 Credits, 54h)

Objectives:

1. To know about substitution, addition and elimination reactions.
2. To understand the chemistry of carbonyl compounds and natural products.
3. To familiarize pericyclic and photochemical reactions.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Analyze the mechanistic aspects of substitution, addition and elimination reactions, considering various influencing factors	Analyze
C.O.2: Interpret structure, stability and various reactions involving intermediates of reactive intermediates.	Evaluate
C.O.3: Apply the concepts of Frontier orbital theory in the study of ionic, radical and pericyclic reactions.	Apply
C.O.4: Describe molecular structure, synthetic methodologies, rearrangement reactions and applications of various natural products	Understand
C.O.5: Design molecular structure with various functional groups, which follows same kind of reaction mechanism as like as examples.	Create

SEMESTER II
CHE2C08-- ELECTROCHEMISTRY, SOLID STATE CHEMISTRY AND
STATISTICAL THERMODYNAMICS (3 Credits, 54h)

Objective:

1. To introduce the concept of ionic interactions, ionic equilibrium and dynamic electrochemistry.
2. To make the student understand the concepts in solid state chemistry.
3. To make the student familiar with the concepts of statistical thermodynamics.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Describe the theories effecting ionic conductance and apply the concepts to calculate conductance behavior of a given system	Apply
C.O.2: Describe how diffraction patterns can be converted to structural information.	Understand
C.O.3: Explain the different types of statistics and calculate the thermodynamic probability of any given thermodynamic system.	Analyze
C.O.4: Calculate the partition function and thermodynamic properties from spectroscopic data and apply the principles of statistical thermodynamics to ideal gases, solids and metals.	Apply
C.O.5: Predict the electrical properties of materials based on the valence band and conduction band energy level.	Evaluate

SEMESTER I and II
CHE1L01 & CHE2L04 – INORGANIC CHEMISTRY PRACTICALS– I & II (3 Credits)

Objective:

1. To develop the skill of identifying less common cations and quantitative determination of various metal ions.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Identify the cations in a mixture of unknown salts.	Analyze
C.O.2: Estimate the amount of a given metal ion by complexometric and cerimetric reactions.	Analyze
C.O.4: Perform colorimetric determination of various metal ions	Apply
C.O.4: Design a quantitative method to analyse the concentration of various ions	Create

SEMESTER I and II

CHE1L02 & CHE2L05 – ORGANIC CHEMISTRY PRACTICALS– I & II (3 Credits)

Objective:

1. To develop the practical skills in separation of organic mixtures
2. To identify the functional groups, present in the compound
3. To introduce different multistep synthesis to develop the skills in synthetic organic chemistry

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Acquire knowledge on safe laboratory practices of handling laboratory glassware, equipment and chemical reagents.	Knowledge
C.O.2: Separate organic compounds from the organic binary mixture and identify the functional group(s) present	Analyze
C.O.3: Plan and perform synthetic procedures	Understand
C.O.4: Develop a method to separate various organic compound mixtures having more than two using distillation/crystallization/sublimation etc.	Create

SEMESTER I and II

CHE1L03 & CHE2L06 – PHYSICAL CHEMISTRY PRACTICALS– I & II (3 Credits)

Objective:

1. Enable the students to design experiments to measure physical parameters of materials and understand the relation between physical property and chemical composition
2. Introduce experiments related to the measurements of conductivity, viscosity, refractive index, etc.
3. Introduce experiments related to potentiometry, chemical kinetics and adsorption

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Perform experiments based on various laws of physical chemistry.	Apply
C.O.2: Interpret the results obtained from various experiments.	Analyze
C.O.3: Operate various sophisticated instruments.	Apply
C.O.4: Construct phase diagram of various eutectic systems having binary mixture.	Create

SEMESTER III

CHE3C09 – MOLECULAR SPECTROSCOPY (4 Credits, 72h)

Objective:

1. Introduce the principles, instrumentation and applications of various spectroscopic techniques
2. Students learn the structural elucidation of a compound using different spectroscopic techniques.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Explain the fundamental concept of molecular spectroscopy.	Understand
C.O.2: Correlate the structure-property relationship of molecule with UV-Visible and IR and magnetic resonance spectral data.	Apply
C.O.3: Describe and Interpret NMR and ESR spectra.	Analyze
C.O.4: Elucidate the structural elucidation of organic compounds using electronic, vibrational and NMR spectroscopy	Apply
C.O.5: Perform structural elucidation using mass spectrometry	Evaluate

SEMESTER III

CHE3C10 – ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY (4 Credits, 54h)

Objective:

1. To understand and apply the concepts and theories of organometallic chemistry.
2. To make the student familiar with the concepts of metal-metal bond and metallic clusters.
3. Enable the students to understand the role of metals in biological system.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Distinguish the different types of ligands with respect to the type of interaction with the metal.	Analyze
C.O. 2: Evaluate the structure, bonding and reactions of organometallic compounds and metal clusters.	Evaluate
C.O.3: Explain the application of reactions of organometallic complexes in homogeneous catalytic processes	Apply
C.O.4: Predict the stability of organometallic compounds and metal clusters.	Apply
C.O.5: Identify the natural process taking place with the aid of metal in biological systems	Apply

SEMESTER III

**CHE3C11 - REAGENTS AND TRANSFORMATIONS IN ORGANIC CHEMISTRY
(4 Credits, 54h)**

Objective:

1. To make the students conversant with oxidation and reduction reactions in organic chemistry.
2. Familiarize important natural and synthetic polymers.
3. Students will be aware about molecular rearrangements, transformations, heterocyclic compounds and supramolecular chemistry.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Compare the differences in reactivity of various oxidizing agents with mechanistic illustrations.	Analyze
C.O.2: Predict the reagents and conditions for the synthesis of specific target molecules.	Apply
C.O.3: Describe the synthesis and application of different types of polymers in laboratory and in industries.	Understand
C.O.4: Design synthetic scheme for heterocyclic aromatic and nonaromatic organic compounds.	Analyze
C.O.5: Illustrate the mechanistic pathway of different rearrangements reactions, transformations and identify the products.	Analyze

SEMESTER III

CHE3E01 - SYNTHETIC ORGANIC CHEMISTRY (ELECTIVE) (4 Credits, 54h)

Objective:

To understand about

1. Various reagents used for oxidation and reduction.
2. Organometallic and organo-nonmetallic reagents.
3. Coupling reactions, multistep synthesis, retro synthetic analysis.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Describe and analyze the reactivity of various oxidizing agents with mechanistic illustrations.	Analyze
C.O. 2: Predict the reagents and conditions for the synthesis of specific target molecules. .	Apply
C.O.3: Describe the synthesis and mechanistic pathway for various coupling reactions	Understand
C.O.4: Predict the required protecting groups and functional group equivalents for a particular organic transformation	Analyze
C.O.5: Design a synthetic pathway for simple to complex organic molecules by retrosynthetic approach.	Evaluate

SEMESTER III

CHE3E02 - COMPUTATIONAL CHEMISTRY (ELECTIVE) (4credits, 54 h)

Objective:

1. Understand and apply the tools and concepts of computational quantum chemistry methods to the problems of chemistry

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Describe the basic concepts of the various theoretical models and methods.	Understand
C.O. 2: Classify the different basis sets used in the computational calculations.	Understand
C.O.3: Explain the quantum mechanical nature of the chemical bond.	Evaluate
C.O.4: Describe the main similarities and differences between theoretical approaches and identify advantages and disadvantages for modelling various chemical problems.	Apply
C.O.5: Familiarize with the computational chemistry software to perform and interpret electronic structure calculations.	Evaluate

SEMESTER III

CHE3E03- GREEN AND NANOCHEMISTRY (ELECTIVE) (4credits, 54 h)

Objective:

1. Introduce basic and advanced concepts of green chemistry.
2. Helps the students to understand about nanomaterials, their synthesis and applications.
3. To understand various techniques used for the characterization of nanomaterials.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Understand the basic principles and concepts of green chemistry	Understand
C.O. 2: Describe and analyze the various green chemistry methodologies such as microwave assisted synthesis, solvent free reactions, green solvents, phase transfer catalyst etc.	Analyze
C.O.3: Describe the synthesis approach of nanomaterials	Understand
C.O.4: Characterization of nanomaterials with various techniques	Evaluate
C.O.5: Interpret the structure and properties of various multi-functional nanomaterials	Apply

SEMESTER IV

CHE4C12- INSTRUMENTAL METHODS OF ANALYSIS (4 Credits, 72 h)

Objective:

1. To know about statistical treatment of analytical data.
2. To know about conventional analytical methods.
3. To understand various electro analytical methods and different surface characterization techniques.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O. 1: Explain the concepts of various conventional analytical techniques	Understand
C.O.2: Explain the theory, instrumentation and application of various electroanalytical techniques like coulometry, electrogravimetry, polarography and voltammetry and apply the concepts to solve the desired problems	Apply
C.O.3: Explain the theory, instrumentation and applications of various optical methods of analysis	Apply
C.O.4: Explain the instrumentation and applications of various surface characterization techniques.	Understand
C.O.5: Describe the theory, instrumentation and applications of chromatographic techniques and apply the same for solving related problems	Apply

SEMESTER IV**CHE4E04 - PETROCHEMICALS AND COSMETICS (4Credits, 72h)****Objective:**

1. Enable students to understand about fuels, refining crude oil, distillation of crude petroleum, petroleum products, perfumes and cosmetics.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Understand the fuels and various criteria deciding the efficiency of fuels.	Understand
C.O. 2: Awareness in industrial organic synthesis	Apply
C.O.3: Advanced awareness about crude oil and their distillation	Analyze
C.O.4: Describe the formulation of cosmetic products	Analyze

SEMESTER IV

CHE4E05 - INDUSTRIAL CATALYSIS (ELECTIVE) (4

Credits, 72h)

Objectives:

1. To understand the use adsorption isotherm a tool to find rate constant of a reaction.
2. To understand the principles of catalysis.
3. To familiarize phase transfer catalysts industrial catalysts.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Understand the adsorption and various kinds of adsorption isotherms	Understand
C.O. 2: Adsorption isotherms as a tool for obtaining the surface area and rate constants in case of heterogeneous catalysis.	Analyze
C.O.3: Basic concepts of phase transfer catalysis in organic reactions and biocatalysis	Apply
C.O.4: Study on the industrial organic synthesis	Apply

SEMESTER IV

CHE4E06 - NATURAL PRODUCTS & POLYMER CHEMISTRY (4 Credits, 72 h)

Objectives:

1. To know the basic aspects of natural products.
2. Understand about terpenoids, steroids, alkaloids and anthocyanin.
3. Understand basic concepts of polymer science, different polymerization technique, industrial polymers, polymer solutions, copolymers and specialty polymers.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Understand the chemistry and reactions of natural products	Understand
C.O.2: Understand the structural characteristics of terpenoids, steroids, alkaloids	Understand
C.O.3: Elucidate structure and devise synthesis for important natural products.	Apply
C.O.4: Describe the synthesis and applications of different types of polymers in laboratory and in industries.	Understand
C.O.5: Apply characterisation techniques to identify polymers, structural characteristics and applications of conducting polymers	Apply

SEMESTER IV

CHE4E08 – ORGANOMETALLIC CHEMISTRY (ELECTIVE) (4 credits, 72h)

Objectives:

1. Enable students to understand the basic concepts, reactions and various applications of organometallic compounds.
2. Students understand the chemistry of metal carbonyls.
3. To familiarize the different methods for synthesizing organometallic compounds.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Distinguish the different types of ligands with respect to the type of interaction with the metal.	Understand
C.O.2: Evaluate the structure, bonding and reactions of organometallic compounds and metal clusters.	Evaluate
C.O.3: Explain the application of reactions of organometallic complexes in homogeneous catalytic processes.	Apply
C.O.4: Understand the structure and properties of organometallic polymers	Apply

M.Sc. CHEMISTRY – SEMESTER III & IV

CHE3L07 & CHE4L10 – INORGANIC CHEMISTRY PRACTICALS– III & IV (3 Credits)

Objective:

1. To develop the skill of identifying cations and quantitative determination of various metal ions.
2. Students learn about ion-exchange separation and then estimating binary mixtures.
3. Students get an idea to prepare some inorganic complexes

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Studies involving quantitative separation of suitable binary mixtures of ions in solution	Analyze
C.O.2: Analyse the ion-exchange separation and estimation of binary mixtures	Analyze
C.O.3: Learn the various synthesis of metal complexes	Apply

M.Sc. CHEMISTRY – SEMESTER III & IV

**CHE3L08 & CHE4L11 – ORGANIC CHEMISTRY PRACTICALS– III & IV
(3 Credits)**

Objective:

1. Students develop skills in quantitative analysis of organic compounds.
2. To develop practical skills in extraction of natural products by chromatographic techniques.

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Insight into the quantitative analysis of organic molecules using volumetric and spectrophotometric techniques.	Understand
C.O.2: Acquire an idea in identification as well as separation of mixtures by chromatographic techniques	Apply
C.O.3: Describe the extraction of natural products and chromatographic techniques.	Apply

M.Sc. CHEMISTRY – SEMESTER III & IV

CHE3L09 & CHE4L12 – PHYSICAL CHEMISTRY PRACTICALS– III & IV

(3 credits)

Objective:

1. To enable the students to design experiments to measure different kinetic parameters.
2. Students learn to determine the concentration of organic acid and surface area of adsorbant from Langmuir adsorption isotherm and the phase diagrams of binary and ternary liquid systems.
3. Introduce experiments related to measurement of cryoscopic constant, optical rotation, equilibrium constant and computational chemistry

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Insights into the practical physical chemistry- kinetics, adsorption, phase diagram of three component system, cryoscopic methods	Understand
C.O.2: Learn the practical aspects of Computational chemistry.	Apply
C.O.3: Drawing adsorption isotherm.	Apply
C.O.4: Perform experiments using polarimeter and spectrophotometers.	Apply

SEMESTER IV

CHE4P01 & CHE4VO2 -Research Project & Viva Voice (Credit- 4 &2)

Objective:

1. Familiarize with new research works in chemistry.
2. Students get an exposure to work under prominent scientists.
3. Students may be able to solve a research problem in short span of time.

Course Outcome

Course Outcome After completion of the full course the student should be able to	Cognitive level
C.O.1: Identify and hypothesise an advanced level research problem.	Create
C.O.2: Design experiments and validate the hypothesis of an advanced level research problem.	Create

- 1) The students shall carry out research project in reputed research laboratory for the entire semester.
- 2) The students shall submit a project report on the research work carried out.
- 3) The students will have to present the results of the research project in a seminar and appear for a comprehensive viva-voce.