Department of chemistry

St.Aloysius College, Elthuruth

Chemistry department is conducting 3 year B.Sc. Degree chemistry programme. Since the college is affiliated to University of Calicut, we are following the well oriented syllabus constructed by the experts in chemistry.

B.Sc. CHEMISTRY PROGRAMME OUTCOME

Communication skills, problem-solving skills, Information retrieval skills of the students will be highly improved during the programme. By completing the programme students can confidently join for post graduate programmes or can enter in to job market or can run small scale industries.

B.Sc. CHEMISTRY COURSE OUTCOME

During three years of B.Sc. chemistry, students can acquire knowledge in inorganic, organic, physical and environmental chemistry.

Inorganic Chemistry:

Inorganic Chemistry theory papers provide an overview of fundamental topics in this area. During three years, students could study topics such as Chemistry as a Discipline of Science, Some Basic Chemical Concepts, Analytical Chemistry (*Laboratory Hygiene and Safety, Volumetric Analysis,* Significant figures), Atomic Structure, Nuclear Chemistry; Periodic Properties [Periodic table and properties, Effective nuclear charge – Slater rule and its applications]; Chemical Bonding [Types of bonds, Octet rule and its limitations, Covalent Bond. Lewis theory. VSEPR theory, Valence Bond Theory. Molecular Orbital Theory, Coordinate bond. Hybridization, Metallic Bond, Intermolecular forces] ; Analytical Chemistry; Gravimetric analysis; Representative Elements; Alkali and Alkaline Earth Metals; Representative Elements; Nitrogen Family; Oxygen Family; Halogens; Noble Gases; Inorganic Polymers & Non-aqueous Solvents; Environmental Pollution; Solid Waste Management; Metallurgy; Transition and Inner Transition Elements; Coordination Chemistry; Organometallic Compounds; Bioinorganic Chemistry.

Learning outcome

1. Use and safe-handling of chemical materials
2. Explain the atomic structure and properties of atoms.
3. Explain the bonding for both ionic and covalent compounds and predict geometries of simple molecules
4. Predict the structure of molecules
5. Explain crystal structures, electrical properties etc.
6. Explain the different definitions of acids / bases and predict the reactions between acids and bases.
7. Explain the definition of coordination compounds, naming them and decide isomerism.
8. Explaining the theory of the determination of the electron structure of d-metal complexes and explain the properties of these complexes.
9. Explain the periodic properties of the different groups of compounds focusing on production methods and application of selected elements and compounds.
10. Important real world applications of many main group elements

11. The bonding models, structures, reactivity, and applications of coordination complexes, boron hydrides, metal carbonyls, and organometallic compounds.

Organic Chemistry

It is an important part of chemistry because it is really related to daily life. Most of the regular household chemicals, drugs, foods, fuels, plastics, are organic materials. Hence organic chemistry has an important role in daily life.

The course include introduction to Organic Chemistry; Stereochemistry [Representation of Organic Molecules, structural isomerism, Stereoisomerism, Conformational Isomerism, Optical Isomerism, Geometrical Isomerism]; Reaction Mechanism; Aliphatic Hydrocarbons; Aromaticity; Halogen Compounds; Organometallic Compounds; Hydroxy Compounds; Ethers and Epoxides; Ethers; Epoxides; Aldehydes and Ketones; Carboxylic Acids and Sulphonic Acids; Sulphonic Acids; Nitrogen Compounds; Heterocyclic & Active Methylene Compounds; Structure Elucidation Using Spectral Data; Carbohydrates; Proteins Lipids, Steroids, Vitamins & Hormones; Nucleic acids, Alkaloids and Terpenes; Pericyclic Reactions; Polymers and macromolecules, Types of Polymerisation; Properties and Reactions of Polymers; Polymerisation Techniques and Processing; Commercial Polymers.

Learning outcome

1. Clarity in the distinction between alkanes, alkenes, alkynes and aromatic compounds
2. Clear knowledge about the three-dimensional structure of organic molecules through hybridization and geometry of atoms.
3. Knowledge about nucleophiles, electrophiles, free radicals and electron displacement effects. Explanation of stability and reactivity of organic molecules based on structure and functionality.
4. Prediction of organic reaction mechanism, major products and minor products of a variety of organic reactions
5. Structure identification of organic molecules using IR, NMR and mass spectroscopic methods
6. Familiarization of physical properties, structure, bonding, preparation and reactivity of aromatic, conjugated, carbonyl compounds
7. Basic knowledge in structure, properties and reactivity of biologically important molecules like carbohydrates, lipids, amino-acids, proteins and nuclic acids
8. Idea about commonly used polymers, their properties and applications

Physical Chemistry

This branch of chemistry gives the answers for the questions such as why & how reactions take place? It helps to predict the feasibility of reactions, to get quantitative data and speed of reaction.

Topics of the study includes Gaseous State [kinetic theory of gases, Maxwell's distribution of molecular velocities, Deviation from ideal behavior, Critical phenomena]; Thermodynamics [Thermodynamic terms, Zeroth law of thermodynamics, First law of thermodynamics, Joule-Thomson effect, Second law of thermodynamics, Carnot theorem, Entropy, Gibbs-Helmholtz equation, Third law of thermodynamics, Fundamental concepts of Statistical Thermodynamics]; Liquid State; Chemical Equilibria. Quantum Chemistry [Operator algebra, Schrödinger wave equation & applications, Orbitals and concept of Quantum numbers (n, l, m). Radial functions, Shapes of orbitals (s, p and d), Electronic configuration of atoms], Kinetics & Catalysis; Photochemistry; Adsorption & Colloids; Phase Equilibria; Chromatography; Spectroscopy; Molecular Symmetry and Group Theory; Electrochemistry; Ionic Equilibria; Solutions; and Solid State.

Learning outcome of the course

1. Understand and explain the behavior of gas using gas laws.
2. Understand the relationship between kinetic energy and temperature of a gas; between temperature and the velocity of a gas; and between molar mass and the velocity of a gas.
3. Knowledge about the surface phenomenon's like adsorption, mechanism of adsorption, factors affecting adsorption, difference between adsorption and absorption.
4. How to use of mathematical ideas and tools to derive equations and thus to quantify the result.
5. Familiarity in the calculation of rate constants for zero, first, & second order reactions. Determination of order of reaction.
6. Prediction of spectroscopic transitions using selection rules
7. Awareness about basic terms in thermodynamics, application of mass and energy balances (First Law) to a variety of processes. Calculation of efficiencies of simple heat engines.
8. Recognition and assigning of symmetry of molecules
9. Knowledge in electrical potential, voltage, current, electrochemical potential etc. How to evaluate the potential of electrochemical systems based on thermodynamic data. Ideas about transport number and concentration cells.
10. Basic of arrangements of particles in a crystal. Determination of crystal structure using various techniques.

Laboratory Course

Laboratory courses in inorganic chemistry, organic chemistry and physical chemistry areas helps students to sharpen their practical skills.

Learning outcome

1. Familiarize in safe laboratory practices by handling laboratory glassware, equipment, and chemical reagents appropriately
2. Systematic procedure writing to conduct experiments.
3. Ability to explain the experimental data using the theoretical knowledge.
4. qualitative and quantitative analysis of chemicals
5. Methods to evaluate laboratory data
6. Graphical analysis to analyze laboratory results.

MSC CHEMISTRY PROGRAMME OUTCOME

The Chemistry Department has overriding goals which have an impact on our PG program. These include:

- Developing students as successful professionals.
- Developing students as effective researchers.
- Maintaining and enhancing the overall quality of the program.

To meet these goals, we have developed specific expectations (outcomes) for our PG program.

- PO 1: Students should have an advanced level understanding of at least three of the following areas of chemistry - Analytical, Inorganic, Organic, and Physical Chemistry. They should have a graduate level understanding of their major area(s) of research.
- PO 2: Students should broaden their professional foundations through activities such as teaching, internships, and fellowships
- PO 2: Students should be able to communicate scientific results in writing and in oral presentation.
- PO 3: Students should acquire the basic tools needed to carry out independent chemical research. Students should become proficient in their specialized area of chemistry and successfully complete an advanced research project.

MSc Chemisry - Course Outcomes

Semester I

1. **Title of the paper – BASIC CONCEPTS IN QUANTUM CHEMISTRY & GROUP THEORY**

Course Code -CH1C01
Credits 3
Total Hours 54
This paper enables the students to understand

- Formulate the connection between classical and quantum mechanics using the correspondence principle.
- Recall and apply the postulates of quantum mechanics.
- Explain the properties of (electronic) wavefunctions.
- Recall and describe the molecular Schrödinger equation.
- the symmetry of molecules
- various representations of point groups

2. **Title of the paper –ELEMENTARY INORGANIC CHEMISTRY**

Course Code -CH1C02
Credits 3
Total Hours 54
In this course the student will

- Learn various theories about the molecular structure and bonding.
- Understand the different concepts of acids and bases
- Know about the chemistry of boranes.
- Describe the shape and extent of 4f and 5f orbitals
- Understand nuclear chemistry.

3. **Title of the paper – STRUCTURE AND REACTIVITY OF ORGANIC COMPOUNDS**

Course Code -CH1C03
Credits 3
Total Hours 54
After successful completion of the course, the student is expected to :

- Review the concept of isomers and discuss the isomer which results from free rotation of C-C single bond, from a chirallity, from restricted rotation, R, S and E, Z nomenclature.
- Identify the aromaticity in compounds.
- Understand the importance of conformations in organic reactions.
- Know about the different principles behind organic reactions.
- State the importance of asymmetric reactions in organic synthesis and the fundamental concepts and nomenclature of the subject.

4. **Title of the paper THERMODYNAMICS, KINETICS AND CATALYSIS**

Course Code- CH1C04

Credits 3

Total Hours 54

On completion of this course the student will learn about

- The behavior of properties, like heat and energy, as governed by the four laws of thermodynamics.
- The basic concepts in irreversible thermodynamics.
- Optimum conditions for a reaction
- Derive and develop Langmuir-Hinshelwood kinetic expressions for simple hydrogenation reactions.

Semester II

5. **Title of the paper - APPLICATIONS OF QUANTUM MECHANICS & GROUP THEORY**

Course Code -CH2 C05

Credits 3

Total Hours 54

After successful completion of this paper, the student will be well-versed in

- Describing the principles of the self-consistent field (SCF) method and Hartree–Fock theory.
- Explaining the phenomenon of electron correlation and its consequences on solving the Schrödinger equation.
- Summarize the principles of approximate methods to recover the correlation energy.
- Identifying the IR and Raman modes of different molecules.
- Applying group theory in hybridization.

6. **Title of the paper –COORDINATION CHEMISTRY**

Course Code- CH2C06

Credits 3

Total Hours 54

After successful completion of the course, the student is expected to :

- Explain the concepts of ligand field theory, coordination geometry, formal and physical oxidation states, spin ground state, electronic structure, ligand type and strength.
- Apply group theory to the construction of molecular orbital diagrams for six-coordinate complexes possessing octahedral, tetragonal and trigonal symmetry
- Solve problems involving coordination chemistry.
- Expain the magnetic properties of coordination compexes.
- Know the application of different spectroscopic techniques in coordination complexes.

7. **Title of the paper –ORGANIC REATION MECHANISMS**

Course Code- CH2 CO7

Credits 3

Total Hours 54

The students should be able to

- Equip students with the fundamentals of organic reaction mechanism
- Advanced level understanding in Pericyclic and photochemical reactions.
- Fundamentals of natural product extraction and synthesis.

8. **Title of the paper –ELECTROCHEMISTRY, SOLID STATE CHEMSITRY AND STATISTICAL THERMODYNAMICS**

Course Code- CH2 CO8

Credits 3

Total Hours 54

The students should be able to,

- .Have a strong base in Python language regarding different data type such as list,sets,dictionary etc.
- It helps to understand the different modules like NUMPY, Matplotlibetc
- Understand Arrays and matrices and enables data visualization
- Define the Boltzmann distribution through concepts such as instantaneous configurations and employ the Boltzmann law for a system of particles.
- Solve problems in physics such as standing waves, central field motion, Kirchoffs law etc using python language.

9. **Title of the paper –INORGANIC CHEMSITRY PRACTICALS I & II**

Course Code – CHIP01 & CH2P04

Credits 4

This course will enable the student to have basic knowledge about advanced techniques like

- analyse compounds by titrimetric and instrumental methods.
- Identification and confirmation of various metal ions from their mixtures including rare earth metals.

10. **Title of the paper -ORGANIC CHEMSITRY PRACTICALS I & II**

Course Code- CHIP02 & CH2P05

Credits 4

After successful completion of the course, the student is expected to

- Perform qualitative analysis of organic compounds.
- Familiar with various preparative methods in chemistry
- Understand recrystallization and other purification methods in the field of organic chemistry.

11. **Title of the paper- PHYSICAL CHEMISTRY PRACTICALS I & II**

Course Code CHIP03 & CH2P06

Credits 4

After successful completion of the course, the student is expected to

- Handle viscometer to determine the viscosity and relative viscosity of liquids.
- Carry out quantitative analysis by instrumental method using conductometer.
- Understand about classification of electrodes.

Semester III

12. Title of the paper - MOLECULAR SPECTROSCOPY

Course Code –CH3C09
Credits 3
Total Hours 54

After successful completion of the course, the student is expected to :

- Describe vibrational spectroscopy at surfaces and state the associated selection rules.
- Describe the origin and influence of the major interactions that determine the appearance of NMR spectra, such as the chemical shift, J-couplings, the dipolar interaction and quadrupolar couplings. Distinguish between the effects of these in solution-state and solid-state NMR.

13. Title of the paper- ORGANOMETALLIC & BIOINORGANIC CHEMISTRY

Course Code- CH3C10
Credits 3
Total Hours 54

After successful completion of the course, the student is expected to:

- Recognise and describe fundamental organometallic processes (e.g. coordination/dissociation, oxidative addition/reductive elimination, insertion)
- Identify specific reaction conditions required for catalytic cycles to be efficient.

14. Title of the paper –ORGANIC TRANSFORMATIONS & REAGENTS

Course Code – CH3C11
Credits 3
Total Hours 54

After successful completion of the course, the student is expected to

- Study of reactivity, preparation and reactions of various reagents.
- Understand the preparations and reactions of carbonyl group
- Show the mechanism for the formation of key heterocycles based upon the most commonly encountered syntheses.
- Explain the meaning and usage of strategic bonds, synthons, and retrons. Recognise synthetic considerations such as selectivity, step-economy, and convergence.
- Apply the stepwise disconnection approach for a range of compounds having different patterns of functionalisation to support selected strategic and tactical principles in retrosynthetic analysis of complex structures.

15. Title of the paper- SYNTHETIC ORGANIC CHEMSITRY(ELECTIVE)

Course Code –CH3E01
Credits 3
Total Hours 54

This elective course helps to understand various methodologies adopted in the field of organic synthesis. The student who opt this elective will

- Understand the synthesis of synthetic reagents and their synthetic utility.
- Basic level understanding of retrosynthetic analysis

- Fundamentals of synthesis planning.

Semester IV

16. **Title of the paper – INSTRUMENTAL METHODS OF ANALYSIS**

Course Code -CH4C12
Credits 4
Total Hours 72
This paper enables the students to understand

- Understand the importance of analytical chemistry in analysis of compounds by titrimetric, gravimetric and instrumental methods.
- Determine the causes of errors and their minimization during analysis
- Understand techniques chromatography for separation of components in the mixture

17. **Title of the paper –ADVANCED TOPICS IN CHEMISTRY**

Course Code –CH4C13
Credits 4
Total Hours 72
In this course the student will

- Recall, illustrate and use the principles of molecular recognition and self-assembly
- Describe the factors important in designing drugs for use in the central nervous system.
- Understand the fundamentals of advanced fiels in chemistry such as green chemistry, combinatorial chemistry, industrial catalysis and nanochemistry.

18. **Title of the paper INDUSTRIAL CATALYSIS (ELECTIVE)**

Course Code –CH4E05
Credits 4
Total Hours 72
After successful completion of the course, the student is expected to :

- Illustrate the concepts of per pass conversion, conversion, selectivity, yield, and turnover number/frequency and hence use these concepts in the explanation of process development.
- Reproduce the main catalytic cycle in hydroformylation and illustrate the equilibrium processes occurring between catalytic complexes.
- Define different catalytic processes and be able to compare and contrast the catalysts and methodologies used in these processes

19. **Title of the paper – INORGANIC CHEMISTRY PRACTICALS III & IV**

Course Code- CH3P07 & CH4P10
Credits 4
On completion of this course the student will learn to

- Prepare various inorganic complexes.
- analyse compounds in the given mixture by titrimetric, gravimetric and instrumental methods..

20. **Title of the paper - ORGANIC CHEMISTRY PRACTICALS III & IV**

Course Code –CH3P08 & CH4P11

Credits 4

After successful completion of this paper, the student will be well-versed in

- Various quantitative approaches in the field of organic chemistry
- Chromatographic techniques in the identification of organic compounds.

21. Title of the paper –PHYSICAL CHEMISTRY PRACTICALS III & IV

Course Code- CH3P09 & CH4P12

Credits 4

After successful completion of the course, the student is expected to :

- Gain expertise in the determination of reaction kinetics
- Monitor adsorption and related events
- Hand on experience with various instrumental methods like polarimeter and spectrophotometer etc.

22. Title of the paper –RESEARCH PROJECT

Course Code- CH4Pr01

Credits 4

The students should be able to

- Conduct independent research in their area of interest
- Understand the fundaments of various research methodologies
- Handle instruments for the characterization of chemicals
- Thesis writing and summarization of the obtained data.