

Shivaji University, Kolhapur

Name of Department: Chemistry

Name of Programme: M.Sc Analytical Chemistry

Vision: Engender Human Resource to Lead the Competitive Science World for Nation Building

Mission : Impart most advanced scientific knowledge and training to the students so that genuine researchers and skilled scientists of world standard will be made available for the advancement of national science and technology programs as well as to cater the needs of industrial and pharma sectors

Program Outcomes

PO1: The M.Sc. analytical chemistry program at Shivaji University, Kolhapur provides the key knowledge base and laboratory resources to prepare students for careers as professionals in the field of chemistry and particularly in analytical chemistry enabling them to interface not only with various branches of chemistry (organic, inorganic, physical, biological, industrial, environmental, pharmaceuticals etc) but also with the related fields, and for professional courses and areas of research including medical, forensic, food, agriculture, dental, law, intellectual property, business programs etc.

PO2: Students will be able to solve various problems by identifying the essential parts of a problem, formulate strategy for solving the problem, applying appropriate techniques to arrive at a solution, test the precision and accuracy of the solution and interpret the results.

PO3: Students will be able to acquire domain specific knowledge and technical skills needed for employment in industries, teaching fields and pursue research. Students will be skilled in problem solving, critical thinking and analytical reasoning

PO4: Students will be able to apply the fundamental knowledge to address the cross-cutting issues such as sustainable development

PO5: Students will get perfect insight into qualitative and quantitative analytical chemistry and research ethics for production of quality research.

PO6: Students will be able to communicate effectively i.e. being able to articulate, comprehend and write effective reports, make effective presentations and documentation and capable of expressing the subject through technical writing as well as through oral presentation.

Program Specific Outcomes

PSO1: Students will be able to prepare and qualify subject specific competitive exams like NET, SET and GATE and also other general public administration exams like M.P.S.C. and U.P.S.C. etc. exams.

PSO2: Student will be able to utilize the knowledge and analytical skills in QA-QC and R&D departments in almost all the industries enabling them to secure jobs where analytical chemistry is the core requirement to ensure and ascertain the quality of the product.

PSO3: Students will have opportunity for higher education leading to Ph.D. program.

PSO4: Students will be able to explore contemporary research in chemistry and allied fields of science and technology, collaborate in team projects, communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.

PSO5: Students can start their own laboratories/startups/ chemical industry/ business (entrepreneurship).

PSO6: Students will be able to interpret data from the state of art Analytical instruments for ascertaining the product/material.

Course Outcomes

Part-I Semester-I

CH-1.1

(Inorganic Chemistry – I)

1. CO1: Students will be able to explain the basic chemistry of transition metals and its compounds, spectroscopic characteristics of such compounds,

		<p>nomenclature, reactions and applications.</p> <p>CO2: Students will obtain knowledge about Preparation, structure, physical and chemical properties of metal carbonyls of transition metals.</p> <p>CO3: Students will be able to understand the all aspects of synthesis, bonding, structure and reactivity of organometallic compounds and their applications in homogenous catalysis.</p> <p>CO4: Student will be able determine the stability of the complexes and will be able to explain the nuclear stability and reactions.</p>
CH-1.2	(Organic Chemistry – I)	<p>CO1: Students will able to differentiate between various organic reactive intermediates.</p> <p>CO2: Students can recognize, classify, explain, and apply fundamental organic reactions.</p> <p>CO3: Students will have ability to distinguish between different kinds of isomers.</p> <p>CO4: Course will develop interest in writing and finding mechanisms of new reactions.</p> <p>.</p> <p>.</p>
CH-1.3	(Physical Chemistry – I)	<p>CO1: Students will be able to understand basic principles of thermodynamics and statistical mechanics</p> <p>CO2: Able to learn advanced topics like quantum statistics and molecular dynamic simulation methods.</p>

		<p>CO3: Develop abilities to understand how to estimate and analyze the physicochemical properties of condensed and gas phase materials.</p> <p>CO4: Able to utilize spectral data to estimate molecular thermodynamic properties through partition function calculations.</p> <p>CO5: Understand properties of detergents and colloidal materials</p> <p>CO6: Learns the principles and techniques to understand gas and liquid adsorptions on solid surfaces</p> <p>CO7: Can learn spectral techniques to study surface adsorption phenomena.</p> <p>CO8: Learn principles and techniques for estimation of average molecular weight of a polymer or biological macromolecules</p> <p>CO9: Develop abilities to characterize polymers through understanding theories of virial coefficients, concepts of glass transition temperatures, etc.</p>
CH.1.4:	Analytical Chemistry-I	<p>CO1: Students would acquire the knowledge about the fundamentals of Analytical Chemistry including the sampling, sample pretreatment, basic techniques, methods and data handling, processing and statistical analysis of the same.</p> <p>CO2: Students would acquire the knowledge and understand the scope of Analytical Chemistry spanning various fields. The students will learn fundamentals of qualitative analysis using conventional techniques</p> <p>CO3: Students will learn the chromatographic</p>

		<p>techniques, choice of chromatographic techniques and tuning of the chromatographic technique as per the need based on the samples to deal with, learn electroanalytical techniques and computation chemistry which would groom them for alternative analytical strategies which form one of the important components of analytical chemistry.</p> <p>CO4: Students will learn about referring to the standard reference books and infer information from the same. Analytical case study problems would be discussed to familiarize with the scope and advantages of Analytical Chemistry.</p>
PCH-1.1	(Practical – I)	<p>CO1: Ability in professional sampling and sample treatment before actual analysis</p> <p>CO2: Ability to treat and evaluate the results of analysis</p> <p>CO3: Understanding and capability of performing basic chemical processes in a chemical laboratory</p> <p>CO4: Capability of performing measurements on basic analytical instruments (photometers, spectrometers, chromatographs, ion-selective electrodes)</p>
PCH-1.2	(Practical – II)	<p>CO1: Students can be able to prepare various concentration solutions like molar, normal, ppm, etc.</p> <p>CO2: Determine the rate constants of various first order and second order reactions</p> <p>CO3: Determine the redox potential of a system, relative strength of acid etc using potentiometer, conductometer</p> <p>CO4: Know the formation of alloys like Brass,</p>

		<p>Bronze, phase diagram for binary and ternary systems studied in details like a composition, critical temperature, etc</p> <p>CO5: Validity of Freundlich adsorption isotherms to remove toxic material such as dye, acetic acid, and other industrial effluents</p>
Part-I Semester-II		
CH-2.1	(Inorganic Chemistry – II)	<p>CO1: Students will get the knowledge of the basic chemistry of non-transition elements and their compounds, synthesis and structural features, and applications.</p> <p>CO2: To be able to explain the structures of inorganic compounds based on different theories. Student will understand the chemistry of various types of solvents.</p> <p>CO3: Be well versed with the knowledge about the chemistry of Lanthanides and Actinides with respect to occurrence, separation, compounds and applications.</p> <p>CO4: To understand the three dimensional structures of solid-state materials of industrial importance and to get the knowledge of bio-inorganic Chemistry.</p>
CH-2.2	(Organic Chemistry – II)	<p>Course Outcomes (COs)</p> <p>CO1: Illustration of modern synthetic methods and applications of reagents.</p> <p>CO2: Provide knowledge of different organometallic compounds and various coupling reactions.</p> <p>CO3: Understand principle and applications of protection and deprotection of various functional groups.</p>

		CO4: It will elaborate to understand the concept of chemoselectivity, regioselectivity and enantioselectivity.
CH2.3	(Physical Chemistry – II)	<p>CO1: Students will learn basics of quantum mechanics.</p> <p>CO2: Knowledge of the course will form the basis or essential requirement for the course “Advanced Quantum Chemistry”</p> <p>CO3: Able to understand selection rules and to predict the electronic spectra of conjugated organic molecules.</p> <p>CO4: Able to study photochemical and photophysical phenomena</p> <p>CO5: Capable of qualitative and quantitative analysis of various ingredients from industrial, food and pharma samples using techniques of emission spectroscopy.</p> <p>CO6: Capable of understand the electrochemical aspects of materials, ionic processes and electrochemical sensors, battery materials and characterizations etc.</p> <p>CO7: Able to study electrokinetic effects and their applications in the field of protein separation, characterization etc.</p> <p>CO8: Understanding the molecular dynamics through kinetic studies. Applications to explore reaction pathways, protein-ligand binding rates, etc. will help to understand life governing processes.</p>
CH.2.4:	Analytical Chemistry-II	CO1: Students will acquire the knowledge of spectroscopic tools/instruments used in chemical

		<p>analysis and interpretation of the data. The scope and limitations of the spectroscopic tools would be discussed so that the students learn about the type of samples which could be analyzed by these tools offering choices among the spectroscopic tools.</p> <p>CO2: Students will learn about the simple and advanced instruments used for analysis like NMR, MS, AAS, ICP and thermal analysis (TGA, DTA, DSC etc.) techniques spanning wide variety of samples to be considered for analysis.</p> <p>CO3: Students will learn about the instrumentation, sample preparation and handling of sample, analysis and data interpretation and structural elucidation.</p> <p>CO4: Learning about different instruments will give them idea about appropriate choice of the instrument for analysis based on the source and type of analyte(s) in the sample under consideration.</p>
PCH-2.1	(Practical – III)	<p>CO1: Students developed for precise sample solution preparation and sample treatment before actual analysis.</p> <p>CO2: Students can be able to perform the calculations and error analysis</p> <p>CO3: Develop understanding of basic chemical processes and deciding methods of analysis.</p> <p>CO4: Capability of performing measurements on basic analytical instruments (photometers, spectrometers, chromatographs, high end thermometers, refractometer, pH meter etc.)</p>
PCH-2.2	(Practical – IV)	<p>CO1: Students can be able to prepare various concentration solutions like molar, normal, ppm, etc.</p>

		<p>CO2: Determine the unknown concentration and thermodynamic parameters using conductometer</p> <p>CO3: Student will explore how to estimate order of reaction and the catalysis</p> <p>CO4: students can estimate refractive index and molecular weights of species.</p> <p>CO5: Students can understand the estimation of equilibrium properties like redox potential, phase diagram etc</p>
Part-II Semester-III		
ACH-3.1	(Advanced Analytical Techniques)	<p>CO1: Develop knowledge of fundamental, instrumentation and working of state of art instrumental analytical techniques, effective use and choice of technique, written and/or oral communication of the concepts of analytical chemistry which will be useful as analytical chemist and R&D.</p> <p>CO2: Acquire knowledge of mass spectrometry, type of MS, ionization types and specific practical applications of MS.</p> <p>CO3: Acquire knowledge of basics of nanochemistry, nanomaterials and nanotechnology and application orientated synthesis and characterization of nanomaterials.</p> <p>CO4: This course gives wide understanding about the instrumental analytical techniques (SEM, TEM, EDS, STM, AFM, Raman, XFS, ESR, XPS, AES, SIMS etc.) employed for qualitative and quantitative analysis for contemporary research.</p>

ACH-3.2	(Organic Analytical Chemistry)	<p>CO 1: Students will gain knowledge of the instruments used at the interface of Analytical-Organic chemistry useful for R&D and structural elucidation using UV-Visible, IR, 1H & 13C NMR, Mass spectrometry data and interpretation of the same.</p> <p>CO 2: Students will acquire knowledge about the drug, their classification, sources of impurities (chemical, atmospheric and microbial contamination) in pharmaceutical raw materials and analysis of the same.</p> <p>CO 3: Students will gain knowledge about the conventional and advanced analytical approaches for analysis of drug, vitamin, body fluids and clinical samples.</p> <p>CO 4: Students will have an idea of commonly used pesticides and their analysis and also about forensic science and forensic sample analysis.</p>
ACH- 3.3:	(Electroanalytical Techniques in Chemical Analysis)	<p>CO1: Fundamental knowledge of electrochemistry, electrodes, types of electrodes, its construction will lay foundation for the course.</p> <p>CO2: Students will gain knowledge and skill in electroanalytical techniques like cyclic voltammetry and its types, polarography, coulometry and dynamic light scattering technique for qualitative and quantitative analysis.</p> <p>CO3: Students will be familiar with the advanced electrodes used for chemical analysis, liquid-liquid membrane electrodes, enzymes and gas electrodes.</p> <p>CO4: Students will learn about electrophoretic techniques, advances in electrophoresis techniques and its analytical applications.</p> <p>.</p>
ACH-3.4)	(A) (Environmental	<p>CO1: Students will acquire knowledge about sampling, criteria of good sampling, handling, preservation and storage of the samples, pretreatment and post treatment of samples.</p>

	Chemical Analysis and Control)	<p>CO2: Students will acquire knowledge of conditions and strategies required during sampling and electrochemical and spectral methods for analysis of environmental samples.</p> <p>CO3: Students will learn about the air and water pollution, sources of pollution, typical parameters and properties (physical, chemical and biological) to be measured in air and water pollution with relevance to specific case studies.</p> <p>CO4: Students will be acquainted with organic pollutants and their analysis with special reference to pesticide analysis.</p>
ACH-3.4)	(B) (Recent Advances in Analytical Chemistry)	<p>CO1: Students will be acquainted with ultra purity and ultra trace analysis required in electronic and semiconductor processing.</p> <p>CO2: Students will learn Radio-Analytical techniques for analysis.</p> <p>CO3: Student will be well versed with C13, P15 and O17 NMR Spectroscopy applications.</p> <p>CO4: Student will learn about ESR spectrometry and its applications quantitative analysis.</p> <p>.</p>
ACH-3.4	(B) (Recent Advances in Analytical Chemistry)	<p>CO1: Students will be acquainted with ultra purity and ultra trace analysis required in electronic and semiconductor processing.</p> <p>CO2:</p>

		<p>Students will learn Radio-Analytical techniques for analysis.</p> <p>CO3:</p> <p>Student will be well versed with C13, P15 and O17 NMR Spectroscopy applications.</p> <p>CO4:</p> <p>Student will learn about ESR spectrometry and its applications quantitative analysis.</p>
ACHP – V	Practical -V	<p>CO1: In-depth training on laboratory solution preparations on all concentration scales</p> <p>CO2: Training on laboratory safety and lab ethics in scientific work</p> <p>CO3: Training on planning, design and execution of experiments</p> <p>CO4: Training on uncertainty estimations for experimentally measured and derived properties of solutions</p>
ACHP – VI	Practical-VI	<p>CO1: Training on scientific literature search, defining the objective of the work, research skills, data representation in tabular and graphical form etc.</p> <p>CO2: Training on experimental verification of fundamental theories, comparison of data with literature and scientific discussion on any deviation of data from expected theoretical values or reported literature.</p> <p>CO3: Developing analytical skills</p> <p>CO4: Training on qualitative and quantitative</p>

		analysis of analyte
Part-II semester-IV		
ACH	4.1 (Modern Separation Method in Analysis)	<p>CO1: Students will learn about modern separation and chromatographic used for analysis of different type of samples.</p> <p>CO2: The student will understand instrumentation and mechanism of various separation techniques.</p> <p>CO3: Student will acquire knowledge regarding various choice of instrument and detectors to be used for analysis depending on the sample and matrix.</p> <p>CO4: Student will learn fundamentals of extractive chromatography, types of extraction techniques, advances in extraction methods and their hyphenations with chromatography leading to addressing challenging problems in analytical chemistry.</p>
ACH-4.2	(Organic Industrial Analysis)	<p>CO1: Acquire knowledge of handling and investigating the characteristics of the oils, fats, detergents and soap samples and analysis of the same providing opportunity in cosmetic, pharmaceuticals, dyes and polymers industries.</p> <p>CO2: Student will gain knowledge and</p>

		<p>importance of food quality, probe for food adulteration and adulterants, food preservative, food flavors and analysis of their components.</p> <p>CO3: Students will also gain knowledge about the animal food stuff and the additives added in the animal food stuff as antibiotics, dietary supplements and growth promoting drugs, preservatives etc. and analysis of the same.</p> <p>CO4: Student will learn about the analysis of cosmetics, face powder, hair dyes and hair care products, types of cosmetics, precautionary measures and composition of the cosmetics and specific roles of the ingredients. Will acquire knowledge about the paints, pigments and petroleum products, composition and analysis of the same using conventional and instrumental techniques.</p>
ACH- 4.3	(Advanced Methods in Chemical Analysis)	<p>CO1: Students will be skilled in the techniques like fluorescence, phosphorescence, types of quenching, FRET and applications of the same in Analytical Chemistry and for addressing research problems.</p> <p>CO2: Students will gain knowledge of the kinetic methods of analysis supporting the analysis and data procured in research.</p> <p>CO3: The students will acquire the knowledge of advanced method of chemical analysis XPS, XRF, fluorescence and phosphorescence spectroscopy which will be beneficial in research.</p> <p>CO4: Students will acquire knowledge of identifying types of plastic and will also be able to and determination of metallic impurities in plastics</p>
ACH-4.4 (A)	(Industrial Analytical Chemistry)	<p>CO1: The students will acquire knowledge of analysis of metals, alloys, minerals and ores commonly used in the industry.</p> <p>CO2: The students will be acquainted with the analysis of real samples like cement, plaster of Paris, different commercial ores, soil composition, soil fertility, fertilizers etc using conventional and instrumental</p>

		<p>methods of analysis.</p> <p>CO3:</p> <p>Students will also gain the knowledge of analysis of commercial materials, explosives, polymers, resins, rubber, luminescent paints, lubricants and adhesives.</p> <p>CO4:</p> <p>These would offer opportunity to the students to get employment in industries for quality assurance and quality control (QA-QC) of the product.</p>
ACH-4.4 (B)	(Quality Assurance and Accreditation)	<p>CO1:</p> <p>Students will acquire knowledge of QA-QC which is essential for analytical chemist, This covers a variety of chemical fields and this knowledge would help students working on various materials, understanding the basics of samples, sampling, sample storage, and pre-post treatment of samples.</p> <p>CO2:</p> <p>Students will acquire knowledge of good laboratory practices, professional ethics, and instrumental analytical chemistry, awareness of health hazards, remedial measures, analytical method development and validation.</p> <p>CO3:</p> <p>The students would be aware of the importance of documentation for raw materials and finished products, their monitoring, maintenance and management. World-wide agencies involved in regulating the analytical protocols and establishing standards.</p> <p>CO4:</p> <p>Students will gain knowledge about the quality assurance and accreditation, evolution and significance of quality management, available accreditation agencies and advantages of accreditation.</p>
ACHP – VIII	Practical-VIII	<ol style="list-style-type: none"> 1. The students will acquire hands on training for conducting the representative experiments for the analysis of wide variety of samples of inorganic, organic and physical approaches by qualitative and quantitative analysis. Demonstrate professional and ethical attitude to serve the society 2. Students will have knowledge of safety signs on container of chemicals, safety in handling of

		<p>chemicals, MSDS sheets, learn sample preparation and characterization for confirming the purity.</p> <ol style="list-style-type: none">3. Students would acquire knowledge about the separation and estimation of amount of metal, metal ions, organic compounds etc. in given samples.4. Based on the experience of project work, students will have ability to start their R & D laboratory.
--	--	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------