

**Bharati Vidyapeeth's**  
**Dr. Patangrao Kadam Mahavidyalaya, Sangli**  
**Internal Quality Assurance Cell**  
**Department of Chemistry**

**PROGRAMME OUTCOMES**

Name of Programme: **M. Sc. Analytical Chemistry**

**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.

## **PROGRAMME SPECIFIC OUTCOMES**

Name of Programme: M. Sc. Analytical Chemistry

**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

<b>M. Sc. I (NEP-2020) Semester I</b>	
<b>Course</b>	<b>Outcomes</b>
OCH 101- (Organic Chemistry-I)	<b>After completion of these courses, students should be able to,</b> CO-1: To learn and understand types of reactions, structure, stability and reactivity of carbenes, arynes, nitrenes, and $SN^1$ , $SN^2$ , $SN^i$ reactions. CO-2: To learn three, four and five membered system. To understand aromatic electrophilic substitution and nucleophilic aromatic substitution reactions. CO-3: To learn E1, into E1cB reaction, CO-4: To understand the concept of chirality, R/S configuration, conformational analysis of cyclohexane.
ICH 102- (Inorganic Chemistry-I)	CO-1: To understand CFT for Td, Oh, Sq. planar, TBP filled, CFSE and its applications. CO-2: To learn the classification, nomenclature, synthesis, bonding and properties of organometallic compounds. CO-3: To learn preparation, structure and properties of metal carbonyls. CO-4: To understand symmetry, point groups and Milliken symbolism rules.
E-ACH103- (Analytical Chemistry I) Elective paper	CO-1: To understand TGA, DTA, DTG and DSC and its applications. CO-2: To learn AAS in detail and its application, FES, ICP and its application. CO-3: To understand Beer-Lambert's law, structural problems and its application. CO-4: To understand IR spectroscopy in detail, problems and its applications.
CH104- (Research Methodology)	CO-1: To understand Research methodology and implementation of research. CO-2: To learn online searching, impact factor and paper writing for international journals. CO-3: To understand Errors, accuracy, precision. CO-4: To learn how to operate PC and How to learn standard programs.

<b>M.Sc.I, Sem-I (Chemistry Practical)</b>	
<b>Course</b> Laboratory practical	<b>Outcomes</b> <b>After completion of these courses, students should be able to,</b> CO-1: To learn ore, alloy analysis. CO-2: To learn preparation of coordination complexes CO-3: To learn instrumentation techniques. CO-4: To learn single stage preparation of important organic products. CO-5: To learn rate of reaction, kinetics of reaction. CO-6: To learn estimation and preparation of organic compounds.
<b>M. Sc. I (NEP-2020) Semester II</b>	
<b>Course</b> PCH 201- (Physical Chemistry-II)	<b>Outcomes</b> <b>After completion of these courses, students should be able to,</b> CO-1: To understand wave functions, spectroscopic term symbols and numericals. CO-2: To understand partition function, thermodynamic properties and numericals. CO-3: To know the theory of strong electrolyte, Debye Hukkel theory and numericals. CO-4: To learn kinetics of reaction and steady state approximation.
ACH 202- (Analytical Chemistry-II)	CO-1: To learn basics of analysis, statistics in chemical analysis and MS office in chemistry applications. CO-2: To understand volumetric and gravimetric analysis. CO-3: To understand Gas, HPLC and Ion exchange chromatography. CO-4 To learn Voltametry, polarography, amperometry and electrogravimetry analysis.
E-ACH203- (Analytical Chemistry) Elective paper	CO-1: To understand NMR and Instrumentation of FT-NMR and its applications. CO-2: To learn types of ionization, analyzers and application's. CO-3: To learn Rigid and non-rigid rotors and numericals. CO-4: To understand Raman Spectra, Vibrational Raman spectra and numericals.

### Course Outcomes M.Sc.I, Sem-II (Chemistry Practical)

Course	Outcomes
Laboratory practical	<b>After completion of these courses, students should be able to,</b> Co-1: To learn ore, alloy analysis CO-2: To learn preparation of coordination complexes . CO-3: To learn instrumentation techniques. CO-4: To learn single stage preparation of important organic products. CO-5: To learn rate of reaction, kinetics of reaction. CO-6: To learn estimation and preparation of organic compounds.

### M. Sc. II (NEP-2020) Semester III

ACH-3.1	(Advanced Analytical Techniques)	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. CO2: Acquire knowledge of mass spectrometry, type of MS, ionization types and specific practical applications of MS. CO3: Acquire knowledge of basics of nanochemistry, nanomaterials and nanotechnology and application orientated synthesis and characterization of nanomaterials. 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.
ACH-3.2	( Organic Analytical Chemistry)	CO1: 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, <sup>1</sup> H & <sup>13</sup> C NMR, Mass spectrometry data and interpretation of the same. 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. CO 3: Students will gain knowledge about the

		<p>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>
<b>ACH-3.3:</b>	<b>(Electroanalytical Techniques in Chemical Analysis)</b>	<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>
<b>ACH-3.4 )</b>	<b>(A) (Environmental Chemical Analysis and Control)</b>	<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> <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>
<b>ACH-3.4 )</b>	<b>(B) (Recent Advances in Analytical Chemistry)</b>	<p>CO1: Students will be acquainted with ultra-purity and ultratrace 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>
<b>ACH-3.4</b>	<b>(B) (Recent Advances in Analytical Chemistry)</b>	<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>
<b>ACHP - V</b>	<b>Practical -V</b>	<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>
<b>ACHP - VI</b>	<b>Practical-VI</b>	<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 analysis of analyte</p>
	<b>Part-II semester-IV</b>	
<b>ACH4.1</b>	<b>(Modern Separation Method in Analysis)</b>	<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>
<b>ACH-4.2</b>	<b>(Organic Industrial Analysis)</b>	<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 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>
<b>ACH-4.3</b>	<b>(Advanced Methods in Chemical Analysis)</b>	<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>
<b>ACH-4.4 (A)</b>	<b>(Industrial Analytical Chemistry)</b>	<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 methods of analysis.</p> <p>CO3: Students will also gain the knowledge of analysis of commercial materials, explosives, polymers, resins, rubber, luminescent paints, lubricants and adhesives.</p> <p>CO4: These would offer opportunity to the students to get employment in industries for quality assurance and quality control (QA-QC) of the product.</p>



<b>ACH-4.4 (B)</b>	<b>(Quality Assurance and Accreditation)</b>	<p>CO1: 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: 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: The students would be aware of the importance of documentation for raw materials and finished products, their monitoring, maintenance and management.</p> <p>World-wide agencies involved in regulating the analytical protocols and establishing standards.</p> <p>CO4: Students will gain knowledge about the quality assurance and accreditation, evolution and significance of quality management, available accreditation agencies and advantages of accreditation.</p>
<b>ACHP - VIII</b>	<b>Practical-VIII</b>	<p>CO1: 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</p> <p>CO2: Students will have knowledge of safety signs on container of chemicals, safety in handling of chemicals, MSDS sheets, learn sample preparation and characterization for confirming the purity.</p> <p>CO3: Students would acquire knowledge about the separation and estimation of amount of metal, metal ions, organic compounds etc. in given samples.</p> <p>CO4: Based on the experience of project work, students will have ability to start their R &amp; D laboratory.</p>