SHIVAJI UNIVERSITY, KOLHAPUR

DEAPRTMENT OF CHEMISTRY

Academic Year 2018-2019

PART – A

Name of Department: Department of Chemistry

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

Department 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

Name of Program: M.Sc. Analytical Chemistry

Analytical Chemistry is a pervasive and a key subject not only for Chemistry, but all the branches of Science, Engineering and Technology which involves Chemistry. It is an experimental science and students need to be trained in theory and practical dealing with fundamental and advanced analytical skills of conventional analysis and instrumental analysis so as to get expertise in doing fine experiments and handle sophisticated instruments.

The M.Sc. Analytical Chemistry program offered by Shivaji University is a Two Years full time program. The first and second semester gives general background of analytical chemistry and its importance to all the branches of Chemistry to make a good theoretical background of students. The semester third and fourth is totally assigned to analytical chemistry and it covers most of the fundamental and advance aspects of modern analytical chemistry. In order to make students more careers oriented and nurturing their scientific temperaments, students will get exposure to the depth of core understanding of various dimensions of analytical chemistry during these two years the study.

Program Outcomes (POs)

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 (PSOs)

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.

Part B

Syllabus Structure: Annexure – I

Semester-wise courses, their COs and Mapping Matrices

Semester: I

Courses:

CH-1.1 (Inorganic Chemistry – I)

CH-1.2 (Organic Chemistry – I)

CH-1.3 (Physical Chemistry – I)

CH-1.4 (Analytical Chemistry – I)

PCH-1.1 (Practical – I)

PCH-1.2 (Practical – II)

CH-1.1 (Inorganic Chemistry – I)

Course Outcomes (COs)

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

CO2: Students will obtain knowledge about Preparation, structure, physical and chemical properties of metal carbonyls of transition metals.

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.

CO4: Student will be able determine the stability of the complexes and will be able to explain the nuclear stability and reactions.

COs – POs & PSOs mapping matrix (1-Low, 2-Medium, 3-High, 0-No correlation)

PO→ CO↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	3	3	3	3	3	1	2
CO2	2	2	3	2	2	3	2	3	3	2	3	3
CO3	3	3	3	2	2	2	3	2	3	1	3	3
CO4	3	2	3	1	1	1	2	3	3	2	2	2
Total	11	9	12	7	8	9	10	11	12	8	9	10
Average	2.8	2.2	3	1.8	2	2.2	2.5	2.8	3	2	2.2	2.5

CH-1.2 (Organic Chemistry – I)

Course Outcomes (COs)

CO1: Students will able to differentiate between various organic reactive intermediates.

CO2: Students can recognize, classify, explain, and apply fundamental organic reactions.

CO3: Students will have ability to distinguish between different kinds of isomers.

CO4: Course will develop interest in writing and finding mechanisms of new reactions.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	3	3	3	2	2
CO2	3	3	3	3	3	3	3	3	3	3	2	2
CO3	3	2	2	3	3	3	3	3	3	3	2	2
CO4	3	1	2	3	3	3	3	3	3	3	2	3
Total	12	9	10	12	12	12	12	12	12	12	8	9
Average	3	2.2	2.5	3	3	3	3	3	3	3	2	2.2

CH-1.3 (Physical Chemistry – I)

After completing this course, students will be able to understand basic principles of thermodynamics and statistical mechanics required to learn more advanced topics like quantum statistics and molecular dynamic simulation methods.

Course Outcomes (COs)

CO1: Students will be able to understand basic principles of thermodynamics and statistical mechanics

CO2: Able to learn advanced topics like quantum statistics and molecular dynamic simulation methods.

CO3: Develop abilities to understand how to estimate and analyze the physicochemical properties of condensed and gas phase materials.

CO3: Able to utilize spectral data to estimate molecular thermodynamic properties through partition function calculations.

CO4: Understand properties of detergents and colloidal materials

CO5: Learns the principles and techniques to understand gas and liquid adsorptions on solid surfaces

CO6: Can learn spectral techniques to study surface adsorption phenomena.

CO7: Learn principles and techniques for estimation of average molecular weight of a polymer or biological macromolecules

CO8: Develop abilities to characterize polymers through understanding theories of virial coefficients, concepts of glass transition temperatures, etc.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
COs ↓												
CO1	3	2	1	3	3	3	3	3	2	2	3	1
CO2	2	2	1	3	2	3	2	3	1	2	1	2
CO3	3	3	2	3	3	3	3	3	3	3	3	3
CO4	3	3	2	3	3	2	2	3	1	2	2	2
CO5	3	1	0	3	3	1	2	3	1	1	3	1
CO6	3	3	1	3	3	1	3	3	2	1	3	1
CO7	3	3	1	3	3	3	2	3	1	2	3	2
CO8	3	3	0	3	3	2	1	3	1	2	3	2
Total	23	20	8	24	23	18	18	24	12	15	21	14
Average	2.9	2.5	1	3	2.9	2.2	2.2	3	1.5	1.9	2.6	1.7

CH.1.4: Analytical Chemistry-I

Course Outcomes (COs)

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.

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

CO3: Students will learn the chromatographic 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.

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.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	3	3	3	2	2
CO2	3	3	3	3	3	3	3	3	3	3	2	2
CO3	3	2	2	3	3	3	3	3	3	3	2	2
CO4	3	1	2	3	3	3	3	3	3	3	2	3
Total	12	9	10	12	12	12	12	12	12	12	8	9
Average	3	2.2	2.5	3	3	3	3	3	3	3	2	2.2

PCH-1.1 (Practical – I)

Course Outcomes (COs)

CO1: Ability in professional sampling and sample treatment before actual analysis

CO2:Ability to treat and evaluate the results of analysis

CO3: Understanding and capability of performing basic chemical processes in a chemical laboratory

CO4: Capability of performing measurements on basic analytical instruments (photometers, spectrometers, chromatographs, ion-selective electrodes)

COs – POs & PSOs mapping matrix (1-Low, 2-Medium, 3-High, 0-No correlation)

PO→ CO↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	3	3	2	3	2	3	3	3
CO2	2	3	3	2	3	3	2	2	3	3	3	2
CO3	2	2	2	2	3	3	3	2	1	3	3	3
CO4	2	3	3	2	3	3	3	1	2	3	3	3

Total	8	11	11	8	12	12	10	8	8	12	12	11
Average	2	3	3	2	3	3	2.5	2	2	3	3	3

PCH-1.2 (Practical – I)

Course Outcomes (COs)

CO1: Students can be able to prepare various concentration solutions like molar, normal, ppm, etc.

CO2: Determine the rate constants of various first order and second order reactions

CO3: Determine the redox potential of a system, relative strength of acid etc using potentiometer, conductometer

CO4: Know the formation of alloys like Brass, Bronze, phase diagram for binary and ternary systems studied in details like a composition, critical temperature, etc

CO5:Validity of Freundlich adsorption isotherms to remove toxic material such as dye, acetic acid, and other industrial effluents

Cos – Pos & PSOs mapping matrix (1-Low, 2-Medium, 3-High, 0-No correlation)

PO→ CO↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	3	3	2	3	2	3	3	3
CO2	2	3	3	2	3	3	2	2	3	3	3	2
CO3	2	2	2	2	3	3	3	2	1	3	3	3
CO4	2	3	3	2	3	3	3	2	2	3	3	3
CO5	2	2	2	1	2	1	2	1	2	2	1	2
Total	10	13	13	9	14	13	12	10	10	14	13	13
Average	2	2.6	2.6	1.8	2.8	2.6	2.4	2	2	2.8	2.6	2.6

Semester: II

Courses:

CH-2.1 (Inorganic Chemistry – II)

CH-2.2 (Organic Chemistry – II)

CH-2.3 (Physical Chemistry – II)

CH-2.4 (Analytical Chemistry – II)

PCH-2.1 (Practical – III)

PCH-2.2 (Practical – IV)

CH-2.1 (Inorganic Chemistry – II)

Course Outcomes (COs)

CO1: Students will get the knowledge of the basic chemistry of non-transition elements and their compounds, synthesis and structural features, and applications.

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.

CO3: Be well versed with the knowledge about the chemistry of Lanthanides and Actinides with respect to occurrence, separation, compounds and applications.

CO4**:**To understand the three dimensional structures of solid-state materials of industrial importance and to get the knowledge of bio-inorganic Chemistry.

COs – POs & PSOs mapping matrix (1-Low, 2-Medium, 3-High, 0-No correlation)

PO→ CO↓	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	3	3	3	1	3	2
CO2	3	1	3	3	2	3	2	2	3	3
CO3	2	2	2	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	1	3	3	2
Total	11	8	11	12	11	12	9	8	12	10
Average	3	2	3	3	3	3	2	2	3	3

CH-2.2 (Organic Chemistry – II)

Course Outcomes (COs)

CO1: Illustration of modern synthetic methods and applications of reagents.

CO2: Provide knowledge of different organometallic compounds and various coupling reactions.

CO3: Understand principle and applications of protection and deprotection of various functional groups.

CO4: It will elaborate to understand the concept of chemoselectivity, regioselectivity and enantioselectivity.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ / COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	3	3	3	1	2
CO2	3	3	2	3	3	3	3	3	3	2	2	2
CO3	3	2	2	3	2	3	3	2	3	3	2	2
CO4	3	1	2	3	3	3	3	3	3	3	2	2
Total	12	9	9	12	12	12	12	12	12	11	7	8
Average	3	2.2	2.2	3	3	3	3	3	3	2.7	1.7	2

CH2.3 (Physical Chemistry – II)

Students will learn the fundamentals of quantum mechanics and how to solve the Schrodinger wave equation for some simple systems as well as derive selection rules for such systems. Knowledge gained through this course will help students to learn more advanced topics in quantum mechanics and hence becomes the basis or essential requirement for the course "Advanced Quantum Chemistry"

Course Outcomes (COs)

CO1: Students will learn basics of quantum mechanics.

CO2: Knowledge of the course will form the basis or essential requirement for the course "Advanced Quantum Chemistry"

CO3: Able to understand selection rules and to predict the electronic spectra of conjugated organic molecules.

CO4: Able to study photochemical and photophysical phenomena

CO5: Capable of qualitative and quantitative analysis of various ingredients from industrial, food and pharma samples using techniques of emission spectroscopy.

CO6: Capable of understand the electrochemical aspects of materials, ionic processes and electrochemical sensors, battery materials and characterizations etc.

CO7: Able to study electrokinetic effects and their applications in the field of protein separation, characterization etc.

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.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ / COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	3	3	2	3	3	3	2	3	3
CO2	3	2	1	3	3	2	3	3	3	2	3	3
CO3	3	3	1	3	3	0	3	3	3	1	3	3
CO4	3	3	0	3	3	3	3	3	2	2	3	2
CO5	2	3	0	3	3	3	3	3	2	0	2	1
CO6	2	3	3	2	3	0	3	3	3	1	2	1
CO7	3	3	3	3	1	2	1	3	1	1	2	2
CO8	3	2	1	3	2	3	2	3	1	3	2	3
Total	22	22	10	23	21	15	21	24	18	12	20	18
Average	2.7	2.7	1.2	2.9	2.6	1.9	2.6	3	2.2	1.5	2.5	2.2

CH.2.4: Analytical Chemistry-II

Course Outcomes (COs)

CO1: Students will acquire the knowledge of spectroscopic tools/instruments used in chemical 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.

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.

CO3:Students will learn about the instrumentation, sample preparation and handling of sample, analysis and data interpretation and structural elucidation.

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.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	3	3	3	3	1	2
CO2	3	3	2	3	3	3	3	3	3	2	2	2
CO3	3	2	2	3	2	3	3	2	3	3	2	2
CO4	3	1	2	3	3	3	3	3	3	3	2	2
Total	12	9	10	12	12	12	12	12	12	12	8	9
Average	3	2.2	2.5	3	3	3	3	3	3	3	2	2.2

ACH-2.1 (Practical – III)

Course Outcomes (COs)

CO1: Students developed for precise sample solution preparation and sample treatment before actual analysis.

CO2:Students can be able to perform the calculations and error analysis

CO3: Develop understanding of basic chemical processes and deciding methods of analysis.

CO4: Capability of performing measurements on basic analytical instruments (photometers, spectrometers, chromatographs, high end thermometers, refractometer, pH meter etc.)

COs – POs & PSOs mapping matrix (1-Low, 2-Medium, 3-High, 0-No correlation)

PO→ CO↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	3	3	2	3	2	3	3	3
CO2	2	3	3	2	3	3	2	2	3	3	3	2
CO3	2	2	2	2	3	3	3	2	2	3	3	3
CO4	2	3	3	2	3	3	3	2	2	3	3	3
Total	8	11	11	8	12	12	10	9	9	12	12	11
Average	2	3	3	2	3	3	2.5	2.2	2.2	3	3	3

ACH-2.2 (Practical – IV)

Course Outcomes (COs)

CO1: Students can be able to prepare various concentration solutions like molar, normal, ppm, etc.

CO2: Determine the unknown concentration and thermodynamic parameters using conductometer

CO3: Student will explore how to estimate order of reaction and the catalysis

CO4: students can estimate refractive index and molecular weights of species.

CO5:Students can understand the estimation of equilibrium properties like redox potential, phase diagram etc

Cos – Pos & PSOs mapping matrix (1-Low, 2-Medium, 3-High, 0-No correlation)

PO→ CO↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	3	3	2	3	2	3	3	3
CO2	2	3	3	2	3	3	2	2	3	3	3	2
CO3	2	2	2	2	3	3	3	2	1	3	3	3
CO4	2	3	3	2	3	3	3	2	2	3	3	3
CO5	2	2	2	2	2	2	2	2	2	2	1	2
Total	10	13	13	10	14	14	12	11	10	14	13	13
Average	2	2.6	2.6	2	2.8	2.8	2.4	2.2	2	2.8	2.6	2.6

Semester III

Courses:

ACH-3.1 (Advanced Analytical Techniques)

ACH-3.2 (Organo Analytical Chemistry)

ACH-3.3 (Electroanalytical Techniques in Chemical Analysis)

ACH-3.4 (A) (Environmental Chemical Analysis and Control)

ACH-3.4 (B) (Recent Advances in Analytical Chemistry)

ACH-V (Practical Course – V)

ACH-VI (Practical Course – VI)

ACH-3.1 (Advanced Analytical Techniques)

~~This course is designed by keeping in mind today's power and utility of computational science in the advancement of our understanding at molecular level and in the developments of new technologies. The knowledge of basic quantum mechanics helps to understand spectral selection rules, concept of atomic orbitals, electronic transitions etc and that of advanced quantum chemistry topics such as *ab initio* methods, electron correlation techniques and density functional theory is useful to solve electronic structures of atoms and molecules. This helps students to learn how to predict and calculate the reaction mechanisms, transition state analysis, design of new molecules, spectral and other molecular properties of molecules and molecular assemblies etc. All these if supported through computational lab experiments will make the students capable of doing most advanced science through experimentation and computational tools.~~

Course Outcomes (COs)

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.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ / COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	3	1	3	3	3	1	3
CO2	3	3	3	2	3	3	3	3	3	2	2	3
CO3	3	2	3	3	2	3	3	2	3	3	2	3
CO4	3	2	2	3	3	3	2	3	3	3	2	3
Total	12	10	11	11	11	12	9	11	12	11	7	12
Average	3	2.5	2.7	2.7	2.7	3	2.2	2.7	3	2.7	1.7	3

ACH-3.2 (Organic Analytical Chemistry)

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Course Outcomes (COs)

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.

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 conventional and advanced analytical approaches for analysis of drug, vitamin, body fluids and clinical samples.

CO 4: Students will have an idea of commonly used pesticides and their analysis and also about forensic science and forensic sample analysis.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ / COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	3	2	3	3	3	3	3
CO2	3	3	2	2	3	3	3	3	3	2	2	3
CO3	3	2	3	3	2	3	3	2	3	3	2	3
CO4	3	2	2	3	2	3	2	3	3	3	2	3
Total	12	10	10	11	10	12	10	11	12	11	9	12
Average	3	2.5	2.5	2.7	2.5	3	2.5	2.7	3	2.7	2.2	3

ACH- 3.3: (Electroanalytical Techniques in Chemical Analysis)

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Course Outcomes (COs)

CO1:Fundamental knowledge of electrochemistry, electrodes, types of electrodes, its construction will lay foundation for the course.

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.

CO3: Students will be familiar with the advanced electrodes used for chemical analysis, liquid-liquid membrane electrodes, enzymes and gas electrodes.

CO4: Students will learn about electrophoretic techniques, advances in electrophoresis techniques and its analytical applications.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ / COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	3	2	3	3	3	3	3
CO2	3	3	2	2	2	3	3	3	3	2	2	3
CO3	2	2	3	3	2	3	3	2	3	3	2	3
CO4	3	2	2	3	2	3	2	3	3	3	3	3
Total	11	10	10	11	9	12	10	11	12	11	10	12
Average	2.7	2.5	2.5	2.7	2.2	3	2.5	2.7	3	2.7	2.5	3

ACH-3.4 (A) (Environmental Chemical Analysis and Control)

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Course Outcomes (COs)

CO1: Students will acquire knowledge about sampling, criteria of good sampling, handling, preservation and storage of the samples, pretreatment and post treatment of samples.

CO2: Students will acquire knowledge of conditions and strategies required during sampling and electrochemical and spectral methods for analysis of environmental samples.

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.

CO4: Students will be acquainted with organic pollutants and their analysis with special reference to pesticide analysis.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ / COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	3	2	3	3	3	3	3
CO2	3	3	2	2	2	3	2	3	3	2	3	3
CO3	3	3	3	3	2	3	2	2	3	2	3	3
CO4	3	2	2	3	2	3	2	3	3	3	3	3
Total	12	11	10	11	9	12	8	11	12	10	9	9
Average	3	2.7	2.5	2.7	2.2	3	2	2.7	3	2.5	3	3

ACH-3.4 (B) (Recent Advances in Analytical Chemistry)

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Course Outcomes (COs)

CO1: Students will be acquainted with ultra purity and ultra trace analysis required in electronic and semiconductor processing.

CO2: Students will learn Radio-Analytical techniques for analysis.

CO3: Student will be well versed with C13, P15 and O17 NMR Spectroscopy applications.

CO4: Student will learn about ESR spectrometry and its applications quantitative analysis.

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COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ / COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6

CO1	3	3	3	3	3	3	2	3	3	3	3	3
CO2	3	3	2	2	2	3	2	3	3	2	3	3
CO3	3	3	3	3	2	3	2	2	3	2	3	3
CO4	3	2	2	3	2	3	2	3	3	3	3	3
Total	12	11	10	11	9	12	8	11	12	10	12	12
Average	3	2.7	2.5	2.7	2.2	3	2	2.7	3	2.5	3	3

PRACTICAL COURSES

Experimentation/practical training is provided in such way that the students will learn to plan, design, execute and analyze the particular laboratory work independently. Furthermore, the practical course is correlated to the theory courses so that the learners can have better understanding of the theoretical concepts through practical approach. The training provided through variety of experiments, computational tools like electronic structure calculations, molecular mechanics and molecular dynamic simulations will make students self-sufficient to work independently at national or international laboratories on their chosen topics or to work in high standard R&D sectors.

Practical ACHP – V

Course Outcomes (COs)

CO1: In-depth training on laboratory solution preparations on all concentration scales

CO2: Training on laboratory safety and lab ethics in scientific work

CO3: Training on planning, design and execution of experiments

CO4: Training on uncertainty estimations for experimentally measured and derived properties of solutions

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

Pos→ Cos ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	3	3	2	3	1	3	3	2
CO2	1	1	2	0	3	2	3	3	1	2	1	1
CO3	2	3	3	3	3	3	3	3	3	3	3	3
CO4	2	3	3	3	3	3	3	3	3	3	3	3
Total	10	13	13	11	15	13	14	15	11	13	13	12
Average	2	2.6	2.6	2.2	3	2.6	2.8	3	2.2	2.6	2.6	2.4

Practical ACHP – VI

Course Outcomes (COs)

CO1: Training on scientific literature search, defining the objective of the work, research skills, data representation in tabular and graphical form etc.

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.

CO3: Developing analytical skills

CO4: Training on qualitative and quantitative analysis of analyte

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2	2	2	2	3	2	2	2	2
CO2	3	3	3	3	3	3	3	3	2	3	3	2
CO3	2	3	2	3	3	3	2	3	2	3	2	3
CO4	3	3	3	2	3	1	3	3	3	2	2	3
Total	10	10	10	11	11	9	10	12	9	10	9	10
Average	2.5	2.5	2.5	2.7	2.7	2.2	2.5	3	2.2	2.5	2.2	2.5

Semester – IV

Courses:

ACH-4.1 (Modern Separation Method in Analysis)

ACH-4.2 (Organic Industrial Analysis)

ACH-4.3 (Advanced Methods in Chemical Analysis)

ACH-4.4 (A) (Industrial Analytical Chemistry)

ACH-4.4 (B) (Quality Assurance and Accreditation)

ACH-VII (Practical Course – VII)

ACH-VIII (Practical Course – VIII)

ACH-4.1 (Modern Separation Method in Analysis)

Course Outcome (COs)

CO1: Students will learn about modern separation and chromatographic used for analysis of different type of samples.

CO2: The student will understand instrumentation and mechanism of various separation techniques.

CO3: Student will acquire knowledge regarding various choice of instrument and detectors to be used for analysis depending on the sample and matrix.

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.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	3	3	3	3	3	3	2
CO2	3	3	2	2	3	3	3	2	3	3	1	2
CO3	3	3	2	1	3	3	3	1	3	3	1	2
CO4	3	2	2	2	3	3	3	2	3	3	3	2

Total	12	11	9	8	12	12	12	8	12	12	8	8
Average	3	2.7	2.2	2	3	3	3	2	3	3	2	2

ACH-4.2 (Organic Industrial Analysis)

COs

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.

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.

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.

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.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	3	2	3	3	3	3	2
CO2	3	3	3	2	3	3	2	2	3	2	2	2
CO3	3	3	3	3	3	3	3	1	3	3	1	2
CO4	3	2	2	3	3	3	3	2	3	2	3	2
Total	12	11	11	11	12	12	10	8	9	10	9	8
Average	3	2.7	2.7	2.7	3	3	2.5	2	2.2	2.5	2.2	2

PCH- 4.3 (Advanced Methods in Chemical Analysis)

COs

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.
CO2: Students will gain knowledge of the kinetic methods of analysis supporting the analysis and data procured in research.
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.
CO4: Students will acquire knowledge of identifying types of plastic and will also be able to and determination of metallic impurities in plastics

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ / COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	3	2	3	3	3	3	2
CO2	3	3	3	2	3	3	2	2	3	2	2	2
CO3	3	3	3	3	3	3	3	1	3	3	1	2
CO4	3	2	2	3	3	3	3	2	3	2	3	2
Total	12	11	11	11	12	12	10	8	12	10	9	8
Average	3	2.7	2.7	2.7	3	3	2.5	2	3	2.5	2.2	2

ACH-4.4 (A) (Industrial Analytical Chemistry)

COs

CO1: The students will acquire knowledge of analysis of metals, alloys, minerals and ores commonly used in the industry.
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.
CO3: Students will also gain the knowledge of analysis of commercial materials, explosives, polymers, resins, rubber, luminescent paints, lubricants and adhesives.
CO4: These would offer opportunity to the students to get employment in industries for quality assurance and quality control (QA-QC) of the product.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ / COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	2	3	3	3	3	3	3	2	3
CO2	3	3	3	3	3	2	2	3	3	3	3	3
CO3	3	3	2	2	3	3	3	2	3	3	1	3
CO4	3	3	2	2	3	3	1	2	3	2	3	1

Total	12	12	9	9	12	11	9	10	12	11	9	10
Average	3	3	2.2	2.2	3	2.7	2.2	2.5	3	2.7	2.2	2.5

ACH-4.4 (B) (Quality Assurance and Accreditation)

Cos

CO1: Students will acquire knowledge of QA-QC which in 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.

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.

CO3: 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.

CO4: Students will gain knowledge about the quality assurance and accreditation, evolution and significance of quality management, available accreditation agencies and advantages of accreditation.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	2	2	3	3	3	3	3	3	2	3
CO2	3	3	2	2	3	3	3	2	3	2	1	3
CO3	3	3	2	2	3	3	3	2	3	3	1	3
CO4	3	3	2	2	3	3	1	2	3	2	3	1
Total	12	12	8	8	12	12	10	9	12	10	7	10
Average	3	3	2	2	3	3	2.5	2.2	3	2.5	1.7	2.5

Practical ACHP – VII

Course Outcomes (COs)

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 chemicals, MSDS sheets, learn sample preparation and characterization for confirming the purity.

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.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

POs→ COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	2	3	3	2	2	2	1
CO2	2	3	0	3	2	2	2	3	2	2	1	2
CO3	3	3	2	1	2	2	3	2	2	3	2	2
CO4	3	3	2	2	3	1	3	2	2	2	3	2
Total	11	12	7	9	10	7	11	10	10	9	8	7
Average	2.7	2.63	1.7	2.2	2.5	1.7	2.7	2.5	2.5	2.2	2	1.7

Practical PCHP – VIII

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Course Outcomes (COs)

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 chemicals, MSDS sheets, learn sample preparation and characterization for confirming the purity.

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.

COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)

Pos→ Cos ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	3	2	3	3	3	3	3	3
CO2	2	2	1	2	3	1	2	1	2	1	1	2
CO3	3	3	1	3	2	3	2	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3
Total	11	10	8	11	11	9	10	10	11	10	10	11
Average	2.7	2.5	2.0	2.7	2.7	2.2	2.5	2.5	2.7	2.5	2.5	2.7

COPO Mapping Matrix for All Courses

Course ID	Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CH-1.1	Inorganic Chemistry – I	2.8	2.2	3	1.8	2	2.2	2.5	2.8	3	2	2.2	2.5
CH-1.2	Organic Chemistry – I	3	2.2	2.5	3	3	3	3	3	3	3	2	2.2
CH-1.3	Physical Chemistry – I	2.9	2.5	1	3	2.9	2.2	2.2	3	1.5	1.9	2.6	1.7
CH-1.4	Analytical Chemistry – I	3	2.2	2.5	3	3	3	3	3	3	3	2	2.2
PCP-1.1	Practical – I	2	3	3	2	3	3	2.5	2	2	3	3	3
PCH-1.2	Practical – II	2	2.6	2.6	1.8	2.8	2.6	2.4	2	2	2.8	2.6	2.6
CH-2.1	Inorganic Chemistry – II	3	2	3	3	3	3	--	--	2	2	3	3
CH-2.2	Organic Chemistry – II	3	2.2	2.2	3	3	3	3	3	3	2.7	1.7	2
CH-2.3	Physical Chemistry – II	2.7	2.7	1.2	2.9	2.6	1.9	2.6	3	2.2	1.5	2.5	2.2
CH-2.4	Analytical Chemistry – II	3	2.2	2.5	3	3	3	3	3	3	3	2	2.2
ACP-2.1	Practical – III	2	3	3	2	3	3	2.5	2.2	2.2	3	3	3
ACH-2.2	Practical – IV	2	2.6	2.6	2	2.8	2.8	2.4	2.2	2	2.8	2.6	2.6
ACH-3.1	Advanced Analytical Techniques	3	2.5	2.7	2.7	2.7	3	2.2	2.7	3	2.7	1.7	3
ACH-3.2	Organo Analytical Chemistry	3	2.5	2.5	2.7	2.5	3	2.5	2.7	3	2.7	2.2	3
ACH-3.3	Electroanalytical Techniques in Chemical Analysis	2.7	2.5	2.5	2.7	2.2	3	2.5	2.7	3	2.7	2.5	3
ACH-3.4 (A)	Environmental Chemical Analysis and	3	2.7	2.5	2.7	2.2	3	2	2.7	3	2.5	3	3

	Control												
ACH-3.4 (B)	Recent Advances in Analytical Chemistry	3	2.7	2.5	2.7	2.2	3	2	2.7	3	2.5	3	3
ACHP-V	Practical – V	2	2.6	2.6	2.2	3	2.6	2.8	3	2.2	2.6	2.6	2.4
ACHP-VI	Practical – VI	2.5	2.5	2.5	2.7	2.7	2.2	2.5	3	2.2	2.5	2.2	2.5
ACH-4.1	Modern Separation Method in Analysis	3	2.7	2.2	2	3	3	3	2	3	3	2	2
ACH-4.2	Organic Industrial Analysis	3	2.7	2.7	2.7	3	3	2.5	2	2.2	2.5	2.2	2
ACH-4.3	Advanced Methods in Chemical Analysis	3	2.7	2.7	2.7	3	3	2.5	2	3	2.5	2.2	2
ACH-4.4 (A)	Industrial Analytical Chemistry	3	3	2.2	2.2	3	2.7	2.2	2.5	3	2.7	2.2	2.5
ACH-4.4 (B)	Quality Assurance and Accreditation	3	3	2	2	3	3	2.5	2.2	3	2.5	1.7	2.5
ACHP-VII	Practical – VII	2.7	2.63	1.7	2.2	2.5	1.7	2.7	2.5	2.5	2.2	2	1.7
ACHP-VIII	Practical – VIII	2.7	2.5	2.0	2.7	2.7	2.2	2.5	2.5	2.7	2.5	2.5	2.7
	Total	71	66.63	62.4	65.4	71.8	71.1	63.5	64.4	67.7	66.8	61.2	64.5
	Average	2.7	2.6	2.4	2.5	2.8	2.7	2.4	2.5	2.6	2.5	2.3	2.5

Correlations between contribution of Each Course for fulfillment of POs and PSOs are defined using numbers: 0 – No correlation; 1 – Small Correlation; 2 – Large Correlation and 3 – Full Correlation