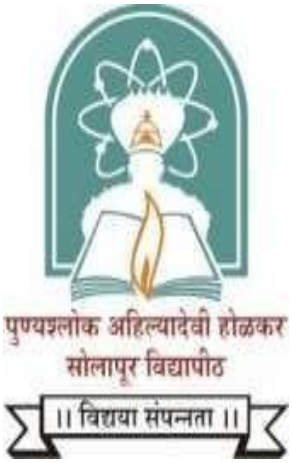
Punyashlok Ahilyadevi Holkar Solapur University, Solapur



NAAC Accredited-2022
'B^{++}'Grade (CGPA 2.96)

Name of the Faculty: Science &Technology

(As per New Education Policy 2020)

Syllabus: Analytical Chemistry

Name of the Course: M.Sc. II (Sem. III &IV)

(Syllabus to be implemented from June 2024)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Faculty of Science & Technology
NEP 2020 Compliant Curriculum

M. Sc. (Analytical Chemistry)
Program Preamble

The Master of Science (M. Sc.) in Analytical Chemistry is a comprehensive and dynamic program designed to provide students with a deep understanding of the fundamental principles of Quality Control and Quality Assurance, along with the advanced analytical and instrumental skills can lead to a fulfilling and challenging career in academia and research institutions in various scientific and technological contexts. Aligned with the vision of the National Education Policy (NEP) 2020, the program offers a flexible, multidisciplinary, and learner-centric curriculum that encourages critical thinking, innovation, holistic development as well as Entrepreneurship. The M. Sc. Analytical Chemistry program spans two years, with each year offering a progressively advanced curriculum designed to build a strong foundation in Analytical Chemistry while allowing for specialization and interdisciplinary learning. The curriculum is structured around several key components:

1. **Discipline Specific Core Courses:** These core courses form the backbone of the program, providing in-depth knowledge and understanding of essential Analytical Chemistry concepts, theories, and methodologies. Students will engage with topics from Advanced Separation Techniques, Instrumental Methods of Chemical Analysis-I, Analytical Spectroscopy etc. ensuring accurate identification, quantification and comprehensive education in the multidisciplinary approach.

2. **Discipline Specific Electives:** The program encourages intellectual exploration within the core discipline by offering a wide range of elective courses. These electives enable students to pursue their interests in diverse subjects, fostering creativity, critical thinking, and a well-rounded educational experience.

3. **Field Projects /Internships /Apprenticeships /On-Job Training:** To bridge the gap between theoretical knowledge and real-world applications, the program includes opportunities for internships, apprenticeships, and On-Job Training. These experiences provide students with practical insights, problem-solving abilities, and exposure to professional environments, enhancing their readiness for careers in industrial applications of Analytical Chemistry.

4. **Research Methodology and Research Projects:** Research is a critical component of the MSc Analytical Chemistry program, with students acquiring skills in research methodology, data collection, analysis, and scientific inquiry. By engaging in independent research projects, students

are encouraged to develop innovative solutions to complex scientific problems, preparing them for advanced studies and research-oriented careers. These research projects and methodologies drive innovation and advancements in analytical chemistry, addressing real-world challenges and useful to improve various industrial project.

Multiple Entry and Multiple Exit Options

In accordance with the NEP 2020, the M. Sc. Analytical Chemistry program incorporates a Multiple Entry and Multiple Exit framework, offering students the flexibility to enter or exit the program at various stages. This approach ensures that students can tailor their educational journey according to their personal and professional goals, with options to earn certificates, diplomas, or degrees based on the duration of study completed.

- **Year-I**
  Upon completion of the first year, students may exit with a **PG Certificate in Analytical Chemistry**

- **Year-II**
  Upon Completion of the two-year, student may exit with a **M. Sc. Degree in Analytical Chemistry**.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Faculty of Science & Technology
NEP 2020 Compliant Curriculum

M. Sc. (Analytical Chemistry)

Program Outcomes (POs)

Students Post graduating from the Master of Science in Analytical Chemistry program will be able to:

Discipline Specific Core Courses:

- **PO1**: Demonstrate in-depth knowledge and understanding of core concepts, theories, and methodologies in the chosen major discipline.
- **PO2**: Learn about excellence of analytical chemistry, lab safety, preparation of solutions numerically, handling the different types of instruments

Discipline Specific Electives:

- **PO3**: Explore diverse subjects beyond the core discipline, fostering a broad-based education and cultivating critical thinking and creativity.

Field Projects/Internship/Apprenticeship/ On Job Training/ Internship/Apprenticeship:

- **PO4**: Apply theoretical knowledge to real-world situations through field projects, internships, community engagement and On Job Training for gaining practical experience and problem-solving skills.

Research Methodology and Research Project:

- **PO5**: Acquire research skills, including data collection, analysis, and interpretation, fostering a scientific approach to problem-solving to develop independent research projects handling capabilities.
- **PO6:** Design and conduct experiments and demos to analyze and interpret data.

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।। विद्यया संपन्नता ।।
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Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Faculty of Science & Technology
NEP 2020 Compliant Curriculum
M. Sc. (Analytical Chemistry)
Program Specific Outcomes (PSOs)

Students post graduating from the Master of Science in Analytical Chemistry will able to:

- **PSO 1:** Analytical or experimental skills make the students capable of doing higher-level research work in the emerging fields of Chemistry.
- **PSO 2:** The students get thorough training to analyze various samples.
- **PSO 3:** Students will gain a thorough Knowledge of the subject to work on projects at different research and academic institutions.
- **PSO 4:** Entrepreneurial skills shall improve ability of students to start their own chemical industries.
- **PSO 5:** Positive approach towards environment and ecology from the chemistry perspective.

M. Sc. II Analytical Chemistry Syllabus (w.e.f. academic year 2024-25)

Credit Frameworks for M.Sc.-II Programs (As per NEP-2020)

Semester	Paper code	Title of the paper	Semester Examination			L	T	P	Credit
			UA	CA	Total				
III		**Mandatory**							
	DSC-5 2304301	Advanced Separation Techniques	60	40	100	4			4
	DSC-6 2304302	Instrumental Methods of Chemical Analysis-I	60	40	100	4			4
		Elective (Any one)							
	DSE-3 2304306 2304307	A) Analytical Spectroscopy B) Applied Analytical Chemistry	60	40	100	4			4
	RP-1 2304303	Research Project-1	60	40	100			4	4
		Practical (Mandatory)							
	DSC-5 P 2304304	Analytical Chemistry Practical-1	30	20	50			4	2
	DSC-6 P 2304305	Analytical Chemistry Practical-2	30	20	50			4	2
		Practical (Elective-Any one)							
	DSE-3 P 2304308 2304309	A) Analytical Chemistry Practical-3 B) Analytical Chemistry Practical-4	30	20	50			4	2
		Total for semester III	**330**	**220**	**550**	**--**	**--**	**---**	**22**
IV		**Mandatory**							
	DSC-7 2304401	Advanced Analytical Techniques	60	40	100	4			4
	DSC-8 2304402	Instrumental Methods of Chemical Analysis-II	60	40	100	4			4
		Elective (Any one)							
	DSE-4 2304405 2304406 2304407	A) Biochemical & Food Analysis B) Pharmaceutical Analysis C) Environmental Chemical Analysis	60	40	100	4			4
	RP-2 2304403	Research Project-2	90	60	150			6	6
		Practical (Mandatory)							
	DSC-7 P 2304404	Analytical Chemistry Practical-5	30	20	50			4	2

		Practical (Elective-Any one)							
	DSE-4 P 2304408 2304409	A) Analytical Chemistry Practical-6 B) Analytical Chemistry Practical-7	30	20	50			4	2
		Total for semester IV	**330**	**220**	**550**	**--**	**--**	**---**	**22**
Total for M.Sc.-II			**660**	**440**	**1100**	**--**	**--**	**---**	**44**

L = Lecture, T = Tutorials, P = Practical, RP- Research Project

DSC- Discipline Specific Course, DSE- Discipline Specific Elective Course

4 Credits of Theory = 4 Hours of teaching per week

2 Credit of Practical = 4 hours per week

Semester – III

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Second Year M.Sc. (Analytical Chemistry) Sem-III** **Vertical: DSC** **Course Code: DSC 5** **Course Name: Advanced Separation Techniques**
***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: This course named Advanced Separation Techniques provides an in-depth understanding of the fundamental concepts of chromatography technique including detail study of High Performance Liquid Chromatography, Electrophoresis, Membrane-Based Methods, Dialysis and Electro-dialysis. Students will study these subtopics in detail by combining theoretical knowledge with instrumentation. Goal of Course is to develop theoretical and practical skills in Chromatographic concepts like separation, Identification, Quantification and Purification.

	Course Objectives:
●	To acquire skill with advanced chromatographic techniques.
●	To acquire knowledge about solvent extraction processes and role of equilibrium for solvation.
●	To Learn dialysis and filtration methods and applications.

●	To analyze and interpret data from separation techniques.
	Course Outcomes:
CO1:	Students able understand principle of HPLC, Instrument Operation, Method Development, Column Selection, Sample Preparation, Data analysis etc.
CO2:	Students aware about Principle, theory, instrumentation, sample preparation and applications of Electrophoresis.
CO3:	Students getting knowledge about processes of filtration, Ultrafiltration, extraction, and distillation for the purification of compounds.
CO4:	Students Gain knowledge removal of toxic metals from water resources by Chelation Method.
Unit 1:	**High Performance Liquid Chromatography: [15] Weightage: 20M**
	Definition, theory and principle, techniques, one, two dimensional and circular paper chromatography, mechanism of separation, structure of cellulose and types of paper, methodology-separation of sample, choice of solvents, location of spots and measurement of Rf value, factors affecting Rf value, advantages and applications. Affinity Chromatography: Introduction, theory stationary phase, preparation of column, separation of antigens. Exclusion Chromatography: Theory and principle of size exclusion chromatography, experimental techniques for gel filtration chromatography (GFC) and gel-permeation chromatography (GPC), materials for packing-factors governing column efficiency, methodology and applications.
Unit 2:	**Electrophoresis: [15] Weightage: 20M**
	Theory and classification, factors affecting mobility, macromolecular size and charge interactions with supporting electrolyte, pH and concentration discontinuities, Factors affecting electrophoresis phenomena-electrolysis, electroosmosis, temperature and supporting media. Instrumentation, methodology, Preparation of gel staining and destaining, preparative zone electrophoresis, continuous electrophoresis and Applications. Capillary Electrophoresis: Principle, theory, instrumentation, sample preparation and applications, Capillary electrochromatography and Micellar electrokinetic capillary chromatography
Unit 3:	**Membrane-Based Methods: [15] Weightage: 20M**
	Dialysis-Working of techniques, membranes, general consideration of diffusion, Donnan Membrane equilibrium and Applications. Electrodialysis: working of techniques, membranes, Electrodialysis cells and Applications. Ultrafiltration: working of techniques, membranes, non-gelatinous membranes and Applications. Dialysis compared with other membrane-separation methods. Other Separation Methods: Ultracentrifugation-Principle, sedimentation constant, sedimentation equilibrium, sedimentation velocity, methodology and applications. Zone refining: Principle, zone

	leveling and applications.
Unit 4:	**Solvent Extraction: [15]** **Weightage: 20M**
	Basic principles, classification of solvent exaction systems, Factors affecting extraction process, Mechanism of extraction, extraction by chelation extraction by solvation, extraction equilibria for chelates, extraction equilibria for solvation, techniques of extraction, separation of metals by extraction, extraction by ion-pair formation, application of solvent extraction in industry, solid-phase extraction (SPE) and uses.
	Reference books:
	1) Solvent Extraction in Analytical Chemistry. By G H Morrison and H Freiser (John Wiley New York,1958) 2) Solvent Extraction of metals by A K D, S M Khopkar and R A Chalmers. (Van Nostrand Reinhold, London, 1970) 3) A Textbook of Inorganic Qualitative Analysis. By A I Vogel. 4) Chromatography. By E Heftman, 5th edition, part-A and part-B, Elsewhere Science Publisher, 1992. 5) Chromatography Today. By C F Poole and S K Poole, Elsewhere Science Publisher, 1991. 6) Electrophoresis- Analytical Chemistry. Open Learning by M Melvin John Wiley andSons.1987. 7) Analytical Chemistry. By G D Christian 4th edition, John Wiley and Sons, 1986. 8) Instrumental Methods of Analysis, by B K Sharma, 19thedition, Goel Publisher, 2000. 9) Basic Concept in Analytical chemistry, by S. M. Khopkar.

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Second Year M.Sc. (Analytical Chemistry) Sem-III** **Vertical: DSC** **Course Code: DSC-6** **Course Name: Instrumental Methods of Chemical Analysis-I**
***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Instrumental Methods of Chemical Analysis-I is one of the core courses in the Analytical Chemistry curriculum. This course provides an in-depth understanding of the fundamental concepts in Thermal Methods of Analysis, Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Radio Analytical Techniques, Electro Analytical Techniques, High frequency titration like Amperometry titration and Electro-gravimetric titration. Students will study these subtopics in detail. By combining theoretical knowledge with Instrumentation, Methodology, the course aims to develop skills in analysis of sample using different instrumental techniques.

	Course Objectives:
•	To understand the thermal techniques like TGA, DTA and DSC
•	To Explain instrumentations of Cyclic Voltammeter, coulometer, Amperometer.
•	To Define / understand various terms involved practical methods of quantitative analysis.
•	To Design / modify and validate new analytical method for chemical analysis of particular sample.
	Course Outcomes:
CO1:	Students learn thoroughly thermal techniques like TGA, DTA and DSC to analyze samples.
CO2:	Explain instrumentations of Cyclic Voltammeter, coulometer, Amperometer.
CO3:	Confronted with instrumental titrations like Amperometry titration Electrogravimetric titration.
CO4:	Capable to Design / modify and validate new analytical method for chemical analysis of particular sample.
Unit 1:	**Thermal Methods of Analysis** **[15]** **Weightage: 20M**
	Thermal Methods of Analysis: Introduction, thermogravimetric analysis (TGA), types

	of thermogravimetric analysis, principle, factors affecting the results-heating rate, furnace, and instrument control/data. Application-purity and thermal stability, evaluation of correct drying temperature, analysis of complex mixture and determination and kinetic parameters of thermal degradation. Differential Thermal Analysis (DTA): Theory, variables affecting the DTA curves, Difference between TGA and DTA. General principle, instrumentation, applications. Analysis of physical mixtures and thermal behaviors study. Determination of melting point, boiling point and decomposition point. Differential Scanning Calorimetry (DSC): Basic principle, Difference between DTA and DSC. Instrumentation-Power compressed DSC, Heat flux DSC. Applications- Studies of thermal transition and isothermal crystallization. Thermometric titrations.
Unit 2:	**Radio Analytical Techniques [15]** **Weightage: 20M**
	Determination of nuclear radiation and counting devices. Radioactivity tracers-Principal and applications. Isotopic Analysis- direct and inverse. Special analytical application-radiometric titrations. Neutron activation analysis: principle, instrumentation, applications and limitations. Radio chromatography and Radioimmunoassay: principle, instrumentation, applications and limitations. **Radiometric titration:** Principle, types, instrumentation and applications
Unit 3:	**Electro Analytical Techniques [15]** **Weightage: 20M**
	Ion Selective Electrodes: Terminology, types and construction of selective electrodes glass electrode, solid state and precipitate electrodes, liquid-liquid membrane electrode, Enzyme and glass-sensing electrodes. Voltammetry and Stripping voltammetry: Principle, instrumentation and applications. Cyclic Voltammetry. Electrogravimetric analysis: Theory, apparatus, cell process, deposition and separation, electrolytic separation of metals and applications. Coulometric Methods: Introduction, Principle, Coulometric techniques, potentiostatic couloumetry, Coulometric titrations, Coulometric determination, Advantages, Instrumentation for coulometric titration and applications.
Unit 4:	**High frequency titration [15]** **Weightage: 20M**
	Principle, instrumentation, advantages and disadvantages of high frequency method. Applications acid-base, complxometric measurement dielectric constant and analysis of mixture. Amperometry titration: Principles of Amperometric titrations, instrumentation, titration procedure, advantages and disadvantages Electrogravimetric titration: Principle & theory, methods of electrogravimetric analysis, instrumentation, advantages and disadvantages
	Reference books:

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***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

	1. Thermal methods of Analysis by W W Wendlandt. 2. Radioactivity applied to chemistry. By Arthur C Wahs and R J Words 3. An introduction to radiation chemistry. By J W T Spinks and R J Words. 4. Fundamentals of analytical chemistry. By D A Skoog, D M West, Holler and Crowh. 5th edition. Sounders College publishing New York. 5. Analytical Chemistry. By G D Christian 5th edition 2005.John Wiley and Sons Inc.India. 6. Vogel's Textbook of Quantitative Chemical Analysis. By J Mendham R C, Denney J D, Barnes and MJK Thomas.6th edition. Third Indian Reprint 2003. Pearson Education. Pvt. Ltd. New Delhi. 7. Radioisotopes Techniques MGH by Overman and Clark 8. Radio-bioassay by Faund S. Ashkar, Volume-I page 1-35 and 53 to 65 CRC press, Inc. Boca Ratin, Florida. 9. Basic Concept in Analytical chemistry, by S. M. Khopkar. 10. Instrumental methods of chemical analysis, by H. Kaur (Pragati Prakashan).

Course Preamble: A) Analytical Spectroscopy is one of the core courses in the Analytical Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in UV-Visible and IR spectroscopy, Chromatography, Analytical Techniques, Thermal Analysis. Students will study these subtopics in detail. By combining theoretical knowledge with numerical treatment, the course aims to develop practical skills in analyzing and optimizing the Analytical instruments.

	Course Objectives:
•	To Define / understand various terms and principles in Raman spectroscopy, Mossbauer spectroscopy, Photoelectron spectroscopy, Electron Spin Resonance spectroscopy etc.
•	To understand theoretical and practical aspects of the instruments

•	To Solve numerical problems on analysis all these spectroscopic methods.
•	To interpret various spectrochemical parameters.
	Course Outcomes:
CO1:	Students understand various terms and principles in Raman spectroscopy, Mossbauer spectroscopy, Photoelectron spectroscopy, Electron Spin Resonance spectroscopy etc.
CO2:	Proficient to solve numerical problems on analysis of all these spectroscopic methods.
CO3:	The students can able to interpret various spectrums of Raman spectroscopy, Mossbauer spectroscopy, Photoelectron spectroscopy, Electron Spin Resonance spectroscopy.
CO4:	Interpret ESR spectra, super hyperfine splitting and g value in ESR, and parameters affecting.
Unit 1:	**Raman spectroscopy [15] Weightage: 20M**
	Introduction, principle, quantum mechanical theory of Raman effect, classical theories of Raman effect, rotational Raman spectra, vibrational Raman spectra, Vibrational-rotational spectra, Instrumentation, Applications of Raman Spectroscopy. Resonance Raman Spectroscopy: Introduction, technique, difference between normal and resonance Raman spectrum, Resonance Raman effect, Applications of resonance Raman spectroscopy.
Unit 2:	**Mossbauer spectroscopy [15] Weightage: 20M**
	Theory, isomer shift and quadrupole interaction, spectra of iron and tin compounds. Mossbauer spectrophotometer, applications. [Fe3(CO)12, Prussian blue, oxyhemerythrin, tin halides, hexacyano ferrates, nitroprussides] Nuclear Quadrupole Resonance Spectroscopy- Introduction, effect of magnetic field on the spectra, relation between electric field gradient and structure applications of NQR.
Unit 3:	**Photoelectron Spectroscopy [15] Weightage: 20M**
	Basic, principle of ESCA instrumentation, scope and limitations of ESCA. Ultraviolet photoelectron spectroscopy, Comparison between ESCA and UPS spectroscopy. Photo acoustic spectroscopy-Basic principles of photo acoustic spectroscopy (PAS), PAS gases and condensed system, chemical and surface applications.
Unit 4:	**Electron Spin Resonance Spectroscopy [15] Weightage: 20M**
	Electron behavior, ESR spectrometer, spectra, hyperfine interaction, free radical and interpretation of the spectra. Applications in quantitative analysis. Numerical

	problems. Electron Microscopy-classification of electron microscopy methods, scanning electron microscopy, working of SEM instrument, comparison of probe microscopy (SPM or STM). Scanning tunnelling microscopy (STM)-basic principles, atomic force microscopy (AFM), application AFM, comparison of electron microscopy with electron spectroscopy.
	Reference books:
	1. Fundamentals of Molecular Spectroscopy. By C N Banwell. 2. Electron Spin Resonance. By Assculiein. 3. Molecular Spectroscopy. By G M Barrow 4. Molecular Spectroscopy. By I N Levine. Wiley Inter-science. 5. Basic Concept in Analytical chemistry, by S. M. Khopkar. 6. Spectroscopy (Atomic and Molecular) by G R Chatwal and S K Anand 7. Instrumental methods of chemical analysis by H. Kaur 8. Organic Spectroscopy by Donald L. Pavia, 5th Edition.

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***Teaching Scheme** **Project work: 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: B) Applied Analytical Chemistry is one of the core courses in the Analytical Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in Soil Analysis, Agricultural Analysis-II, Analysis of Minerals, Ores and Alloys, Cosmetics Analysis . Students will study these subtopics in detail. By combining theoretical knowledge with numerical treatment, the course aims to develop practical skills in analyzing various samples.

	Course Objectives:
•	To learn about analysis of agricultural feeds, soil as well as fertilizers and pesticides.
•	To know about key role of chemistry in analysis of mineral, ore and alloy.
•	To know about composition of insecticides and pesticides.
•	To get knowledge about cosmetics composition and methods of analysis.
	Course Outcomes:
CO1:	Learn about analysis of agricultural feeds, soil as well as fertilizers and pesticides.
CO2:	Students confronted with key role of chemistry in analysis of mineral, ore and alloy.
	Students confronted with key role of chemistry in analysis of mineral, ore and alloy as well as cosmetic product analysis
CO3:	To understand composition of insecticides and pesticides and its application and diverse effect on environment.
CO4:	Getting thorough knowledge about cosmetics composition and methods of analysis.
Unit 1:	**Soil Analysis [15]** **Weightage: 20M**
	Soil Analysis: Soil sampling, field description of soils, physical analysis, determination of major and minor constituents, exchange capacity, soil reaction (pH), chemical analysis as a measure of soil fertility. Stock feeds analysis: Feeding stuffs, qualitative analysis and quantitative analysis. Plant analysis Preparation of sample, moisture determination- methods of ashing, methods of plant analysis- starch, sugars, determination of mineral constituents (Fe, Mn, Mo, Si, Ca, Mg, P, S, C and N).
Unit 2:	**Agricultural Analysis-II [15]** **Weightage: 20M**
	Analysis of Fertilizers: Sampling, sample preparation. Analysis of nitrogen, phosphorus and potassium. Nitrogen: urea nitrogen, Kjeldahl nitrogen method, Ammonia nitrogen, Phosphorus: total phosphorus. Alkalimetric ammonium molybdophosphate method, Potassium: potassium by sodium tetraphenyl borate method. Pesticides and insecticides analysis: Introduction, classification, analysis of DDT, gammexane, zinab, ziram, thiram, thiometon, and chlordane.
Unit 3:	**Analysis of Minerals, Ores and Alloys [15]** **Weightage: 20M**
	Minerals and ores: Hematite, pyrolusite, gypsum, dolomite, bauxite, and illmenite ores. Metal and alloys analysis: Steel, Cu-Ni alloy, solder, bronze, brass, aluminum alloy, Chrome alloy.

Unit 4:	**Cosmetics Analysis** **[15]** **Weightage: 20M**
	Composition of creams and lotions, determination of water, propylene glycol, non-volatile matter and ash content. Determination of borate, sulphate, phosphate, chlorides, titanium and zinc oxide. Analysis of face powder Estimation of boric acid, magnesium, calcium, zinc, iron, aluminum and Barium Analysis of Deodorants and antiperspirants Composition, analysis of fats and fatty acids, boric acid, Mg, Ca, Zn, Fe, Ti, Al, Phenol, Hexachlorophene, Methenamine, sulphonate and urea.
	Reference books:
	1. Agricultural Analysis. By Kanwar. 2. Soil Analysis. By Jackson. 3. Encyclopedia of industrial chemical analysis. By F D Snell (ed. By-Hilton C L, Ettre L S) 4. Quantitative Inorganic Analysis. By A I Vogel. 5. Standard Methods of Chemical Analysis. By F J Welcher. 6. Instrumental methods of chemical analysis by Chatwal and Anand. 7. Instrumental methods of chemical analysis by Merit, Dean, Settle 8. Analytical Instrumentation, Handbook, Marcel Dekker Inc. (1987) by Garen U. Ewing, 9. Principle and practice of Analytical chemistry by F. U. Fifield and D. Kealey 3rd edition, Blackie and sons Ltd. 10. Cosmetics (Poucher's Perfumes, Cosmetics and Soaps), by Walter A. Poucher (Author), H. Butler 11. Instrumental methods of chemical analysis H. Kaur

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***Teaching Scheme** **Project work: 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Research is a critical constituent of the M.Sc. Analytical Chemistry program, with students acquiring skills in research methodology, data collection, analysis, and scientific review. By engaging in independent research projects, students are encouraged to develop innovative solutions to complex scientific problems, preparing them for advanced studies and research-oriented careers.

	Course Objectives:
●	To know the basic idea behind the research.
●	To understand the terms for research project like introduction, background and significance, literature and review, research designs and methods, results and discussion, and conclusion etc.
●	To know the data collection and analysis/interpretation of data
●	To know the project report writing and submission.
	Course Outcomes: Students can able to understand -
CO1:	Basic idea behind the research.
CO2:	Terms for research project like introduction, background and significance, literature search and review, research designs and methods, results and discussion, and conclusion etc.
CO3:	Knowledge of data collection and analysis/interpretation of data
CO4:	Project report writing and submission.
	Candidates are expected to work on assigned research project and submit the results at the end of the semester in the form a dissertation. Open defense of the student on his/her dissertation shall be arranged. This defense shall be in front of the panel of examiners. This will be valued for 40 marks. Project work involving organic synthesis/evaluation of biological studies or in-plant training in any of the pharmaceutical or chemical industry for at least 21 days will be considered. Project should be completed under the guidance of a faculty member in the same Department or Industry or research organization. In case of Industry / research organization one member of that body can also be included as project guide.

	Guidelines for Assessment • Quality of Literature survey and Novelty in the problem • Clarity of Problem definition and Feasibility of problem solution • Clarity of objective and scope • Quality of work attempted • Presentation skills

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***Teaching Scheme** **Practical: 04 Hours/week, 02 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

Course Preamble: Analytical Chemistry Practical-1is one of the core courses in the Analytical Chemistry curriculum and one of the traditional courses and now bridged to advanced instrumental techniques. This course provides an in-depth understanding and interpretation of data from spectrophotometer, flame photometer, potentiometer, conductivity meter, colorimeter etc. Students will study these subtopics in detail. Experiments designed in such a way to create awareness and sense of responsibilities towards environment and apply knowledge to solve the issues related to Environmental pollution.

	Course Objectives:
•	To provide laboratory experience to the students by performing experiments based on topics taught in theory
•	Apply various aspects of analytical chemistry to develop interdisciplinary approach
	Course Outcomes:

CO1:	Students getting skill to handle instruments like flame photometry, Conductivity meter, Refractometer, Potentiometer and pH meter.
CO2:	Able to determine dissociation constant, relative strength of acids, concentrations using suitable instrument.
	List of Practicals
1.	Analysis of plane Paracetamol Tablet by UV-spectroscopy According to British Pharmacopeia.
2.	Determination NaCl Content in Saline by Flame Photometry.
3.	Estimation of Riboflavin by Spectrophotometry and Photofluorometry and Comparison of two Methods.
4.	Determination of dissociation constant of weak acid pH-metrically.
5.	Determination of relative strength of acetic acid, chloroacetic acid and trichloroacetic acid through measuring their Ka-value by conductivity measurement method.
6.	Determination of strength of acetic acid from the commercial vinegar sample by potentiometric titration and its confirmation by conductometric / pH-metric titration using standard solution of NaOH.
7.	Determination of concentration of sulphuric acid, acetic acid and copper sulphate from their mixture by conductometric titration with std. NaOH.
8.	Determination of the pKa value of chloroacetic acid and trichloro acetic acid by potentiometry / pH metry using standard solution of NaOH.
9.	Simultaneous estimation of Cl- and I- by potentiometrically.
10.	Determination of an indicator constant and isosbestic point of an azo dye spectrophotophometrically.
11.	Determination of dissociation constant of Cu-ammonia complex potentiometrically.
12.	Estimation of Na and K / Ca and K from the binary mixture by internal standard method using lithium as internal standard on flame photometry.
13.	To determine the amount of each para nitro-phenol and meta nitro-phenol from the given mixture by spectrophotometric titration using standard solution of NaOH (λmax280nm)
14.	Estimation of calcium in the sample of dairy whitener by flamephotometry.
15.	Estimation of sodium in the sample of dairy whitener by flamephotometry.
	References:
	1. A Textbook of Practical Organic Chemistry - A. I. Vogel. 2. Practical Organic Chemistry - Mann & Saunders. 3. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke. 4. Organic Synthesis Collective Volumes by Blat. 5. Laboratory Handbook of Instrumental Drug Analysis by B.G. Nagavi. 6. Spctrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004. 7. Organic Spectroscopy - William Kemp, 3 rd edition, ELBS, 1991.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Analytical Chemistry) Sem-III** **Course Code: DSC-6 P** **Course Name: Analytical Chemistry Practical-2**
***Teaching Scheme** **Lectures: 04 Hours/week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble: Analytical Chemistry Practical-1 is one of the core courses in the Analytical Chemistry curriculum and one of the traditional courses and now bridged to advanced instrumental techniques. This course provides an in-depth understanding and interpretation of data from spectrophotometer, flame photometer, potentiometer, conductivity meter, colorimeter etc. Students will study these subtopics in detail. Experiments designed in such a way to create awareness and sense of responsibilities towards environment and apply knowledge to solve the issues related to Environmental pollution.

	Course Objectives:
•	Create awareness and sense of responsibilities towards environment and apply knowledge to solve the issues related to Environmental pollution.
•	To impart knowledge of Analytical Chemistry covering all the aspects viz. , Advanced analytical Chemistry, spectroscopy, chromatography, Thermal and electroanalytical methods, Extraction methods, laboratory automation, Analysis of food, polymer and soil.
	Course Outcomes:
CO1:	Learn various techniques to estimate and determinate biological component from food and beverages.
CO2:	Apply knowledge to build up small scale industry to solve the issues related to Environmental pollution.
	List of Practicals
1.	Analysis Aspirin: Assay
2.	Analysis of Malathion by colorimetry.
3.	Table work: Statistical Treatment to Results and Regression Analysis of Calibration Curve.
4.	Analysis of waste water with respect to (a) alkalinity (b) T.D.S. (c) Sulphate(d) Dissolved chlorine.
5.	Estimate the amount of calcium from plaster of paris.
6.	Estimation of potassium from given fertilizer by volumetry / Flame photometry.
7.	Isolation of casein from milk.
8.	Estimation of sulphur from the given organic compound by Messenger test.

9.	Preparation of p- Iodo nitrobenzene by Sandmeyer reaction.
10.	Preparation of p- nitroaniline from acetanilide
11.	Analysis Aspirin: Limit Test
12.	Chemical analysis of chilli-powder.
13.	Preparation of p- chloro nitrobenzene by Sandmeyer reaction.
14.	Preparation of sulphanilic acid.
15.	Preparation of p-amino benzoic acid.
16.	Assay of sulpha drugs.
17.	Analysis of borax by conductometry.
18.	Analysis of feldspar ore.
19.	Determination of moisture content in food sample by Karl Fisher reagents.
20.	Estimation of COD from wastewater.
	References:
	1) Vogel's textbook of Quantitative Inorganic analysis 2) A.J.E. Welch, Inorganic Preparations, George Allen and Unwin Ltd. 3) W.G. Palmer, Experimental Inorganic Chemistry, Cambridge Press, 1965. 4) M.A. Malati Experimental Inorganic / Physical Chemistry, Harvard Publishing Chichester. 5) A text book of Practical Organic Chemistry – A. I. Vogel 6) Practical Chemistry – Mann and Saunders. 7) A Handbook of quantitative and qualitative analysis – H. T. Clarke. 8) Organic Synthesis collective volumes – Gillman and Batt. 9) Laboratory experiments in Organic chemistry-Arun Sethi 10) Findlay's Practical Physical Chemistry – Revised by J.A. Kitchner (V Edition) 11) Experimental Physical Chemistry – F. Daniels and J. Williams 12) Experimental Physical Chemistry – R.C. Das and B. Behera

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Analytical Chemistry) Sem-III** **Vertical: DSE** **Course Code: DSE-3 P** **Course Name: A) Analytical Chemistry Practical-3**
***Teaching Scheme** **Practical: 04 Hours/week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble: Analytical Chemistry Practical-3 is one of the core courses in the Analytical Chemistry curriculum and includes study of Spectral analysis. This course provides an in-depth understanding of the fundamental concepts in Nuclear Magnetic Resonance Spectroscopy, ^{13}C-NMR Spectroscopy, Two-dimensional (2D) NMR spectroscopy, Mass Spectrometry. Students will study these subtopics in detail. By combining theoretical knowledge with spectral problems, the course aims to develop practical skills in analyzing and optimizing the spectroscopic concepts.

	Course Objectives:
•	To know the applications of IR spectroscopy
•	To understand the different types of NMR techniques and their applications for structural determination
•	To get skill for the confirmation of structure based on mass spectrometry
•	To analyze drug molecules based on all spectral techniques.
	Course Outcomes:
CO1:	The student is able to apply IR techniques to various compounds.
CO2:	The student can determine the structure of molecules on the basis of different NMR techniques.
CO3:	The student can adopt the skill to interpret spectra of molecules.
	List of Practicals:
1.	Spectral Problems will be selected with reference to theory syllabus (IR, NMR, 13C NMR, Mass, UV-vis Fluorescence Spectroscopy as well as TGA, DTA etc.)
	References:
	1) Vogel's textbook of Quantitative Inorganic analysis 2) A.J.E. Welch, Inorganic Preparations, George Allen and Unwin Ltd. 3) W.G. Palmer, Experimental Inorganic Chemistry, Cambridge Press, 1965. 4) M.A. Malati Experimental Inorganic / Physical Chemistry, Harvard Publishing Chichester.

	5) A text book of Practical Organic Chemistry – A. I. Vogel 6) Practical Chemistry – Mann and Saunders. 7) A Handbook of quantitative and qualitative analysis – H. T. Clarke. 8) Organic Synthesis collective volumes – Gillman and Batt. 9) Laboratory experiments in Organic chemistry-Arun Sethi 10) Findlay's Practical Physical Chemistry – Revised by J.A. Kitchner (V Edition) 11) Experimental Physical Chemistry – F. Daniels and J. Williams 12) Experimental Physical Chemistry – R.C. Das and B. Behera

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Analytical Chemistry) Sem-III** **Vertical: DSE** **Course Code: DSE-3 P** **Course Name: B) Analytical Chemistry Practical-4**
***Teaching Scheme** **Practical: 04 Hours/week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble: Analytical Chemistry Practical-4 is one of the core courses in the Analytical Chemistry curriculum and one of the traditional courses and now bridged to advanced instrumental techniques. This course provides an in-depth understanding and interpretation of data from spectrophotometer, nephelometry, turbidimeter, colorimeter etc. Students will study these subtopics in detail. Experiments designed in such a way to create awareness about accuracy and precision.

	Course Objectives:
•	To handle the instrument like spectrophotometer, nephelometry, turbidimeter, colorimeter etc.
•	To understand the principle of instrument like spectrophotometer, nephelometry, turbidimeter, colorimeter etc.
•	To analyze data obtained and convert in to readable form.
•	To apply theoretical knowledge for analysis of pesticides, insecticides, plastics and detergents.
	Course Outcomes:
CO1:	Proficiently handle the instruments like spectrophotometer, nephelometry, turbidimeter, colorimeter etc.

CO2:	Understand the principle of instrument like spectrophotometer, nephelometry, turbidimeter, colorimeter etc.
CO3:	The student can adopt the skill to interpret spectra of molecules.
CO4:	Skilled to apply theoretical knowledge for analysis of pesticides, insecticides, plastics and detergents.
	List of Practicals:
1.	Determination of amount of Zinc from the given sample solution by Nephelometric / Turbidimetric titration using standard solution of $Ba(NO_3)_2$ or $Pb(NO_3)_2$.
2.	Determination of amount of chloride from the given sample solution by Nephelometric/ Turbidimetric titration using standard solution of$AgNO_3$.
3.	To determine the amount of each copper and bismuth or copper and iron (III) from the given mixture at 745 nm by spectrophotometric titration using solution of EDTA.
4.	Determination of iron in syndets by colorimetric method.
5.	Estimation of Al in steel Rhudrescence method.
6.	Estimation of Zn and Cd from unknown solution by polarographic technique.
7.	photometric estimation of each Na, K, Li and Ca from the given sample mixture by calibration curve method
8.	Flame photometric estimation of Na/K/Li/Ca from their given sample by working curve method and its conformation by standard addition method.
9.	Estimation of phosphorus from given fertilizer by volumetry/colorimetry.
10.	Estimation of purity of a given azo dye by colorimetry
11.	Analysis of some common pesticides, insecticides, plastics and detergents.
12.	Determination of alcohol from beverages spectrophotometrically using dichromate.
13.	Estimation of nitrogen from given fertilizer by Kjeldahl method. NOTE: Any other relevant experiments may be added
	References:
	1) Vogel's textbook of Quantitative Inorganic analysis 2) A.J.E. Welch, Inorganic Preparations, George Allen and Unwin Ltd. 3) W.G. Palmer, Experimental Inorganic Chemistry, Cambridge Press, 1965. 4) M.A. Malati Experimental Inorganic / Physical Chemistry, Harvard Publishing Chichester. 5) A text book of Practical Organic Chemistry – A. I. Vogel 6) Practical Chemistry – Mann and Saunders. 7) A Handbook of quantitative and qualitative analysis – H. T. Clarke. 8) Organic Synthesis collective volumes – Gillman and Batt. 9) Laboratory experiments in Organic chemistry-Arun Sethi 10) Findlay's Practical Physical Chemistry – Revised by J.A. Kitchner (V Edition) 11) Experimental Physical Chemistry – F. Daniels and J. Williams 12) Experimental Physical Chemistry – R.C. Das and B. Behera

Semester IV

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Analytical Chemistry) Sem-IV** **Vertical: DSC** **Course Code: DSC-7** **Course Name: Advanced Analytical Techniques**
***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Advanced Analytical Techniques provides an in-depth understanding of the fundamental concepts of chromatography technique including detail study of High Performance Liquid Chromatography, Electrophoresis, Membrane-Based Methods, Dialysis and Electro-dialysis. Students will study these subtopics in detail by combining theoretical knowledge with instrumentation. Goal of Course is to develop theoretical and practical skills in Chromatographic concepts like separation, Identification, Quantification and Purification.

	Course Objectives:
•	To know about Principle, and detectors used in ion chromatography.
•	To Learn Hyphenated techniques like LC-MS, GC-MS to increase accuracy and precision.
•	To Learn technology used in automated system and flow injection analysis.
•	To understand principle and instrumentation of Super critical fluid chromatography
	Course Outcomes:
CO1:	Students know principle and applications of ion chromatography.
CO2:	Learn Hyphenated techniques like LC-MS, GC-MS to increase accuracy and precision.
CO2:	Able to solve numerical problems on chromatography.
CO1:	Learn principle and instrumentation of Super critical fluid chromatography to separate and analyses biological sample.
Unit 1:	**Ion Chromatography** **[15]** **Weightage: 20M**
	Ion Chromatography: Principle, structure and characteristics of resins, eluent, suppressor columns and detectors used in ion chromatography, analytical

	applications, environmental speciation by ion chromatography and applications Hyphenated Techniques for Chromatographic Detection: Introduction, Electronic Spectral Detection, MS Detection, NMR Detection, FTIR Detection, Atomic Spectrometric Detection, Other Types of Detection, Serial or Parallel Multiple Detection
Unit 2:	**LC-MS: (15)** **Weightage: 20M**
	LC-MS: Fundamentals of LC, MS and LC-MS, Comparison of LCMS and other techniques, Basic instrumentation of LCMS, Interfaces for LCMS, Applications of High Performance Liquid Chromatography– Mass Spectrometry: Method Development, The Molecular Weight Determination of Biopolymers, Structure Determination of Biopolymers, Molecular Weight Determination of Small Molecules, Structure Determination of Low-Molecular-Weight Compounds GC-MS: Introduction, Basic principles, Interfaces, Computerization, Computerized operation, Characteristics, Data analysis, Reconstructed gas chromatogram, Mass chromatogram, Selected ion monitoring, Compound identification using reference spectra matching, Mass spectral compilations, Quantitative analysis by selected ion monitoring, Choice of ions: basic considerations, Magnetic sector versus quadrupole analysers, Identification and quantitation procedures
Unit 3:	**Automated Systems: (15)** **Weightage: 20M**
	Automated Systems- An overview, distinction between automatic and automated systems, advantages and disadvantages of automation, types of automated techniques. Non-discrete techniques, segmented flow methods and basic equipment, special techniques and devices, theoretical considerations and problems, applications. Single and multi-channel auto analyzers, BUN analyzers, automatic glucose analyzer and ammonia in water analyzer, COD analyzer. Non-segmented flow methods. Flow injection analysis- Principle, types of dispersion, factors affecting dispersion, applications of small, medium and large dispersion, stopped flow methods, flow injection titrations. Discrete methods- Centrifugal fast scan analyzer, automatic multipurpose analyzer, automatic elemental analyzer, automated analyzer based on multilayer film principles, film structure, instrumentation applications.
Unit 4:	**Super critical fluid chromatography (SFC): (15)** **Weightage: 20M**
	Super critical fluid chromatography (SFC): Introduction, properties of super critical fluids, supercritical fluid chromatography-instrumentation and operating variables, comparison to other types of chromatography, applications, Super critical fluid extraction (SFE): Introduction, advantages of SFE, instrumentation, supercritical fluid choice, Off-line and On-line extraction and applications. Particle size determination: Introduction, Low-angle laser light scattering instrumentation, theoretical models and

	application. Dynamic light scattering-principles, instrumentation and applications. Photosedimentation- settling velocity and particle size, instrumentation and applications.
	Reference books:
	1. A Textbook of Inorganic Qualitative Analysis. By A I Vogel. 2.Chromatography.By E. Heftman, 5th edition, part-A and part-B, Elsevier Science Publisher, 1992. 3. Chromatography Today. By C F Poole and S K Poole, Elsewhere Science Publisher,1991. 4. Analytical Chemistry. By G D Christian 4th edition, John Wiley and Sons,1986. 5. Instrumental Methods of Analysis, by B K Sharma, 19thedition, Goel Pubisher,2000. 6. Absorption Spectroscopy of Organic Molecules (Addition Wesley) by V.M. Parikh 7. Instrumental Methods of Analysis (CBS) by Willard, Merrit, Dean &Settle: 8. Spectroscopic Methods in Organic Chemistry (Mc Graw Hill) by D.H. Williams & J. Fleming: 9.Silverstein Spectroscopic Identification of Organic Compounds.(John. Wiley) 10. Applications of NMR Spectroscopy of Organic Chemistry (Pergamon Press) by Jackman & Sternhill: 11. Nuclear Magnetic Resonance (Mc Graw Hill) by J. D. Roberts: 12. Mass Spectroscopy by K. Benjamin: 13. Introduction to Instrumental Analysis by R.D. Brown, McGraw Hill(1987) 14. Instrumental Methods of Chemical Analysis by Chatwal and Anand. 15. Basic Concept in Analytical chemistry, by S.M. Khopkar. 16. Handbook of Spectroscopy, Edited by G. Gauglitz and T. Vo-Dinh, ;John Wiley VCH 17. Basic Gas Chromatography -Mass Spectrometry Principles and Techniques: F.W. Karasek and R.E. Clement, Elsevier Science B V(3rdEdn). 18. Liquid Chromatography– Mass Spectrometry: An Introduction; Robert E. Ardrey; John Wiley & Sons Ltd A book from series- Analytical techniques in the Science.

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Second Year M.Sc. (Analytical Chemistry) Sem-IV** **Vertical: DSC** **Course Code: DSC-8** **Course Name: Instrumental Methods of Chemical Analysis-II**
***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Instrumental Methods of Chemical Analysis-II is one of the core courses in the Chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the fundamental concepts in X- ray method of analysis, Nephelometry, turbidometry, Fluorimetry, Phosphorimetry, Flame photometry and emission spectroscopy. Students will study these subtopics in detail. By combining theoretical knowledge with instrumentation, the course aims to develop practical skills analysis of sample with accuracy and precision.

	Course Objectives:
•	To learn analysis of solid surface by X- ray method of analysis and spectroscopically.
•	To learn instrumentation and principle of Nephelometry, turbidometry, Fluorimetry, Phosphorimetry, Flame photometry and emission spectroscopy.
	Course Outcomes:
CO1:	Understand to analyse of solid surface by X- ray method and spectroscopically.
CO2:	Learn instrumentation and principle of Nephelometry, turbidometry, Fluorimetry, Phosphorimetry, Flame photometry and emission spectroscopy.
Unit 1:	**X-ray methods of Analysis** **[15]** **Weightage: 20M**
	Introduction, theory of X-ray generation, comparison with optical spectroscopy, X-ray spectroscopy, X-ray absorption, X-ray diffraction and X-ray fluorescence methods, theory, instrumentation, applications. Surface characterization by spectroscopy: Introduction to the study of solid surfaces, types of surface measurements spectroscopic surface methods, general techniques in surface spectroscopy, sampling of surfaces, surface contamination.
Unit 2:	**Nephelometry and Turbidometry** **[15]** **Weightage: 20M**
	Introduction, theory, comparison of spectrophotometry, turbidimetry and nephelometry, instrumentation and applications. Refractometry -Principle, parameters influencing refraction, significance of critical

	angle during measurements, refractometers, qualitative and quantitative analysis and analytical applications. Interferometry-Principles, instrumentation and applications.
Unit 3:	**Fluorimetry and Phosphorimetry [15]** **Weightage: 20M**
	comparison of absorption and fluorescence methods, theory, instrumentation, applications of fluorimetry and phosporimetry, comparison of fluorimetry and phosphorimetry, comparison of fluorimetry and phosphorimetry with absorption methods, applications of Photoluminescence methods, Chemiluminescence-phenomenon, measurement and applications.
Unit 4:	**Emission Spectroscopy [15]** **Weightage: 20M**
	Introduction, theory, types of emission spectra, excitation energy requirements, relation of emission spectroscopy to flamephotometry, instrumentation-excitation sources, electrodes, sample holder, monochromators, detectors, spectrographs, quantitative and qualitative and specific applications, advantages and disadvantages of emission spectroscopy. Flame photometry: Principle-Instrumentation, interferences in flame photometry. Factors that influences intensity of emitted radiations of flame photometry, limitations of flame photometry and applications.
	Reference books:
	1. Instrumental Methods of Analysis by U. H. Willard L. L. Merrit, J. A. Dean 2. Basic Concept in Analytical chemistry, by S. M. Khopkar. 3. Principles of Instrumental Analysis, Douglas A. Skoog | F. James Holler | Stanley R. Crouch 4. Kinetics in Analytical Chemistry: Inter science N Y by H. Mark and G. Rachnitz 5. Instrumental Methods of Chemical Analysis, Pragati Prakashan Meerut by H. Kaur 6. A Text book of Quantitative Analysis by A. I. Vogel

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Analytical Chemistry) Sem-IV** **Vertical: DSE** **Course Code: DSE-4** **Course Name: A) Biochemical & Food Analysis**
***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Biochemical & Food Analysis is one of the core courses in the Chemistry curriculum and one of the traditional courses, assigned to link chemistry and bio-chemistry. This course provides an in-depth understanding of the Food Analysis, Body Fluid Analysis, Drug Analysis, Clinical Analysis etc. Students will study these subtopics in detail. By combining theoretical knowledge course aims to develop biological awareness in students.

	Course Objectives:
●	To get the information about the routes of administration of drug.
●	To know the different types of dosage forms and routes of administration of drug.
●	To understand the concept of formulations and Pre-formulation of drug.
●	To study the different types of drug delivery systems
	Course Outcomes:
CO1:	The student is able to get the information about the routes of administration of drug.
CO2:	The student knows the different types of dosage forms and routes of administration of drug.
CO3:	The student is able to understand the concept of formulations and Pre-formulation of drug.
CO4:	The student study the different types of drug delivery systems
Unit 1:	**FOOD ANALYSIS** **[15]** **Weightage: 20M**
	Food Analysis: Food flavors, food colour, food preservatives, milk and milk products, floor starches, honey, jam and their major component analysis. Introduction to natural fats and oils, analysis of oils and fats: softening point, congent point, titre point, cloud point, Iodine value, saponification value, acid value by R-M and Polenske value, Elaiden test.
Unit 2:	**BODY FLUID ANALYSIS** **[15]** **Weightage: 20M**
	Composition and detection of abnormal level of certain constituents leading to diagnosis of diseases. Sample collection and preservation of physiological fluids,

	analytical methods to the constituents of physiological fluids (blood, urine and serum). Blood: Estimation of glucose, cholesterol, urea, hemoglobin and bilirubin. Urine: urea, uric acid, creatinine, calcium, phosphate, sodium, potassium and chloride.
Unit 3:	**DRUG ANALYSIS [15]** **Weightage: 20M**
	Introduction, source of drug, difference between drug and medicine, dangerous drugs, narcotics, classification of drugs, impurities / contaminants in pharmaceutical raw materials / chemical and drug, drug screening using gas chromatography, assay of drugs. Characterization and analysis of some of the following drug-molecules; 1. Local anesthetics: Procaine Hydrochloride 2. Sedative-Hypnotics: Phenobarbital 3. Antianxiety agents: Diazepam 4. Anticonvulsants: Phenytoin 5. Antipsychotic agents: Chlorpromazine 6. Central intraneural blocking agents: Levodopa 7. Antidepressant agents: Imipramine hydrochloride 8. Central nervous system stimulants: Fenfluramine hydrochloride 9. Opioid Analgesics and Antitussives: Morphine sulphate 10. Diuretic agents: Hydrochlorothiazide 11. Antihistamines- Antiallergic agents: Meyperamine maleate 12. Nonsteroidal anti-inflammatory drugs: Ibuprofen
Unit 4:	**Clinical Analysis [15]** **Weightage: 20M**
	Biological significance, analysis of assay of enzymes (pepsin, monoamine, oxidase, tyrosinase), vitamins (thiamine, ascorbic acid, Vit. A) and hormones (progesterone, oxytocin, insulin) **Forensic Analysis**-Special features of forensic analysis, sampling, sample storage, sample dissolution, classification of poisons, lethal dose, significance of LD-50 and LC-50, general discussion of poisons with special reference to mode of action of cyanide, organophosphate and snake venom. Estimation of poisonous materials such as lead, mercury and arsenic in biological samples.
	Reference books:
	1. Hand Book of Sugars (A VI) by S.R. Junk and H.M. Pancoast 2. Perfumery Technology (JC1) by B. Bilat and B.V. Well 3. Treatise on Analytical Chemistry Vol. I and Vol. II 4. Laboratory Techniques in Food Analysis by I. M. Kolth of, D. Pearson 5. Handbook of Analysis and Quality, Control for Fruits and Vegetable Products 2nd Ed McGraw hill) by S. Ranganna 6. Standard Methods of Chemical Analysis vol I and II (6th ed) by F. J. Welcher

	7. Analysis of Food Products. (Swan Publishers) by S. N. Mahendru: 8. Chemical Analysis of food by Pearson. 9. Textbook of Forensic Pharmacy by B M Mithal 9th edition 1993, National Centre Kolkata. 10. Textbook of Forensic pharmacy- B. M. Mithal 9th Edn (1993 11. Forensic Pharmacy by B.S Kuchekar, and A. M. Khadatare Nirali Prakshan) 12. Analytical Chemistry by Alka Gupta Pragati Prakashan 13. Quantitative analysis of drugs in pharmaceutical formulations, P. D. Sethi, Unique publisher, New Delhi. 14. A Text Book of Medicinal Chemistry Vol. I and Vol. II, S.N. Pandeya, S.G. Publisher, Varanasi. 15. Analytical chemistry, Alka L. Gupta, Pragati Prakashan, Meerut. 16. Forensic applications of Gas Chromatography by Michelle Carlin and John Dean, CRC press

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Second Year M.Sc. (Analytical Chemistry) Sem-IV** **Vertical: DSE** **Course Code: DSE-4** **Course Name: B) Pharmaceutical Analysis**
***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Pharmaceutical Analysis is one of the core courses in the chemistry curriculum and one of the traditional courses, dating back from the last many centuries. This course provides an in-depth understanding of the sources of impurities in pharmaceutical raw materials and finished products , test and assay of raw materials and finished products, standardization and quality control of different dosage form, and role of FDA in pharmaceutical industry. Students will study these subtopics in detail. By combining theoretical knowledge of drug dosage and pharmaceutical raw materials, the course aims to develop practical skills in analysis of pharmaceutically important components.

	Course Objectives:
•	To get the information about pharmaceutical raw materials.
•	To know various method to test finished products. To know about drug design.
•	To introduce different dosage forms with the IP requirements Analytical methods.
•	To get aware about role of FDA in pharmaceutical industry
	Course Outcomes:
CO1:	Student gets thorough information about pharmaceutical raw materials.
CO2:	Student know various method to test finished products.
CO3:	Student gets thorough information of different dosage forms with the IP requirements Analytical methods.
CO4:	Student getting awareness about role of FDA in pharmaceutical industry
Unit 1:	**Sources of Impurities in Pharmaceutical Raw Materials and Finished Products [15]** **Weightage: 20M**
	Sources of impurities in pharmaceutical raw materials and finished products: Raw materials, Method of manufacture, Contamination-atmospheric, particulate, cross contamination, microbiological, process errors, Packing errors, chemical instability, container contamination (in brief) physical changes, temperature effects. General manufacturing processes.
Unit 2:	**Test and Assay of Raw Materials and Finished Products: [15]**

	Weightage: 20M
	Chemical tests and assays: Limit test, characteristics of limit tests, specificity sensitivity, control of personal errors, Loss on drying (NaCl), loss on ignition (ZnO), limit test for lead, arsenic, chloride and sulphate, moisture determination of moisture by KFR titration method and assay of steroids. steroids (IP) Analysis of vegetable drugs: Sampling, foreign organic matter, ash values and water soluble ash (ginger) Acid insoluble ash, sulphated ash. Physical tests and assays: Disintegration tests for tablets, capsules, pessaries and suppositories Dissolution tests tablets and capsules.
Unit 3:	**Standardization and Quality Control of Different Dosage Form [15]** **Weightage: 20M**
	Brief introduction to different dosage forms with the IP requirements Analytical methods for the following- Tablets (aspirin) additives used in tablet manufacture, capsules Rifampicin) Powders (Sodium benzoate), Solutions (saline NaCl) Suspensions (barium sulphate –limit test for impurity) Mouthwashes (Ointments (salicylic acid) and creams Dimethicone by IR) Injections (Mannitol), ophthalmic preparations (sulphacteamine), Aerosols (salbutamol), Blood products and reporting protocols.
Unit 4:	**Role of FDA in pharmaceutical industry [15]** **Weightage: 20M**
	Drug cosmetic act definitions drug, Misbranded, Adulterated and Spurious drug, New drug Cosmetics, Blood bank, Manner of labeling, GMP in brief (Schedule M), FDA. Role of FDA, introduction to new drugs, brief summary of different phases of test and approval for formulation of a drug. poisonous materials such as lead, mercury and arsenic in biological samples.
	References:
	1. Practical Pharmaceutical chemistry third edition volume 1. By A. H. Beckett & J. B. Stenlake 2. Pharmacoepia of India Vol. I and II. 3. Remington‘s Pharmaceutical sciences. 4. Forensic pharmacy by B.S Kuchekar, A. M Khadatare (Nirali Prakashan) 5. Practical pharmaceutical analysis by Ashitosh Kaur 6. Analytical problems of drug substances and Exp by Florey 7. The theory and practice of Ind pharmacy Leon lachmann, Herbert Liebermann and Joseph L. 8. Karnic 3rd edition By Varghese Publication House, Hind Rajasthan Building Dadar Mumbai–14

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Second Year M.Sc. (Analytical Chemistry) Sem-IV** **Vertical: DSE** **Course Code: DSE-4** **Course Name: C) Environmental Chemical Analysis**
***Teaching Scheme** **Lectures: 04 Hours/week, 04 Credits**	***Examination Scheme** **UA: 60 Marks** **CA: 40 Marks**

Course Preamble: Environmental Chemical Analysis is one of the core courses in the Chemistry curriculum and one of the traditional courses, assigned to create awareness about environmental factors. This course provides an in-depth understanding of the environment, water, waste water treatment , soil pollution etc. Students will study these subtopics in detail. By combining theoretical knowledge course aims to develop environmental awareness in students and need to waste water management.

	Course Objectives:
•	To know about concept of biosphere and its components.
•	To know various methods to check physical parameters of water resources as well as to introduce pollutants in water.
•	To know different Terminology in waste water treatment like Preliminary treatment, Secondary treatment, Tertiary treatment, Advanced waste water treatment.
•	To know about sources of soil pollution and methods of disposal of waste
	Course Outcomes:
CO1:	Student get thorough information about concept of biosphere and its components..
CO2:	Getting thorough information about physical parameters of water resources as well as getting thorough information about pollutants in water.
CO3:	Students get sufficient information about different terminology in waste water treatment like Preliminary treatment, Secondary treatment, Tertiary treatment, Advanced waste water treatment.
CO4:	Student getting sufficient information about sources of soil pollution and methods of disposal of waste
Unit 1:	**Environment** **[15]** **Weightage: 20M**
	Concept of biosphere and its components: Hydrosphere, atmosphere and lithosphere. Hydrological cycles. Formation of soil, Bio-geochemical cycles, C, N, P, S and O. Bio distribution of elements. Air pollution: Suspended particulate matter, aerosol. Generation, hazards and control of SOx, NOx and COx. Monitoring equipment –

	cyclone separator, electrostatic precipitator, filters and settling chambers.
Unit 2:	**Water** **[15]** **Weightage: 20M**
	Water resources, origin of waste water, types of water pollutants and their sources. Chemical analysis of water: Objectives of analysis, parameters of analysis, sample collection and preservation, measurement of colour, turbidity, total solids, alkalinity, hardness, chloride, residual chlorine, sulphates, fluorides, phosphates and different forms of nitrogen in natural and pooluted water and heavy metals. Pollution control. Public health significance of Pb, Cd, Hg, As. Cu, Zn and Mn. Pollution control measures. General survey of instrumental techniques for the analysis of heavy metal in aquatic system. Organic loadings-significance and measurement of DO, BOD, COD, TOD and TOC, phenols, pesticides, surfactants, and tannin and lignin as water pollutants and their determination
Unit 3:	**Waste Water Treatment** **[15]** **Weightage: 20M**
	Terminology in waste water treatment, waste water characteristics, effluent standards. Treatment of domestic waste water: Preliminary treatment. Primary treatment: Sedimentation, equalization, neutralization. Secondary treatment: Aerated lagoons, tricking filters, activated sludge process, oxidation ditch, oxidation pond and anerobic digestion, sludge treatment and disposal. Tertiary treatment: Evaporation, ion-exchange, adsorption, electrodialysis, electrolytic recovery and reverse osmosis. Advanced waste water treatment: Nutrient removal-nitrogen and phosphorus removal, solids removal. Waste water disposal and reuse, industrial waste water and its treatment
Unit 4:	**Soil Pollution** **[15]** **Weightage: 20M**
	Source of soil pollution, soil sediments as a pollutants, treatment and remedial measurements of soil pollution. Soil loss and degradation. Industrial pollution-Sugar industry, paper and pulp industry, nuclear power plant, polymer drugs, radionuclide analysis, disposal of wastes and their management. Principles of decomposition -biodegradability, better industrial process. Hazardous substance analysis-Nature, Source, Physical classification of hazardous substances Chemical classification hazardous wastes, Physical and chemical methods of waste treatment and ultimate disposal of hazardous waste. Case studies-Bhopal gas tragedy, Chernobyl nuclear reactor accident, three mileisland tragedy, Minamata disaster.
	Reference books:
	1. Environmental Chemistry, Environmental Pollution Analysis by S. M. Khopkar, 2. Environmental Chemistry, New Age International Publisher by A. K. De

	3. Industrial Chemistry by B. K. Sharma 4. Introduction to Instrumental Analysis by R. E. Brown, Mc.Graw Hill(1987) 5. Fundamentals of Analytical Chemistry 6th edition by D. A. Skoog, D. M. West and F. S. Holler. 6. Instrumental Methods of Chemical Analysis by Chatwal and Anand. 7. Water and Waste Water Analysis; (NEERI) Ramteke, 8. Industrial Chemistry by B. K. Sharma. 9. Pollution Control in Process Industries by S. P. Mahajan. 10. Measurements of Air Pollutants. By M Katz, WHO, 1969.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Analytical Chemistry) Sem-IV** **Vertical: RP** **Course Code: RP-2** **Course Name: Research Project-2**
***Teaching Scheme** **Project work: 06 Credits**	***Examination Scheme** **UA: 90 Marks** **CA: 60 Marks**

Course Preamble: Research Project is one of the core courses in the Analytical Chemistry curriculum and assigned for credit 6 in Sem-IV. This course provides an in-depth understanding of the fundamental concepts in Project work involving organic synthesis/evaluation of biological studies or in-plant training in any of the pharmaceutical or chemical industry. The course aims to develop research skills in Analytical Chemistry.

	Course Objectives:
•	To know the basic idea behind the research.
•	To understand the terms for research project like introduction, background and significance, literature and review, research designs and methods, results and discussion, and conclusion etc.
•	To know the data collection and analysis/interpretation of data
•	To know the project report writing and submission.
	Course Outcomes: Students can able to understand the -

CO1:	Basic idea behind the research.
CO2:	Terms for research project like introduction, background and significance, literature and review, research designs and methods, results and discussion, and conclusion etc.
CO3:	Knowledge of data collection and analysis/interpretation of data
CO4:	Project report writing and submission.
●	Candidates are expected to work on assigned research project and submit the results at the end of the semester in the form a dissertation. Open defense of the student on his/her dissertation shall be arranged. This defense shall be in front of the panel of examiners. This will be valued for 40 marks. Project work involving organic synthesis/evaluation of biological studies or in-plant training in any of the pharmaceutical or chemical industry for at least 21 days will be considered. Project should be completed under the guidance of a faculty member in the same Department or Industry or research organization. In case of Industry / research organization one member of that body can also be included as project guide. **Guidelines for Assessment** • Quality of Literature survey and Novelty in the problem • Clarity of Problem definition and Feasibility of problem solution • Clarity of objective and scope • Quality of work attempted • Presentation skills

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***Teaching Scheme** **Practical: 04 Hours/week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble: Analytical Chemistry Practical-5 is one of the Mandatory core courses in the Analytical Chemistry curriculum and purposefully consigned to provide laboratory experience to the students by performing experiments based on topics taught in theory. This course provides an in-depth understanding of the fundamental concepts. The course aims to develop practical skills in analyze various samples.

	Course Objectives:
•	Maintain proper record of analytical data in notebook and to Learn method to prepare solutions at milimolal and ppm scale.
•	To analyze information obtained from spectrophotometer, flame photometer, pH meter, Potentiometer, Polarimeter, Karl Fischer titrator.
•	**Course Outcomes:**
CO1:	Able to understand the type of reaction involved in the multistep preparation
CO2:	Able to analyze information obtained from spectrophotometer, flame photometer, pH meter, Potentiometer, Polarimeter, Karl Fischer titrator.
	List of Practicals:
1.	Determine the acidic and basic dissociation constant of an amino acid and hence determine the isoelectric point of given amino acid pH metrically.
2.	To determine the specific refraction of given mixture of liquid and hence find out unknown concentration of mixture.
3.	To determine stoichiometry & stability constant of ferric Sulphosalicylic acid/ salicylic acid complex by Job's Method and mole ratio method spectrophotometrically.
4.	Estimation of various transition elements like Zn/Ni/Co/Cd/Al from various commercial samples by complexometric titrations potentiometerically.
5.	Determination of amount of zinc from given sample solution by Nephelometric / Turbidimetric titration using standard solution of K4[Fe(CN)6] in 0.4 M HCl

6.	To determine pKa value of methyl red indicator at room temperature spectrophotometrically.
7.	Determine the formula of the complex formed between cupric ion and ammonia by distribution method
8.	Determination of Al/Mg by using 8-hydroxyquionoline as complexing agent by spectrophotometric method
9.	Estimation of amount of copper (II) with EDTA spectrophotometrically.
10.	Simultaneous spectrophotometric determination of (Cr & Mn) and (Ti & V).
11.	Colorimetric and spectrophotometric determination of manganese in steel.
12.	Moisture content by i) Loss on drying of caffeine (oven drying method) and water content of dextrose (anhydrous or monohydrate) by Karl Fischer Method.
13.	Determination Dextrose (glucose) Content in Saline by Polarimetry.
14.	Vinegar estimation: pH metric titration with different conc. of NaOH and indicator.
15.	Estimation of Na+ and K+ from water by flame photometry Calibration curve method.
	References:
	1) Vogel's textbook of Quantitative Inorganic analysis 2) A.J.E. Welch, Inorganic Preparations, George Allen and Unwin Ltd. 3) W.G. Palmer, Experimental Inorganic Chemistry, Cambridge Press, 1965. 4) M.A. Malati Experimental Inorganic / Physical Chemistry, Harvard Publishing Chichester. 5) A text book of Practical Organic Chemistry – A. I. Vogel 6) Practical Chemistry – Mann and Saunders. 7) A Handbook of quantitative and qualitative analysis – H. T. Clarke. 8) Organic Synthesis collective volumes – Gillman and Batt. 9) Laboratory experiments in Organic chemistry-Arun Sethi 10) Findlay's Practical Physical Chemistry – Revised by J.A. Kitchner (V Edition) 11) Experimental Physical Chemistry – F. Daniels and J. Williams 12) Experimental Physical Chemistry – R.C. Das and B. Behera

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Analytical Chemistry) Sem-IV** **Vertical: DSE** **Course Code: DSE-4 P** **Course Name: A) Analytical Chemistry Practical-6**
***Teaching Scheme** **Practical: 04 Hours/week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble: A) Analytical Chemistry Practical-6 is the advanced course in the analytical chemistry curriculum provides exposure to multiverse conceptual strengthening. This course provides an in-depth understanding of the preparation, Estimation, analysis of soil as well as biological sample, analysis of alloy and ore etc. Assay, by combining theoretical knowledge, the course aims to develop practical skills preparation of organic compounds as well as analyses biologically important component.

	Course Objectives:
•	To strengthen multiverse concept from one course.
•	To Learn techniques to estimate and determinate biological component from food and beverages.
•	To know different purification techniques in organic chemistry like recrystallization, distillation, steam distillation and extraction.
	Course Outcomes:
CO1:	Students proficient in preparation, analysis, estimation of various samples.
CO2:	Learn techniques to estimate and determinate biological component from food and beverages.
CO3:	Students are trained to different purification techniques in organic chemistry like recrystallization, distillation, steam distillation and extraction.
	List of Practicals
1.	Isolation of caffeine from tea.
2.	Preparation of benzilic acid from benzil.
3.	Determination of sap value and Iodine value of an oil.
4.	Estimation of Glucose from given sample
5.	Preparation of anticonvulsant drug phenytion.

6.	Determination of Latent heat of fusion of naphthalene in toluene.
7.	Assay Local Anesthetic – Benzocaine by non-aqueous titration method
8.	Purity of caffeine by non-aqueous titration method according to IP
9.	Analysis of soda ash.
10.	Agricultural analysis of soil sample, animal feeds, soil micronutrients, milk powder for Ca, Fe and P content.
11.	Analysis of pigments with respect to Zn and Cr.
12.	Preparation of chrome alum.
13.	To determine the capacity of cation exchange resin.
14.	To determine the capacity of anion exchange resin.
15.	Preparation of aluminum 8-hydroxyquinolate chelate.
16.	Analysis of Ilmenite ore.
17.	Estimation of phosphoric acid from given sample of Cola drink by molybdenum Blue method.
	NOTE: Any other relevant experiments may be added
	References:
	Reference Books: 1) Vogel's textbook of Quantitative Inorganic analysis 2) A.J.E. Welch, Inorganic Preparations, George Allen and Unwin Ltd. 3) W.G. Palmer, Experimental Inorganic Chemistry, Cambridge Press, 1965. 4) M.A. Malati Experimental Inorganic / Physical Chemistry, Harvard Publishing Chichester. 5) A text book of Practical Organic Chemistry – A. I. Vogel 6) Practical Chemistry – Mann and Saunders. 7) A Handbook of quantitative and qualitative analysis – H. T. Clarke. 8) Organic Synthesis collective volumes – Gillman and Batt. 9) Laboratory experiments in Organic chemistry-Arun Sethi 10) Findlay's Practical Physical Chemistry – Revised by J.A. Kitchner (V Edition) 11) Experimental Physical Chemistry – F. Daniels and J. Williams 12) Experimental Physical Chemistry – R.C. Das and B. Behera

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***Teaching Scheme** **Practical: 04 Hours/week, 02 Credits**	***Examination Scheme** **UA: 30 Marks** **CA: 20 Marks**

Course Preamble: A) Analytical Chemistry Practical-7 is the advanced course in the analytical chemistry curriculum provides exposure to multiverse conceptual strengthening. This course provides an in-depth understanding of analysis biological sample, as well as preparation etc. By combining theoretical knowledge, the course aims to develop practical skills preparation of organic compounds as well as analyse biologically important component.

	Course Objectives:
•	To know about standards and purity of organic compounds.
•	To Learn techniques to estimate and determinate biological component from food and beverages.
•	To know different purification techniques in organic chemistry like recrystallization, distillation, steam distillation and extraction.
	Course Outcomes:
CO1:	Understand various methods to purify organic compounds.
CO2:	Learn techniques to estimate and determinate biological component from food and beverages.
CO3:	Students are trained to different purification techniques in organic chemistry like recrystallization, distillation, steam distillation and extraction.
	List of Practicals
1.	Kjeldahl method for protein estimation in foods and feeds.
2.	Identification of organic compounds by their IR spectra.
3.	Determination of amount of vit-B2 in the medicinal tablet fluorometrically.
4.	Estimation of N-methyl and C-methyl groups.
5.	Estimation of sodium benzoate/sodium metabisulphite, boric acid and salicylic acid in food.
6.	Estimation of glycine from given unknown solution.

7.	Preparation of methyl salicylate and assay its purity.
8.	Estimation of vit.C by 2,6-dichloroindo phenol method.
9.	Determination of glucose from blood serum.
10.	Estimation of urea from blood sample.
11.	Assay of soaps and detergent.
12.	Preparation of sulphanilide from acetanilide.
13.	Preparation of methyl Salicylate and assay its purity.
14.	To calculate standard deviation of results obtained from redox titration of Fe+2 against standard K2Cr2O7solution.
15.	Solvent extraction separation of iron using diethyl ether and it's titrimetric determination.
16.	Analysis of chrome steel alloy for chromium and nickel content. NOTE: Any other relevant experiments may be added
	References:
	Reference Books: 1) Vogel's textbook of Quantitative Inorganic analysis 2) A.J.E. Welch, Inorganic Preparations, George Allen and Unwin Ltd. 3) W.G. Palmer, Experimental Inorganic Chemistry, Cambridge Press, 1965. 4) M.A. Malati Experimental Inorganic / Physical Chemistry, Harvard Publishing Chichester. 5) A text book of Practical Organic Chemistry – A. I. Vogel 6) Practical Chemistry – Mann and Saunders. 7) A Handbook of quantitative and qualitative analysis – H. T. Clarke. 8) Organic Synthesis collective volumes – Gillman and Batt. 9) Laboratory experiments in Organic chemistry-Arun Sethi 10) Findlay's Practical Physical Chemistry – Revised by J.A. Kitchner (V Edition) 11) Experimental Physical Chemistry – F. Daniels and J. Williams 12) Experimental Physical Chemistry – R.C. Das and B. Behera

Nature of Examination:

Each semester will have theory external assessment examination of 60 marks each (2.5 hrs. duration) and 40 marks college assessment. The practical examination of Semesters III to IV will be conducted at the end of each semester. Duly certified copy of laboratory record must be produced at the time of examination.

Practical Examination of M. Sc. II

The practical examination will be of 3 days for each semester.

Semester III:

Practical courses each	: 30 (UA)+ 20 (CA)
Research Project work	: 60 (UA) + 40 (CA)

Semester IV:

Practical courses each	: 30 (UA)+ 20 (CA)
Research Project work	: 90 (UA) + 60 (CA)

** The evaluation of Research Project will be done by both external and internal examiners at the time of examination.

Nature of question paper (M. Sc. II):

Time: 2 ½ hours Maximum Marks: 60

Instructions

1. All questions are compulsory
2. All questions carry equal marks.
3. Figures to the right indicate full marks.
4. Use of log tables and calculators is allowed.

Question Paper

Q 1.A) Choose correct alternative **Marks 8 (1 x 8)**

Sub-questions (i) to (viii)

B) Fill in the blanks **Marks 4 (1 x 4)**

Sub questions (i) to (iv)

Q 2. Answer the following (Any six) **Marks 12 (2 x 6)**

Sub-questions (a) to (h)

Q 3. Answer the following (Any three) **Marks 12 (3 x 4)**

Sub-questions (a) to (d)

Q 4. Answer the following (Any two) **Marks 12 (6 x 2)**

Sub-questions (a) to (c)

Q 5. Answer the following (Any two) **Marks 12 (6 x 2)**

Sub-questions (a) to (c)

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