VANITA VISHRAM WOMEN'S UNIVERSITY

(Managed By: Vanita Vishram, Surat)

1st Women's University of Gujarat

SCHOOL OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF CHEMISTRY

M.Sc. Analytical Chemistry

SYLLABUS

As per NEP-2020

w.e.f 2024-25

INDEX

1 PREAMBLE – VVWU

Vanita Vishram Women's University (VVWU) is the First-ever Women's University of Gujarat approved by the Government of Gujarat under the provisions of the Gujarat Private Universities Act, 2009. It is a University committed to achieve Women's Empowerment through Quality Education, Skill Development, and by providing employment opportunities to its girl students through its model curriculum, integration of technology in pedagogy and best-in-class infrastructure. The focus is on prioritizing practical component and experiential learning supported through academia-industry linkages, functional MoUs, skill development training, internships etc. It aims at providing opportunities to the girl students for holistic development and self-reliance.

VISION

Empowerment of women through quality education and skill development, so as to make them strong pillars of stability in the society.

MISSION

To provide Education & Professional Training to all women for their all-round development, so as to enable them to become economically independent and socially empowered citizens.

2 SALIENT FEATURES

- Based on NEP-2020 & CBCS
- Interdisciplinary as well as multidisciplinary.
- Practical-oriented, skill-based & vocation-based.
- Based on experiential learning.
- Greater exposure to internship, hands-on training, project work, field work, presentation etc.
- Mode of teaching shall be Offline.
- Qualified & Competent Faculty Members for effective teaching-learning
- Employment-Generating

3 INTRODUCTION OF THE PROGRAM

The M.Sc. Chemistry course is an advanced postgraduate program designed to provide students with a comprehensive and in-depth understanding of complex chemical principles and their practical applications. Delving into various specialized areas, such as organic, physical and analytical, the program equips students with specialized knowledge and expertise.

A significant emphasis is placed on hands-on research, experimentation, and laboratory work, enabling students to develop advanced skills in chemical analysis, compound synthesis, and data interpretation. Through rigorous academic training, the program fosters critical thinking, problem-solving abilities, and a spirit of scientific inquiry, preparing students to tackle challenging scientific questions.

Upon successful completion of the M.Sc. Chemistry students are well-prepared to embark on rewarding careers in diverse fields. They can pursue opportunities in research and development, where they contribute to the advancement of scientific knowledge and the discovery of new materials and processes. Additionally, graduates can find fulfilling roles in quality control, ensuring the safety and effectiveness of various products and processes.

Moreover, the course lays the groundwork for potential teaching careers, empowering graduates to impart their knowledge and passion for chemistry to the next generation of students. Furthermore, the program provides a solid foundation for those considering further studies at the doctoral level, where they can explore cutting-edge research and make significant contributions to the field. Students will develop a deep understanding of chemical concepts and their practical applications in areas such as pharmaceuticals, materials science, polymer science, dyes industries, environmental science, fermentation, food & dairy and forensics etc.

Overall, chemists play a crucial role in addressing real-world challenges, such as sustainable energy, environmental conservation, and advancements in healthcare and technology. By

applying their knowledge and skills, M.Sc. Chemistry graduates become catalysts for progress and innovation, driving society towards a brighter future.

4 Programme Objectives (POs)

PO 1. To impart knowledge of Chemical sciences and application of chemistry in day-to-day life.

PO 2. To strengthen the in-field practical knowledge of the students by providing them hands-on experimentation, project work and field work.

PO 3. To develop capability of thinking, understanding/analyzing and interpreting and solving problems to meet the need of industries such as pharmaceuticals, materials science, polymer science, dyes industries, environmental science, food & dairy, forensics, Academia, etc. and research.

PO 4. To make learners understand about ethical aspects, safety aspects and their responsibilities towards mankind and the environment.

PO 5. To make students capable of finding entrepreneurship opportunities for betterment of society, environment.

PO 6. To make the students avail of all the basic knowledge required for various competitive examinations related to the Sciences.

5 Program Specific Outcomes (PSOs)

Upon completion of the M.Sc. Chemistry program, the students would:

PSO 1. Have the knowledge of advanced principles of Chemistry and its understanding.

PSO 2. Be able to apply their practical skills and knowledge to identify and resolve the problems related to and serve various Chemical Industries such as pharmaceuticals, materials science, polymer science, dyes industries, environmental science, food & dairy etc.

PSO 3. This program fosters interdisciplinary learning habits, enabling students to utilize modern analytical tools and software for industry and research analysis.

PSO 4. Be able to cultivate professional ethics and equip students to pursue careers in various sectors as chemists, researchers, educators, managers, regulators and professionals in chemistry-related industries.

PSO 5. Develop high-quality research encouraging scientific thinking and approach for research.

PSO 6. Develop skills for further higher studies, competitive examinations and employment.

6 PROGRAM HIGHLIGHTS:

<table>
<tr><td>Course Level</td><td colspan="7">PG</td></tr>
<tr><td>Program</td><td colspan="7">Postgraduate in Science</td></tr>
<tr><td>Duration</td><td colspan="7">2 years (4 semesters)</td></tr>
<tr><td>Examination Type</td><td colspan="7">Semester system (1-4 semesters)</td></tr>
<tr><td>Intake</td><td colspan="7">40</td></tr>
<tr><td>Eligibility</td><td colspan="7">Master degree in Analytical Chemistry</td></tr>
<tr><td rowspan="7">Mapping between POs and PSOs</td><td></td><td>PSO 1.</td><td>PSO 2.</td><td>PSO 3.</td><td>PSO 4.</td><td>PSO 5.</td><td>PSO 6.</td></tr>
<tr><td>PO 1.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>PO 2.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>PO 3.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>PO 4.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>PO 5.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>PO 6.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Job Positions</td><td colspan="7">Scientist, Teacher, RnD Officials, QA/QC Executives in various sectors of Chemistry domain such as pharmaceuticals, materials science, polymer science, dyes industries, environmental science, forensics, Academia etc.</td></tr>
</table>

7 Scheme of Assessment

Following is the scheme of assessment followed by the university –

Weightage (%)	Continuous Assessment (CA) (40%)	End Semester Examination (ESE) (60%)
100%	[Internal written Theory Exam] (20%) + [Assignments/Presentations/Viva/group discussion/Journal/ MCQ/QUIZ etc. + Attendance] (20% - Any Two)	End Semester Examination (ESE) Theory/Practical Exams Whole Syllabus

8 Credit Structure

Proposed PG Credit structure for PG -2023					
Semester	**Major (4)**	**DSE(4)**	**Project/Internship**	**Dissertation**	**Total**
1	4*4=16 (Th) 2*4= 08 (Pr)	-	-	-	24
2	4*4=16 (Th) 2*4= 08 (Pr)	-	-	-	24
3	3*4=12 (Th) 1*4=04 (Pr)	**(1*4) Any One** Group A Group B	1*4=4	-	24
4	1*4=04	**Any One** Group A Group B	1*4 = 4(add to Dissertation)	1*12=12	24
Total	**12*4=48** (Th) **5*4 =20** (Pr) **68**	**2*4=08**	**1*4=4** **1*4=4** **08**	**1*12=12**	**96**

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SCHOOL OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF CHEMISTRY

M.Sc. Analytical Chemistry

SEMESTER 3

SYLLABUS

As per NEP-2020

w.e.f 2024-25

9 Course Structure – Paper Titles SEMESTER 3

Semester	Major (4x3=12)	DSE(4x1=4) Anyone	Project/Internship(4)	Dissertation	Total
3	Electro - Analytical Techniques (Th)	Polymer Chemistry (Th)	Project	-	06
	Advanced Analytical Techniques (Th)	Analysis of Industrial Products (Th)			
	Spectroscopic Techniques (Th)				
	Analytical Chemistry Practical - III (Pr)			-	

10 Teaching and Evaluation Scheme for M.Sc. Analytical Chemistry academic year 2024-25

VANITA VISHRAM WOMEN'S UNIVERSITY, SURAT

SCHOOL OF SCIENCE AND TECHNOLOGY

TEACHING & EXAMINATION SCHEME FOR M.Sc. Chemistry Programme, AY 2024-25

Semester	Course Code	Course Category	Course Title	Teaching Scheme				Examination Scheme													Total Credit
								Theory						Practical							
				Contact Hours					CCE		SEE				CCE		SEE				
				Theory	Practical	Total	Total Credit	Credit	Max.	Passing	Max.	Passing	CCE+SEE Passing	Credit	Max.	Passing	Max.	Passing	CCE+SEE Passing	Total	
III (Analytical Chemistry)	CH21420	CC	Electro - Analytical Techniques (Theory)	4	0	4	5	4	40	16	60	24	40	0	0	0	0	0	0	100	4
	CH21430	CC	Advanced Analytical Techniques (Theory)	4	0	4	5	4	40	16	60	24	40	0	0	0	0	0	0	100	4
	CH21440	CC	Spectroscopic Techniques (Theory)	4	0	4	5	4	40	16	60	24	40	0	0	0	0	0	0	100	4
	CH21450	CC	Analytical Chemistry Practical - III (Practical)	0	8	8	4	0	0	0	0	0	0	4	40	16	60	24	40	100	4
	CH21460	CC	Project (Practical)	0	8	8	4	0	0	0	0	0	0	4	40	16	60	24	40	100	4
	CH24090	DSE-A	Polymer Chemistry (Theory)	4	0	4	4	4	40	16	60	24	40	0	0	0	0	0	0	100	4
	CH24110	DSE-B	Analysis of Industrial Products (Theory)																		
TOTAL MARKS																				**600**	**24**

VANITA VISHRAM WOMEN'S UNIVERSITY, SURAT

SCHOOL OF SCIENCE AND TECHNOLOGY
Department of Chemistry
M.Sc. Analytical Chemistry Program
Semester III

CH21420: Electro - Analytical Techniques (Th)

Credit 4 **Contact Hour per week: 4**

Outline of the Course:

Course type	Theory
Purpose of Course	Higher study in chemistry is a current need of the competitive environment. The M.Sc. Analytical Chemistry provides knowledge and skill-based training to the students to flourish in research and in the professional career. The course offers a deep understanding of concept, theory and experiments that make students reach knowledge of techniques and methodologies of analytical chemistry. The dissertation in the end semester provides a research environment for the student to build a career in the research field.
Course Objective	CO 1. To familiarize with the basic principles, theory in potentiometry and To learn the basic concepts of electrical methods such as coulometry with their application in various titrations. • CO 2. To understand basic principles and theory of various Polarographic methods and their modified methods with applications. CO 3. To understand basic principles and theory of various voltammetry methods such Rapid scan, hydrodynamic, anodic stripping, cyclic with their application. CO 4. To understand the basic principles and theory of ion selective electrodes and their application for the determination of various ions in the solution with their instrumentation
Minimum weeks per Semester	15 (Including Class work, examination, preparation, holidays etc.)
Last Review / Revision	April 2024
Pre-requisite	• Fundamentals of Electrochemistry • Theories and Laws of electrochemistry • Basics of Analytical techniques
Teaching Methodology	Class Room Teaching, Use of ICT, Class exercise, Discussion and Assignment

Evaluation Method	40% Continuous Assessment (CA) 60% End Semester Examination (ESE)

Course Content:

Units	Particulars	% Weightage of Unit	Minimum Nos. of Hours
1	**POTENTIOMETRY AND COULOMETRY** (A) Fundamentals of potentiometry, Instrumentation, electrode system, potentiometric titrations, neutralization titrations, end- point detection, oxidation- reduction, precipitation titrations, complexometric titrations with example, applications and advantages. (B) Principle of Coulometry, Controlled current coulometry, Instrumentation and application of Controlled potential coulometry, Coulometric titrations and applications	25 %	15
2	**POLAROGRAPHIC METHODS** Theory and Applications of Polarography, Types of currents: Electro capillary maxima, Maxima of first kind and second kind , Maxima suppressors, DME as electrode, Wave equation, Ilkovic equation, Reversible electrode reactions at DME half wave potential, Interference and removal of oxygen. Modified polarographic techniques such as A. C. Polarography, Rapid Scan Polarography, Pulse polarography.	25 %	15
3	**VOLTAMMETRIC METHODS** Cyclic Voltammetry, Principle, Forward and reverse scan, cyclic voltammogram, Detection limits, Applications. Type of Electrodes, Introduction to Rapid Scan Voltammetry, Introduction to Hydrodynamic Voltammetry, Introduction to Anodic Stripping Voltammetry, Cathodic stripping. Introduction to Amperometric titrations and Biamperometric titration	25 %	15
4	**ION SELECTIVE ELECTRODES** Classification of ion selective electrodes, Solid state electrodes – Glass electrode effect of glass structure on selectivity function of the glass electrode. Acid error, Alkali error, Silver halide, Sulphide, Lanthanum fluoride ion selective electrodes. Liquid ion exchange electrode – Calcium selective ion electrodes. Gas electrodes, ammonia, sulphur dioxide, oxygen and CO2 sensing electrode, enzyme electrodes. Applications	25 %	15

REFERENCE:

1. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage learning, 7 th edition)
2. Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2 nd edition.

3. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5 th edition.
4. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (VanNostrand Reinhold Co., New York), 6 th edition.
5. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2nd edition.
6. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company),New Delhi.
7. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition)
8. Treatise on Analytical Chemistry: I. M. Kohthoff & P. J. Elving (John Wiley & Sons, NewYork).
9. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
10. Basic concepts of Analytical Chemistry by S.M. Khopkar
11. Standard Methods of Chemical Analysis: Vol. I & II (6th edition), D. Van Nostrand Co. Inc.(London).
12. Official Methods of Analysis: Published by Association of Official Analytical Chemists,Washington.
13. Instrumental Methods of Chemical Analysis: B. K. Sharma (Goel Publishing House, Meerut).
14. "Polarography": Kolthoff I. M. and Lingane J. J. (Vol. I & II) (Interscience Publishers, NewYork).
15. "Polarographic Techniques": L. Meites (Interscience Publishers, New York).
16. Principles of Instrumental Analysis (5th ed.) by Skoog, Holler and Nieman (Saunders College Publishing's).
17. Undergraduate Instrumental Analysis (5th ed.), J. W. Robinson (Marcel Dekker Inc.)

COURSE OUTCOMES:

Upon successful completion of the course,

CO 1.	Students will gain the idea for application of potentiometry and coulometry,
CO 2.	To understand the importance and applicability of polarographic methods of analysis
CO 3.	Students will be able to understand the importance of voltammetric methods of analysiss.
CO 4.	Obtain theoretical understanding of various type of ion selective electrode and their working with applications

COURSE OUTCOMES MAPPING

Unit No.	Title of the Unit	Course Outcomes			
		CO 1	CO 2	CO 3	CO 4
1	POTENTIOMETRY AND COULOMETRY				

2	**POLAROGRAPHIC METHODS**				
3	**VOLTAMMETRIC METHODS**				
4	**ION SELECTIVE ELECTRODES**				

COURSE ARTICULATION MATRIX

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1						
CO2						
CO3						
CO4						

VANITA VISHRAM WOMEN'S UNIVERSITY, SURAT
SCHOOL OF SCIENCE AND TECHNOLOGY
Department of Chemistry
M.Sc. Analytical Chemistry Program
Semester III

CH21430 : Advanced Analytical Techniques

Credit 4 **Contact Hour per week: 4**

Outline of the Course:

Course type	Theory
Purpose of Course	Higher study in chemistry is a current need of the competitive environment. The M.Sc. Analytical Chemistry programme provides knowledge and skill-based training to the students to flourish in research and in the professional career. The course offers a deep understanding of concept, theory and experiments that make students reach knowledge of chemistry. The dissertation in the end semester provides a research environment for the student to build a career in the research field.
Course Objective	CO 1. To learn the basic concept, theory, principles and instrumentation of electron spectroscopy and microscopic techniques which is applied for characterization of surface morphology of compounds. CO 2. To understand and familiarize the basic principles, theory and instrumentation of atomic X-ray spectroscopy, to impart knowledge in theory and principles of spectroscopy, spectroscopic technique for characterization and differentiation of various elements/ions CO 3. To understand the principles, instrumentation of advanced chromatography techniques and also learn the comparison and application in the various fields. • CO 4. Study of combination of two techniques and their advantages over single techniques and their application in various fields.
Minimum weeks per Semester	15 (Including Class work, examination, preparation, holidays etc.)
Last Review / Revision	April 2024
Pre-requisite	Basic knowledge of spectroscopy and chromatography
Teaching Methodology	Class Room Teaching, Use of ICT, Class exercise, Discussion and Assignment
Evaluation Method	40% Continuous Assessment (CA) 60% End Semester Examination (ESE)

Course Content:

Units	Particulars	% Weightage of Unit	Minimum Nos. of Hours
1	**SURFACE CHARACTERIZATION BY SPECTROSCOPY AND MICROSCOPY** Introduction, Types of surface measurements, Common Spectroscopy Techniques for Analysis of Surface, Sampling surfaces **Electron Spectroscopy:** X-ray Photoelectron spectroscopy, Principle instrumentation and Application. **Ion Spectroscopic Techniques:** Introduction to Secondary Ion Mass Spectrometry (SIMS) and Introduction to Laser Microprobe Mass Spectrometry **Microscopic Techniques:** Introduction to Scanning Electron Microscopy (SEM) , Introduction toScanning Tunneling Microscopy (STM) and Introduction to Atomic Force Microscopy (AFM)	25 %	15
2	**X- RAY METHODS OF ANALYSIS** Principle, Theory- X-ray spectral lines, instrumentation, Powder XRD and Single crystal XRD, Chemical analysis using X-ray absorption, X-ray Fluorescence instrumentation and chemical analysis, X-ray Diffraction, Chemical analysis with X-ray diffraction, numerical problems.	25 %	15
3	**ADVANCED CHROMATOGRAPHY** **Size Exclusion chromatography :** Theory, instrumentation and applications of gel permeation chromatography, retention behavior, inorganic molecular sieves. **Supercritical Fluid Chromatography (SFC):** Properties of supercritical fluid, Instrumentation and operating variables like effect of pressure, stationary phase, mobile phase, detectors, comparison with other chromatography, application.	25 %	15
4	**HYPHENATED TECHNIQUES AND AUTO ANALYSER** MS-FTIR, ICP-MS, GC- MS, LC-MS, MS-MS, GC-FTIR. TG-FTIR, TG-MS. Auto analyser: Importance and instrumentation for auto analyser, applications.	25 %	15

REFERENCE:

1. Chromatography Concept and Contrast, James M. Miller
2. Introduction to Spectroscopy By Pavia, Lampman, Kriz, Vyvyan
3. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage learning, 7 th edition)
4. Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2 nd edition.
5. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5 th edition.
6. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle

(VanNostrand Reinhold Co., New York), 6 th edition.
7. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2nd edition.
8. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company),New Delhi.
9. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition)
10. Treatise on Analytical Chemistry: I. M. Kohthoff & P. J. Elving (John Wiley & Sons, NewYork).
11. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
12. Basic concepts of Analytical Chemistry by S.M. Khopkar
13. Standard Methods of Chemical Analysis: Vol. I & II (6th edition), D. Van Nostrand Co. Inc.(London).
14. Instrumental Method of Chemical Analysis by G. R. Chatwal and S. K. Anand
15. Vogel's Textbook of Quantitative Chemical Analysis, Fifth Edition.

COURSE OUTCOMES:

Upon successful completion of the course,

CO 1.	to be able to understand and apply knowledge for various type of surface analysis
CO 2.	will be able to apply theoretical knowledge to perform eX-ray based spectroscopy
CO 3.	to be able to explain the extraction and exclusion chromatography
CO 4.	will be able to apply knowledge of hyphenated techniques in sample analysis

COURSE OUTCOMES MAPPING

Unit No.	Title of the Unit	Course Outcomes			
		CO 1	CO 2	CO 3	CO 4
1	SURFACE CHARACTERIZATION BY SPECTROSCOPY AND MICROSCOPY				
2	X- RAY METHODS OF ANALYSIS				
3	ADVANCED CHROMATOGRAPHY				
4	HYPHENATED TECHNIQUES AND AUTO ANALYSER				

COURSE ARTICULATION MATRIX

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

VANITA VISHRAM WOMEN'S UNIVERSITY, SURAT
SCHOOL OF SCIENCE AND TECHNOLOGY
Department of Chemistry
M.Sc. Analytical Chemistry Program
Semester II

CH21440 : Spectroscopic Techniques

Credit 4 **Contact Hour per week: 4**

Outline of the Course:

Course type	Theory
Purpose of Course	Higher study in chemistry is a current need of the competitive environment. The M.Sc. Chemistry and chemistry programmes provides knowledge and skill-based training to the students to flourish in research and in the professional career. The course offers a deep understanding of concept, theory and experiments that make students reach knowledge of chemistry. The dissertation in the end semester provides a research environment for the student to build a career in the research field.
Course Objective	CO 1. To understand and familiarize the basic principles, theory and instrumentation of NMR spectroscopy, spectroscopic technique for characterization CO 2. To understand and familiarize the basic principles, theory and instrumentation of ESR spectroscopy CO 3. To familiarize with the basic properties, theory and interpretation molecular mass edge in the theory and principles of spectroscopic techniques for characterization and differentiation of various molecules CO 4. To understand and familiarize the basic principles, theory and instrumentation of absorption and emission spectroscopy, to impart knowledge in theory and principles of spectroscopy,
Minimum weeks per Semester	15 (Including Class work, examination, preparation, holidays etc.)
Last Review / Revision	April 2024

Pre-requisite	Elementary knowledge of Spectroscopy
Teaching Methodology	Class Room Teaching, Use of ICT, Class exercise, Discussion and Assignment
Evaluation Method	40% Continuous Assessment (CA) 60% End Semester Examination (ESE)

Course Content:

Units	Particulars	% Weightage of Unit	Minimum Nos. of Hours
1	**NMR SPECTROSCOPY** Theory, principles and instrumentation of NMR spectroscopy. (i) ^{1}H NMR Spectroscopy Proton resonance condition, Aspects of PMR spectra – number of signals, chemical shift, factors influencing chemical shift, deshielding, Anisotropic effect, chemical shift values and correlation for protons bonded to carbons, effect of deuteration, spin-spin coupling, (n+1) rule, factors affecting coupling constant "J" (ii) ^{13}C NMR spectroscopy Types of ^{13}C NMR Spectra: proton coupled and decoupled ^{13}C spectra, chemical shift, calculations of chemical shifts, factors affecting chemical shifts .	25 %	15
2	**ELECTRON SPIN RESONANCE SPECTROSCOPY** Introduction, Factors affecting the g-value, Limitations of ESR, Difference between ESR and NMR, Instrumentation, Electron nucleus coupling, Hyperfine interactions-isotropic and anisotropic coupling constants, Quantitative analysis, Sensitivity, Choice of solvent, applications of ESR, Study of free radicals, Electronic and Hyperfine splitting, Triplet states- zero field splitting and Krammer's degeneracy, Analytical applications of ESR, Structural determination by ESR.	25 %	15
3	**MOLECULAR MASS SPECTROSCOPY** Theory and principles of mass spectroscopy; Instrumentation; Ionization techniques – Electron Impact (EI) ionization, Chemical Ionization (CI) etc, Mass Analyzers, Detectors; Determination of molecular weight and molecular formula, nitrogen rule, detection of molecular ion peak, metastable ion peak; Fragmentations – rules governing the fragmentations, McLafferty rearrangement; Interpretation of mass spectra of different class of compounds, To write possible fragmentation for given compound; To identify structure from mass spectral data.	25 %	15
4	**ATOMIC SPECTROSCOPY** **Atomic Absorption Spectroscopy (AAS)** : Principle of AAS, Instrument, Continuous sources and line sources, Flames, Flame atomizers, Non flame atomizers (furnaces), Monochromator and Detector, Quantitative Analysis with AAS, Applications. **Atomic Emission Spectroscopy (AES):** Emission spectroscopy with plasma sources, Instrument, AES with electrical discharge,	25 %	15

	Electrodes of AES, DC- arc, spark, Laser microprobe, Salient features of the emission spectrograph, Qualitative and Quantitative analysis and applications**.**		

REFERENCE:

1. Introduction to Spectroscopy By Pavia, Lampman, Kriz, Vyvyan
2. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage learning, 7 th edition)
3. Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2ndedition.
4. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5 th edition.
5. Spectroscopy by H. Kaur, Pragati Prakashan
6. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (VanNostrand Reinhold Co., New York), 6 th edition.
7. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company),New Delhi.
8. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
9. Basic concepts of Analytical Chemistry by S.M. Khopkar
10. Instrumental Methods of Chemical Analysis: B. K. Sharma (Goel Publishing House, Meerut).
11. Instrumental methods of Chemical Analysis by H. Kaur.
12. Undergraduate Instrumental Analysis (5th ed.), J. W. Robinson (Marcel Dekker Inc.).
13. Fundamentals of Molecular Spectroscopy, by Banwell.
14. Introduction to Spectroscopy (3rd ed.) by Pavia Lampman Kriz, Cengage Learning Harcourt College Publishers

COURSE OUTCOMES:

After completion the course, the learner shall be able to:

CO 1.	Explain principle working and structural elucidation using NMR.
CO 2.	Having a detailed knowledge ofESR spectroscopy.
CO 3.	Knowledge mass spectroscopy and understanding of fragmentation of compounds using mass spectroscopy.
CO 4.	Having a detailed knowledge of Absorption and Emission spectroscopy and its application.

COURSE OUTCOMES MAPPING

Unit No.	Title of the Unit	Course Outcomes			
		CO 1	CO 2	CO 3	CO 4
1	NMR SPECTROSCOPY				

2	**ELECTRON SPIN RESONANCE SPECTROSCOPY**				
3	**MOLECULAR MASS SPECTROSCOPY**				
4	**ATOMIC SPECTROSCOPY**				

COURSE ARTICULATION MATRIX

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1						
CO2						
CO3						
CO4						

VANITA VISHRAM WOMEN'S UNIVERSITY, SURAT

SCHOOL OF SCIENCE AND TECHNOLOGY

Department of Chemistry

M.Sc. Analytical Chemistry Program

Semester III

CH21450: Analytical Chemistry Practical-III (Pr)

Credit 4 **Contact Hour per week: 4**

Outline of the Course:

Course type	Practical
Purpose of Course	Higher study in chemistry is a current need of the competitive environment. The M.Sc. Analytical Chemistry and chemistry programmes provides knowledge and skill-based training to the students to flourish in research and in the professional career. The course offers a deep understanding of concept, theory and experiments that make students reach knowledge of chemistry. The dissertation in the end semester provides a research environment for the student to build a career in the research field.
Course Objective	CO 1. Equip students with practical skills in analyzing commercial and industrial samples using various analytical techniques and spectrophotometry. CO 2. Teach precise quantitative assays, chromatographic methods, and electrochemical analysis for comprehensive sample analysis. CO 3. Equip students with skills in using MS Word for report writing, MS Excel for data analysis, and MS PowerPoint for presentations. CO 4. To prepare students to use Origin software for advanced statistical data analysis and creating charts/graphs.
Minimum weeks per Semester	15 (Including Class work, examination, preparation, holidays etc.)
Last Review / Revision	April 2024
Pre-requisite	Elementary knowledge of Chemistry
Teaching Methodology	Class Room Teaching, Use of ICT, Class exercise, Discussion and Assignment
Evaluation Method	40% Continuous Assessment (CA) 60% End Semester Examination (ESE)

Units	Particulars	% Weightage of Unit	Minimum Nos. of Hours
1	**Analytical Experiments: (Any Four)** 1.1 Analysis of Given Sample of commercial Tablet (Aspirin or Analgin) 1.2 Analysis of Cement Sample. 1.3 Analysis of Ultramarine Sample. 1.4 Determination of Fe by photometric Titration. 1.5 Determination of Ni by Spectrophotometry. 1.6 Titrimetric Assay of Vitamin - C (L- Ascorbic Acid) 1.7 Determination of Iodine value And/OR saponification value of given Oil/Fat sample. 1.8 Analysis of Organic Material. (Aniline/Glycerol/Glycine/Phenol). 1.9 Determination of salt content by Ion Exchange Column. 2.0 Thin Layer Chromatography. 2.1 Constant Current coulometric Titration of Arsenic/Phenol. 2.2 Electrogravimetric Analysis of Copper.	**50 %**	
2	**Computer Assisted Research Tools:** 2.1 Report Writing in **MS Word**, Its Features and Function 2.2 Usage of **MS Excel**, Its Formulas and Functions 2.3 Creating **MS PowerPoint** Presentation 2.4 **Origin Software** in Research, Its Features for Statistical Data Analysis, Generating Charts/Graphs	**50%**	

REFERENCE:

1. Vogel's Textbook of Quantitative Chemical Analysis, Fifth Edition.
2. Quantitative Chemical Analysis, R.B. Fischer and D.G. Peters, 3rd Edition, D.B. Saunders Company, 1968 or latest edition.
3. Advanced Physical Chemistry Practicals by J. B. Yadav
4. Laboratory directions for analytical separation and determinations, C.T. Kenner, MacMillan Company, New York, 1971.
5. Inorganic Qualitative analysis, A.I. Vogel, 5th Edition, ELBS/ Longman, 1989.
6. Colorimetric methods of analysis, Snell and Snell, D. Van Nostrand, latest edition. E.D.T.A. titrations, latest edition, Fleshka, Pergamon process.
7. Academic Writing and Composition, Dev, Anjana Neira.. New Delhi: Pinnacle, 2015.
8. Introduction to Computers-PeterNorton-TheMcGraw-Hill Companies.

COURSE OUTCOMES:

After completion the course, the learner shall be able to:

CO 1.	Students will be able to perform detailed analyses of various samples, including pharmaceuticals, industrial materials, and organic compounds, using multiple analytical techniques.
CO 2.	Students will gain expertise in titrimetric, spectroscopic, chromatographic, and electrochemical methods for precise and accurate determinations.
CO 3.	Students will be able to create professional reports, presentations, and manage data efficiently using MS Word, Excel, and PowerPoint.
CO 4.	Students will gain the ability to perform advanced statistical data analysis and create detailed visualizations using Origin software.

COURSE OUTCOMES MAPPING

Unit No.	Title of the Unit	Course Outcomes			
		CO 1	CO 2	CO 3	CO 4
1	**Analytical Experiments**				
2	**Computer Assisted Research Tools**				

COURSE ARTICULATION MATRIX

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

VANITA VISHRAM WOMEN'S UNIVERSITY, SURAT
SCHOOL OF SCIENCE AND TECHNOLOGY
Department of Chemistry
M.Sc. Analytical Chemistry Program
Semester III
DSE-I

CH24090 : Polymer Chemistry

Credit 4 **Contact Hour per week: 4**

Outline of the Course:

Course type	Theory
Purpose of Course	Higher study in chemistry is a current need of the competitive environment. The M.Sc. Organic Chemistry provides knowledge and skill-based training to the students to flourish in research and in the professional career. The course offers a deep understanding of concept, theory and experiments that make students reach knowledge of organic chemistry. The dissertation in the end semester provides a research environment for the student to build a career in the research field.
Course Objective	CO1. The aim is to give basic understanding of polymers and their importance as well as application in various fields. CO2. To furnish a strong foundation in the subject of polymer chemistry. CO3. To gain the understanding of various methods of polymer processing.
Minimum weeks per Semester	15 (Including Class work, examination, preparation, holidays etc.)
Last Review / Revision	April 2024
Pre-requisite	Elementary knowledge of Polymers
Teaching Methodology	Class Room Teaching, Use of ICT, Class exercise, Discussion and Assignment
Evaluation Method	40% Continuous Assessment (CA) 60% End Semester Examination (ESE)

Course Content:

Units	Particulars	% Weightage of Unit	Minimum Nos. of Hours
1	**Chemistry and Mechanism of polymerization:** History of Polymers, Introduction to polymers with emphasis on important concepts such as – monomers, functionality and physical state (amorphous and crystalline), classification of polymers: Natural and Synthetic, Organic and Inorganic, Thermoplastic and Thermosetting etc., geometry and stereo regularity. Nomenclature of polymers. Definition of polymerization, factors affecting on polymerization, Addition polymerization (free radical, ionic and co-ordination polymerization).Condensation polymerization.	25 %z	15
2	**Concept of polymer molecular weight:** Importance of molecular weight control. Arthemitic mean-molecular weight, number –average molecular weight (M_n) ,Weight average molecular weight, (M_w), and sedimentation and viscosity average molecular weight (M_v). Molecular weight and degree of polymerization, polydispersity and molecular weight distribution, practical significance of polymer molecular weight. Determination of molecular weight- End group analysis, cryoscopic method, light scattering & viscometry.	25 %	15
3	**Polymer processing and testing** Processing of polymers: Moulding-compression moulding, injection moulding, Blow moulding, Extrusion moulding, Thermoforming, Determination of glass transition temperature: dilatometric method, Thermomechanical method(TMA), calorimetric method. Rheology of Polymers, Structure–Rheology Relationship Typical Stress–Strain Behavior Use of Rheology to Produce Better Final Products	25 %	15
4	**Speciality Polymers** ***Thermoplastic polymers***: Polycarbonate(Lexan),Preparation, Physical properties, Applications ***Biodegradable polymers***: Features, Factors, Physical properties and applications of Polyhydroxybutarete (PHB), Polyhydroxyvalarate (PHV) ***Conducting Polymers:*** Intrinsically Conducting Polymers (ICP), Doped Conducting Polymers(DCP) and Coordination Conducting Polymers (CCP), Conductivity in Conducting Polymers, Applications and Limitation.	25 %	15

REFERENCE BOOKS:

- Polymer Chemistry- Seymour& Carreher, Marcel Dekkar, NY.
- Polymer Science -Gowarikar, Wiley Estern Ltd. New Delhi
- Principles of Polymerization-Odian G, wiley Inter Science, New Delhi
- Fundamentals of Polymer Science and Engineering- anilkumar & S.K. Gupta, Tata McGraw Hill, New Delhi
- Textbook of Polymer Science - F.W. Billmeyer.

COURSE OUTCOMES:

Upon successful completion of the course, the learner shall be able to:

CO 1	Have a strong foundation in understanding the basic chemical and polymer reactions
CO 2	Develop practical skills along with their theory components of polymers.
CO 3	Help in them in academic institutions and in R & D programmes of industries

COURSE OUTCOMES MAPPING

Unit No.	Title of the Unit	Course Outcomes		
		CO 1	CO 2	CO 3
1	Chemistry and Mechanism of polymerization			
2	Concept of polymer molecular weight			
3	Polymer processing and testing			
4	Speciality polymers			

COURSE ARTICULATION MATRIX

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						

SCHOOL OF SCIENCE AND TECHNOLOGY
Department of Chemistry
M.Sc. Analytical Chemistry Program
Semester III
DSE-II

CH24110 : Analysis of Industrial Products

Credit 4 **Contact Hour per week: 4**

Outline of the Course:

Course type	Theory
Purpose of Course	Higher study in chemistry is a current need of the competitive environment. The M.Sc. Analytical Chemistry provides knowledge and skill-based training to the students to flourish in research and in the professional career. The course offers a deep understanding of concept, theory and experiments that make students reach knowledge of organic chemistry. The dissertation in the end semester provides a research environment for the student to build a career in the research field.
Course Objective	CO1. The aim is to give basic understanding of various type of industrial and clinical sample analysis . CO2. To furnish a strong foundation in the analysis of various samples. CO3. To gain the understanding of determination of various vitamins and pain pigment samples.
Minimum weeks per Semester	15 (Including Class work, examination, preparation, holidays etc.)
Last Review / Revision	April 2024
Pre-requisite	Elementary knowledge of various analytical methods
Teaching Methodology	Class Room Teaching, Use of ICT, Class exercise, Discussion and Assignment
Evaluation Method	40% Continuous Assessment (CA) 60% End Semester Examination (ESE)

Course Content:

Units	Particulars	% Weightage of Unit	Minimum Nos. of Hours
1	**ANALYSIS OF SOAPS, DETERGENTS AND AGRO-CHEMICALS** Soaps and Detergents: Classification of detergents, Action of detergents, Determination of alcohol soluble materials, moisture, active constituents, silicates, phosphates, borates. Agro-Chemicals: Introduction of Various Agro-chemicals, Classical and instrumental method of various agrochemicals analysis, ISI specification and analysis of BHC, Malanion, DDT.	25 %z	15
2	**ANALYSIS OF VITAMINS** General Classification of Vitamins, Carr-Price Method of Vitamin A, Spectroscopic Method For Vitamin D, Determination of Total Assay Vitamin E, Determination of Vitamin B1, Determination of Assay of Vitamin B2 by Fluorometric Method, Method, Spectroscopic Determination of Vitamin B12, Folic Acid by Colorimetric Method, Ascorbic Acid by Iodate Titration Method.	25 %	15
3	**FORENSIC AND CLINICAL ANALYSIS** Forensic Analysis: Introduction and Importance of forensic Analytical analysis, Drug Identification: overview, drug classes, spot tests, Toxicology: ethanol, breath testing, headspace GC, Trace analysis: microscopy-hair, fiber, forensic pathologist, DNA analysis Clinical analysis: Introduction and overview of clinical analysis, Composition of blood, collection and preservation of samples and its analysis, Hyphenated techniques use in clinical analysis, Pharmacogentic testing.	25 %	15
4	**ANALYSIS OF PAINTS AND PIGMENT** Introduction, test of Volatile and Non-volatile content, separation of pigment binder, Analysis of pigments, Identification of inorganic pigments, Analysis of white and tinted pigments, analysis of ultramarine blue, Black pigments, Red Lead pigments	25 %	15

REFERENCE BOOKS:

- Standard Methods of Chemical analysis Vol. I & II wil W. Scott D. Van Nostrand Co. Inc.

Rinceton New Jersey, Toronto, N.Y.
- Commercial method of analysis By Foster Dec Snell, Frank M. Biffeu Taraporwak and sons.
- Encyclopaedia of Industrial chemical analysis Vol. I & II, W. Scott, D. Van Nostrand Co. Inc. Princeton New Jersey, Toronto, N.Y.
- Spectroscopy of Polymer IInd Edition By Jack L. Koenig , Elsevier Science Inc. 655 Avenue of Americas, New York USA.
- Food composition and analysis By Howard Triebold, Leonard W. Auranel D Van Nostrand Company, Inc. Prienceton, New Jersey, Toronto.
- Metallurgical analysis By B. C. Agrawal & S. P. Jain Khanna Publisher.
- Applied Complexometry By Rudolf Pribrill and R. A. Chalmess Oxford N. Y. 9. W.G. Eckert,
- Introduction to Forensic Sciences, Second Edition, Elsevier, New York, 1992. 10. B.A. J. Fisher,
- Techniques of Crime Scene Investigation, Seventh Edition, CRC Press, Boca Raton, 2004
- Analytical Chemistry by Gary D Christian, 6th Edition, Wiley India

COURSE OUTCOMES:

Upon successful completion of the course, the learner shall be able to:

CO 1	Have a strong foundation in understanding the various analysis to determine soaps and detergents paints and pigments
CO 2	Develop practical skills along with their theory components to analyze, Vitamins Forensics and clinical samples.
CO 3	Help in them in academic institutions and in R & D programmes of industries

COURSE OUTCOMES MAPPING

Unit No.	Title of the Unit	Course Outcomes		
		CO 1	CO 2	CO 3
1	ANALYSIS OF SOAPS, DETERGENTS AND AGRO-CHEMICALS			
2	ANALYSIS OF VITAMINS			
3	FORENSIC AND CLINICAL ANALYSIS			
4	ANALYSIS OF PAINTS AND PIGMENT			

COURSE ARTICULATION MATRIX

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						

CO2						
CO3						

SCHOOL OF SCIENCE AND TECHNOLOGY
Department of Chemistry
M.Sc. Analytical Chemistry Program
Semester III
Core Course

CH21460: Project (Pr)

Credit 4 **Contact Hour per week: 08**

Course type	Practical
Purpose of Course	Higher study in chemistry is a current need of the competitive environment. The M.Sc. Analytical Chemistry provides knowledge and skill-based training to the students to flourish in research and in the professional career. To train students to find reference material. To train students to analyze, condense and evaluate articles/reports. To understand the importance of different types of scientific writing /documentation. To help students develop an ability to make effective presentations. To develop competence in writing and abstracting skills
Course Objective	To be able to learn how to search, write and present research/experimental work.
Minimum weeks per Semester	15 (Including Research/ Experimental, examination, preparation, holidays etc.)
Last Review / Revision	April 2024
Pre-requisite	Elementary knowledge of various chemical and analytical methods
Teaching Methodology	Experiment Performance, Use of ICT, Class exercise, Discussion and Assignment
Evaluation Method	40% Continuous Assessment (CA) 60% End Semester Examination (ESE)

Course Objectives

This course will enable the students

12 Teaching Methodology

A teaching method comprises the principles and methods used by teachers to enable student learning. In order to achieve its objective of focused process- based learning and holistic development, the teacher/faculty may use a variety of knowledge delivery methods:

12.1 Lectures/Class works:

Lectures should be designed to provide the learners with interesting and fresh perspectives on the subject matter. Lectures should be interactive in a way that students work with their teachers to get new insights in the subject area, on which they can build their own bridges to higher learning. Classwork has the ability to enhance relationships between teachers and students. Create goal- oriented tasks for students to prepare and enable self-learning.

12.2 Discussions/ Seminars/Presentation:

Discussions / seminars / presentations are critical components of learning and can be used as a platform for students to be creative and critical with old and new ideas. Besides developing critiquing skills, arriving at consensus on various real-life issues and discussion groups lead to innovative problem-solving and ultimately to success.

12.3 Case Studies/ Self-Study:

Real case studies, wherever possible, should be encouraged in order to challenge students to find creative solutions to complex problems of individual, community, society and various aspects of the knowledge domain concerned. Technology is transforming higher Education learning and teaching through various case studies to improve overall standards.

12.4 Practical/Problem sheet:

Practical ability is the essential requirement for computer science undergraduates' ability structure, and it emphasizes that computer science undergraduates should have a good grasp of theory from practice and then apply the theory to practice, improving them own software developing skills and employability.

12.5 Assignments:

Computer science assignments not only help students overcome their fear and stress but also help them learn more interesting facts about the subjects of computer science which are part of their syllabus and also out of curriculum.

12.6 Industrial Tours:

Computer Science students have to know the things practically through interaction, working methods and employment practices. Moreover, it gives exposure from an academic point of view. Main aim of the industrial visit is to provide an exposure to students about the practical working environment.

12.7 Team Work:

Teamwork based projects challenge the student to apply the technical knowledge they gain in college to solve meaningful and complex problems. Positive collaboration in the form of team work is critical in the classroom environment, for which it is necessary to transcend one’s prejudices and predilections so as to achieve the desired outcomes. In the process of teamwork, learners will acquire the skills of managing knowledge acquisition and other collaborative learners, thereby understanding how to incorporate and balance personalities.

13 Keywords

Masters of Science (M.Sc.) in Analytical Chemistry
Spectroscopy
Absorption Spectroscopy

Chromatography
Electrochemistry
Surface Chemistry
Material Analysis
Polymer Chemistry