



Re-Accredited 'B++' 2.86 CGPA by NAAC

VEER NARMAD SOUTH GUJARAT UNIVERSITY

University Campus, Udhna-Magdalla Road, SURAT - 395 007, Gujarat, India.

વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી

યુનિવર્સિટી કેમ્પસ, ઉદ્ધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.

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-: પરિપત્ર :-

વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન તમામ કોલેજોનાં આચાર્યશ્રીઓને તથા વિભાગીય વડાશ્રીને જણાવવાનું કે, શૈક્ષણિક વર્ષ ૨૦૨૩-૨૪ થી અમલમાં આવનાર M.Sc.Analytical Chemistry Sem.-3 નો સુધારેલ અભ્યાસક્રમ રસાયણશાસ્ત્ર વિષયની અભ્યાસ સમિતિના ચેરમેનશ્રીએ અભ્યાસ સમિતિ વતી મંજૂર કરી વિજ્ઞાન વિદ્યાશાખાને કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાના અધ્યક્ષશ્રીએ વિદ્યાશાખાની મંજૂરીની અપેક્ષાએ વિદ્યાશાખા વતી મંજૂર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલ તા.૦૬/૦૧/૨૦૨૪ની સભાનાં ઠરાવ ક્રમાંક:૩૭ થી સ્વીકારી મંજૂર કરેલ છે. જેનો અમલ કરવા આથી જાણ કરવામાં આવે છે.

એકેડેમિક કાઉન્સિલ તા.૦૬/૦૧/૨૦૨૪ની સભાનાં ઠરાવ ક્રમાંક:૩૭

:: આથી ઠરાવવામાં આવે છે કે, શૈક્ષણિક વર્ષ ૨૦૨૩-૨૪ થી અમલમાં આવનાર M.Sc.Analytical Chemistry Sem.-3 નો સુધારેલ અભ્યાસક્રમ રસાયણશાસ્ત્ર વિષયની અભ્યાસ સમિતિના ચેરમેનશ્રીએ અભ્યાસ સમિતિવતી મંજૂર કરી વિજ્ઞાન વિદ્યાશાખાને કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાના અધ્યક્ષશ્રીએ વિદ્યાશાખાની મંજૂરીની અપેક્ષાએ વિદ્યાશાખા વતી મંજૂર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ સ્વીકારી મંજૂર કરવામાં આવે છે.

ખિડાણ: ઉપર મુજબ

ક્રમાંક : એસ./સાયન્સ/પરિપત્ર/૬૬૭/૨૦૨૪

તા.૦૮-૦૧-૨૦૨૪

Wiferu
કુલસચિવ વ્હા

પ્રતિ,

- ૧) વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન તમામ કોલેજોનાં આચાર્યશ્રીઓ તથા વિભાગીય વડાશ્રી.
..... આપશ્રીની કોલેજ/વિભાગના સંબંધિત શિક્ષકોને જાણ કરી અમલ કરવા સારૂ.
- ૨) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.
- ૩) પરીક્ષા નિયામકશ્રી, પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.
.....તરફ જાણ તેમજ અમલ સારૂ.

Page 37
Page 13

અકેડેમિક સર્વિસ નં. 06/01-2024
બાંધકામ 37 સુવર્ણજીવન 13

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Veer Narmad South Gujarat University, Surat

Syllabus

M.Sc. Analytical Chemistry

Semester III

To be effective from June-2023

NEP-2020



Faculty and A.C. 211
પ્રભાત મહાપાત્ર ઈ.
(12/15)

M.B. Mahesh Page 1 of 24

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Name of Program	Master of Science (Chemistry) or M.Sc. Organic Chemistry (Evening)
Abbreviation	M.Sc.
Duration	2 Years
Eligibility Criteria	<p>M.Sc. Chemistry (Organic/Inorganic/Analytical/Physical) ELIGIBILITY: Graduation in Science with Chemistry or any subject equivalent to or allied to Chemistry.</p> <p>M.Sc. (Organic Chemistry) ELIGIBILITY: Graduation in Science with Chemistry or any subject equivalent to or allied to Chemistry.</p> <p>M.Sc. (Environmental Chemistry) ELIGIBILITY: Graduation in Science with Chemistry or any subject equivalent to or allied to Chemistry.</p> <p>M.Sc. (Pharmaceutical Chemistry) ELIGIBILITY: Graduation in Science with Chemistry or any subject equivalent to or allied to Chemistry.</p> <p>M.Sc. Organic Chemistry (Evening) ELIGIBILITY: Graduation in Science with Chemistry or any subject equivalent to or allied to Chemistry.</p>
Objective of Program	The core objective of the M.Sc. programme is to prepare the students for dynamic career in industry and academia by providing an excellent environment of teaching and research in the core and emerging areas of the discipline.
Program Outcome	<p>PO1: To enhance the knowledge in chemistry domains and become master in respective branch of chemistry. To be able to communicate clearly and effectively within and across disciplinary lines.</p> <p>PO2: Built up entrepreneurship ability by taking advantage of industrial hub in periphery of our university.</p> <p>PO3: Establishment of research center with the aid of interdisciplinary subject being run in university.</p> <p>PO4: Persuasion of doctoral degree in the concern subject and further study.</p> <p>PO5: Development of related short-term courses related to demanded subject in anticipation of strengthening knowledge and application.</p> <p>PO6: Training/internship of students for employment in public sector, private sector and national laboratories.</p> <p>PO7: Participation in scientific discussions showing respect and lead interdisciplinary work with experts from other fields.</p> <p>PO8: To understand and adopt the best safety practices in chemical research.</p> <p>PO9: Participation in scientific discussions showing respect and lead interdisciplinary work with experts from other fields.</p> <p>PO10: To understand and adopt the best safety practices in research.</p>
Program Specific Outcomes	Students need to build up foundation in the fundamentals & application of current chemical and scientific theories in the concerned branches of Inorganic, Organic, Analytical, Physical, Environmental and Pharmaceutical Chemistry.

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	<p>PSO1: Develop scientific temper, communicate scientific information in a clear, concise and precise manner.</p> <p>PSO2: Find job opportunities at all level of chemical industries (dyes & pharmaceutical), national laboratories & research centers.</p> <p>PSO3: Apply the knowledge in sustainable and ecofriendly technologies.</p> <p>PSO4: Inculcate logical thinking to address the problem and become result oriented.</p> <p>PSO5: Development of research culture in persuasion of Ph.D. program at national & international institute/university.</p> <p>PSO6: Participate in specific competitive examination conducted by various public service commission and other public sector.</p> <p>PSO7: Develop and apply the fundamental knowledge to build small scale industry in context to Atma Nirbhar Bharat.</p> <p>PSO8: Scale up the synthetic product to a pilot level plant and gradually to bulk.</p> <p>PSO9: Enhance the scientific temperament among the students in anticipation of developing research culture and implementation of policies at global & local level.</p> <p>PSO10: Communicate scientific information clear in both writing and orally.</p> <p>PSO11: Students shall start to become better readers, thinkers and learners in their discipline by processing their ideas through writing.</p> <p>PSO12: Will build new scientific understanding as it provides students the opportunity to articulate their thinking as they engage in the science practices during an investigation.</p>												
Mapping between POs and PSOs		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO 10	PSO 11	PSO 12
	PO 1												
	PO 2												
	PO 3												
	PO 4												
	PO 5												
	PO 6												
	PO 7												
	PO 8												
	PO 9												
	PO10												
Medium of Instruction	English												

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M.Sc. Semester-III (ANALYTICAL CHEMISTRY)
Teaching & Evaluation Scheme Semester-III

Theory Paper/ Practical	Teaching schedule Hrs./Week	Exam Schedule			Total Marks	Credit
		Duration (Hrs.)	Internal Marks	External Marks		
Theory Paper						
1. Analytical methods of Analysis (ACC-301)	4	3	30	70	100	4
2. Molecular Spectroscopy (ACC-302)	4	3	30	70	100	4
3. Electroanalytical Techniques. (ACC-303)	4	3	30	70	100	4
Inter/multidisciplinary (AEC) 4. Elective Paper-1 (AEC-301) Applied Analysis-I or Elective Paper-2 (AEC-302) Applied Analysis-II	4	3	30	70	100	4
5. Skilled Based elective Paper/Swayam/other MOOC courses (ASEC-301)	2	2	15	35	50	2
6. Practical (AP-301)	12	12	60	140	200	6
Total	30	26	195	455	650	24

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Master of Science, Analytical Chemistry
 M.Sc. Analytical Chemistry, Semester-III
 Paper-I (Analytical Methods of Analysis)
 Proposed Syllabus To be Effective from June-2023
 (NEP-2020)

Total Periods:60

Course Code	ACC-301	Title of the Course	Analytical Methods of Analysis
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	<ul style="list-style-type: none"> To understand advancement in thermal methods of analysis with various factors affecting the results and their application in various field. To learn the basic concepts of electrical methods such as coulometry, electrogravimetry with their application in various titrations. To understand basic principles and theory of various voltammetry methods such Rapid scan, hydrodynamic, anodic stripping, cyclic with their application. To learn basic principles, theory of radio chemical methods, half- life and different uses of radioactive substance in various application.
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Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1												
	CO2												
	CO3												
	CO4												

Course Content		
Unit	Description	Periods
1.	THERMAL METHODS OF ANALYSIS Differential thermal analysis (DTA), Differential scanning calorimetry (DSC), Instrument, Reference materials, Diluents, Factors affecting DTA results, Applications, Evolved gas detection and analysis, Instrumentation, application, hyphenation with other techniques. Direct Injection Enthalpimetry, Applications, Numerical.	15
2.	ELECTRICAL METHODS OF ANALYSIS	15

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	Liquid Junction Potential, Mass transfer, Electric Double layer, Faradic and Non-faradic Current, Polarization effect, Types of Polarization, Electrogravimetry, Constant Potential and current Electrolysis, Factors affecting the quality of deposits, Applications. Principle of Coulometry, Controlled current coulometry, Instrumentation and application of Controlled potential coulometry, Coulometric titrations (primary and secondary), endpoint detection in coulometry titration, applications, and Problems.	
3.	<p>VOLTAMETRY METHODS OF ANALYSIS</p> <p>Rapid Scan Voltammetry: Principle, Rapid voltage scan at the end of the drop life, Peak current equation, Relation of peak current with the scanning rates, Summit potential equation, Comparison with DC polarography, Limitations.</p> <p>Hydrodynamic Voltammetry: Principle and similarity with DC polarography, Types of electrodes used, Applications of the technique in determination of rate constant of the reaction.</p> <p>Anodic Stripping Voltammetry: Concentration and stripping steps, Importance of Hanging mercury drop electrode and MTFE, Sensitivity of the technique, Adsorptive stripping, Applications, Cathodic stripping.</p> <p>Cyclic Voltammetry: Principle, Forward and reverse scan, cyclic voltammogram, Detection limits, Applications.</p>	15
4.	<p>RADIO-CHEMICAL METHODS OF ANALYSIS</p> <p>Interaction of radiation with matter, Units of radioactivity, Statistics of counting, Background corrections, Neutron activation analysis, Sources of neutrons, Theory of instrumental neutron activation analysis, Experimental considerations, Isotope dilution analysis (Direct and Inverse), Radio immuno assay, Radiometric titrations, Radio release methods, Radiation safety, Numerical.</p>	15

Teaching-Learning Methodology	To meet the effective teaching and the learning requirements, teaching-learning methodology comprise classroom teaching, use of e-resources, library books, IT tools, encouraging students to participate in seminars/ workshops, presentations by students, assignments etc.
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30 marks
2.	University Examination	70 marks

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Course Outcome: Having Completed this course, the learner will be able to	
1.	Learn the temperature-based methods and their advantages and application in various fields. Understand the basic instrument design their working and their application with the help of numerical.
2.	Understand the basic theory of liquid junction potential, coulometer and electrogravimetry and their working. Also learn in-depth of coulometry methods and their application in various titration.
3.	Learn different principles of rapid scan, hydrodynamic, Cyclic and hydrodynamic voltammetry and comparison as well their limitation and application.
4.	Understand the interaction of radioactive radiation with matter such as gamma, beta, alpha, X-ray and neutron. Also learn the application of various radioactive radiation in various titration with experimental consideration.

Suggested Reference Books:

1. Vogel's Text book Quantitative Chemical Analysis 5th edition by G.H.Jeffery, J. Bassett, J.Mendham, R.C. Denney.
2. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage learning, 7th edition)
3. Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2nd edition).
4. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th edition.
5. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (VanNostrand Reinhold Co., New York), 6th 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. 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. "Polarography", J. D. Talati (In Gujarati), University Granth Nirman Board.
13. "Polarography": Kolthoff I. M. and Lingane J. J. (Vol. I & II) (Interscience Publishers, New York).
14. "Polarographic Techniques": L. Meites (Interscience Publishers, New York).
15. Undergraduate Instrumental Analysis (5th ed.), J. W. Robinson (Marcel Dekker Inc.).

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**Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester-III
Paper-II (Molecular Spectroscopy)
Proposed Syllabus To be Effective from June-2023
(NEP-2020)**

Total Periods:60

Course Code	ACC-302	Title of the Course	Molecular Spectroscopy
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	<ul style="list-style-type: none"> • To familiarize with the basic properties, theory & interpretation of IR and Raman edge in the theory and principles of spectroscopic techniques for characterization and differentiation of various molecules. • To familiarize with the basic properties, theory and interpretation of NMR edge in the theory and principles of spectroscopic techniques for characterization differentiation of various molecules. • 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. • To familiarize with the basic properties, theory and interpretation of luminescence edge in the theory and principles of spectroscopic techniques for characterization and differentiation of various molecules.
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Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1	■	■	■	■	■	■	■	■	■	■	■	■
	CO2	■	■	■	■	■	■	■	■	■	■	■	■
	CO3	■	■	■	■	■	■	■	■	■	■	■	■
	CO4	■	■	■	■	■	■	■	■	■	■	■	■

Course Content		
Unit	Description	Periods
1.	IR AND RAMAN SPECTROSCOPY Theory of IR and Raman, selection rules, IR absorption, Raman scattering, Mutual exclusion rule, complimentary techniques, Instrumentation - FTIR and Raman, Cells and sampling techniques,	15

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	Resonance Raman spectroscopy, Interpretation of IR spectra using correlation charts, Advantages of FTIR spectroscopy, Mid-IR Reflection – DRS, ATR, Data processing in Near IR, Applications in structure, elucidation of inorganic and organic molecules.	
2.	NMR SPECTROSCOPY Theory of NMR, NMR Active nuclei, Relaxation, population of energy levels, Larmor precession, chemical shift and factors affecting it, references and solvents, Spin-spin splitting, hyperfine splitting, Coupling constant, Magnetic Anisotropy, Instrumentation, Shift Reagents, Interpretation of simple and higher resolution NMR spectra, Signal averaging, FT-NMR, Pulse FT-NMR spectroscopy, ¹³ C NMR spectra, Calculation of chemical shift in ¹³ C NMR, NMR in medical diagnostics, Double resonance technique, Multi-dimensional NMR, 2D correlation spectra, Problems to elucidate structure from NMR spectra, Interpretation of NMR spectra.	15
3.	MOLECULAR MASS SPECTROSCOPY Instrumentation, Methods of ion production (EI, CI, FI, FD, SIMS, Electrospray, MALDI. Ion separators, Ion collection and recording, Double focusing, Time of flight analyzer, Quadruple-mass spectrometer. Sample handling techniques, Resolution, Parent peak, Base peak, Metastable ions isotope effect, Molecular formula from mass spectra, Nitrogen rule, Ring rule, Fragmentation rules, McLafferty rearrangement, Behavior of classes of compounds, Interpretation and data evaluation of mass spectra, Additional applications, Problems to elucidate structure from mass spectral data, HRMS.	15
4.	MOLECULAR LUMINESCENCE SPECTROSCOPY Introduction to molecular luminescence (fluorescence, phosphorescence and chemiluminescence); theory of luminescence, energy level diagram, Deactivation process, instruments for measuring fluorescence (fluorometer and spectrofluorometer); factor affecting, Emission and excitation spectra, wavelength selector, detector, applications, and problems and data evaluation.	15

Teaching-Learning Methodology	To meet the effective teaching and the learning requirements, teaching-learning methodology comprise classroom teaching, use of e-resources, library books, IT tools, encouraging students to participate in seminars/ workshops, presentations by students, assignments etc.
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Evaluation Pattern		
Sr.	Details of the Evaluation	Weightage

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No.		
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30 marks
2.	University Examination	70 marks

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand fundamental & basic terms involved in IR and Raman spectroscopy, know effects of various factors on the spectra, interpretation from spectral data, identify structure of organic compounds by using combined spectral data.
2.	Understand fundamental & basic terms involved in ¹ H NMR, know effects of various factors on the spectra, interpretation from spectral data, identify structure of organic compounds by using combined spectral data, distinguish isomers and other closely related compounds by using spectral techniques.
3.	Understand fundamental & basic terms involved in Mass spectroscopy, know effects of various factors on the spectra, interpretation from spectral data, identify structure of organic compounds by using combined spectral data.
4.	Understand fundamental & basic terms involved in Molecular luminescence spectroscopy, know effects of various factors on the emission and excitation spectra.

Suggested Reference Books:

1. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage learning, 7th edition)
2. Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2nd edition).
3. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th edition.
4. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (VanNostrand Reinhold Co., New York), 6th edition.
5. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company), New Delhi.
6. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).
7. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
8. Instrumental methods of Chemical Analysis by H. Kaur.
9. Undergraduate Instrumental Analysis (5th ed.), J. W. Robinson (Marcel Dekker Inc.).
10. Fundamentals of Molecular Spectroscopy, by Banwell.
11. Electronic Absorption Spectroscopy and related techniques, D.N. Sathyanarayan, (New Age International ND. 1996) Uni. Press, Hyderabad.
12. Introduction to Spectroscopy (3rd ed.) by Pavia Lampman Kriz, Cengage Learning Harcourt College Publishers

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**Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester-III
Paper-III (Electroanalytical Techniques)
Proposed Syllabus To be Effective from June-2023
(NEP-2020)**

Total Periods:60

Course Code	ACC-303	Title of the Course	Electroanalytical Techniques
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	<ul style="list-style-type: none"> To familiarize with the basic principles, theory in potentiometry and chronopotentiometry techniques for various titration and applications. To learn about basic theory and principles of DC-polarography, amperometry, bio-amperometry methods, their instrumentation and applications. To learn about basic principle and instrumentation as well as theory of modern polarographic technique such as A.C, Square wave and Pulse Polarography for application in determination of various metal ions in the solution. 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.
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Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1												
	CO2												
	CO3												
	CO4												

Course Content		
Unit	Description	Periods
1.	<p align="center">POTENTIOMETRIC TITRATION AND CHRONOPOTENTIOMETRY</p> <p>Fundamentals of potentiometry, Instrumentation, electrode system, accuracy of direct potentiometric measurements and its limitations, potentiometric titrations, neutralization titrations, end- point detection, oxidation- reduction, precipitation titrations, complexometric titrations with example, applications and advantages.</p>	15

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	Chronopotentiometry Principle, Instrumentation and procedure, applications.	
2.	DC-POLAROGRAPHY Theory and Applications of Polarography. Types of currents: Residual Current, Migration Current and Diffusion Current, Nature of the Limiting Current: 1) Kinetic currents, 2) Catalytic currents and 3) Adsorption currents, Electro capillary maxima, Maxima of first kind and second kind, Maxima suppressors, DME as electrode, Wave equation, Ilkovic equation (derivation), Reversible electrode reactions at DME half wave potential, Maxima Suppressor, Interference and removal of oxygen, Reversible Electrode Reactions of Metal Complexes at D.M.E (Ligane method) Determination of stability constants of complexes. Amperometric titrations: Principle, DME & RPE, curves, Bio-Amperometric titration.	15
3.	MODERN POLAROGRAPHIC METHODS A.C. Polarography: Principle of Sinusoidal alternating applied potential, AC peak polarogram, Peak current equation, Characteristic of AC polarographic peak. Importance of signal to noise ratio for the sensitivity, Comparison with DC polarography. Square-wave Polarography: Principle of alternating rectangular wave voltage applied, Frequency of square wave applied, Problems of large condenser currents in A.C., Peak polarogram, Peak current equation, Limitations of techniques. Pulse Polarography: Effect of capillary response with frequency of applied square wave potential, Principles and difference between Normal Pulse Polarography and Differential Pulse Polarography, Importance of charging and Faradaic currents. Application for organic and biomolecule.	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 CO ₂ sensing electrode, Micro ion selective electrode, enzyme electrodes. Application and Numerical.	15

Teaching-Learning Methodology	To meet the effective teaching and the learning requirements, teaching-learning methodology comprise classroom teaching, use of e-resources, library books, IT tools, encouraging students to participate in seminars/ workshops, presentations by students, assignments etc.
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M.B. Mahida

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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30 marks
2.	University Examination	70 marks

Course Outcome: Having Completed this course, the learner will be able to

1.	Understand fundamental & basic terms involved in potentiometry, know effects various factors on the methods, know the limitation and application of potentiometric methods in various titrations.
2.	Understand fundamental & basic theory of polarography methods, learn the various current observed on DC polarography, know the various factors and electrode used in polarography and amperometry techniques.
3.	Understand fundamental & basic theory of different polarographic techniques, learn instrumentation, principles and understand the application, limitation and importance of the polarography techniques.
4.	Understand classification of ion selective electrode, construction and importance of that electrode for the determination of particular species in solutions.

Suggested Reference Books:

1. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage learning, 7th edition)
2. Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2nd edition.
3. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th edition.
4. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (VanNostrand Reinhold Co., New York), 6th edition.
5. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company), New Delhi.
6. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).
7. Instrumental methods of Chemical Analysis by H. Kaur.
8. "Polarography", J. D. Talati (In Gujarati), University Granth Nirman Board.
9. "Polarography": Kolthoff I. M. and Lingane J. J. (Vol. I & II) (Interscience Publishers, New York).
10. "Polarographic Techniques": L. Meites (Interscience Publishers, New York).

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VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester-III
Elective Paper-I (Applied Analysis-I)
Proposed Syllabus To be Effective from June-2023
(NEP-2020)

Total Periods:60

Course Code	AEC-301	Title of the Course	Applied Analysis-I
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	<ul style="list-style-type: none"> To understand basic concepts of ores and cements, their properties and analysis of various elements present in ore and cements by various methods. To understand basic concepts of air and soil, their properties and analysis of various pollutants and minerals present in air and soil by various methods. To understand basic concepts of clinical and food, their properties and analysis of various adulteration present in food and molecules present in blood serum by various methods. To understand basic concepts of paints and pigments, their properties and analysis of various elements present in paints and pigments by various methods.
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Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1	■	■		■	■	■			■	■	■	
	CO2	■	■		■	■	■			■	■	■	■
	CO3	■	■	■	■	■				■	■	■	
	CO4	■	■	■	■	■				■		■	■

Course Content		
Unit	Description	Hours
1.	<p>ANALYSIS OF ORES AND CEMENT.</p> <p>Ores: Dolomite (For silicate, Mg and Ca content), Ilmenite (for silicate, Ti and Fe content), Monazite (Ce and Th metals), Hematite and Magnetite (silicate and Fe content), Pyrolusite (for silicate and Mn content) and bauxite (for Al and Silicate content).</p> <p>Cement: Composition of cement and characterization, setting and hardening of cement. Analysis of cement for silica, calcium, magnesium, iron, sodium and potassium using ISI method.</p>	15

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2.	<p>ANALYSIS OF AIR AND SOIL</p> <p>Air: Sampling, Analysis of air borne particulates using emission spectroscopy, Determination of CO, SO₂, CO₂, NO_x, H₂S, O₃ in air sample. Non-dispersive IR spectrophotometry to determine CO and CO₂.</p> <p>Analysis of Soil: Moisture, pH, Total nitrogen, phosphorous, silica, lime, magnesia, sulfur, manganese.</p>	15
3.	<p>CLINICAL CHEMISTRY AND FOOD PRODUCT ANALYSIS</p> <p>Clinical Chemistry: Determination of glucose, electrolytes, urea, cholesterol, uric acid in blood serum.</p> <p>Food Products: Analysis of (i) Oils and fats, Iodine value, Saponification value, RM value, (ii) reducing and non-reducing sugars (iii) butter, honey, fruit, juices, non-alcoholic beverages, (iv) adulteration in oil, ghee, butter.</p>	15
4.	<p>ANALYSIS OF PAINTS AND PIGMENT</p> <p>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, HCL insoluble, Titanium dioxide, total lead, acid soluble Al and Fe, acid soluble calcium, total zinc, antimony oxide, total sulfate, total carbonate) analysis of ultramarine blue, Black pigments, Red Lead pigments.</p>	15

Teaching-Learning Methodology	To meet the effective teaching and the learning requirements, teaching-learning methodology comprise classroom teaching, use of e-resources, library books, IT tools, encouraging students to participate in seminars/workshops, presentations by students, assignments etc.
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30 marks
2.	University Examination	70 marks

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand fundamental & theory of the sources and available contents in ore and cements. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.
2.	Understand fundamental & theory of the sources and available pollutants/minerals in air and soils. Also learn the different approaches and

M.B. Mahida

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	classical as well as instrumental techniques used for the analysis.
3.	Understand fundamental & theory of the adulteration in food. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.
4.	Understand fundamental & theory of the sources and available contents in paints and pigments. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.

Suggested Reference Books:

1. Vogel's Text book Quantitative Chemical Analysis 5th edition by G.H.Jeffery, J. Bassett, J.Mendham, R.C. Denney.
2. Standard methods of chemical analysis, Sixth Edition, F.J. Welcher.
3. Quantitative Inorganic Analysis including Elementary Instrumental analysis, By A. I. Vogel, 3rd ed., ELBS, 1964.
4. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th 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. Standard Methods of Chemical Analysis: Vol. I & II (6th edition), D. Van Nostrand Co. Inc.(London).
8. Official Methods of Analysis: Published by Association of Official Analytical Chemists, Washington.

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VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester-III
Elective Paper-II (Applied Analysis-II)
Proposed Syllabus To be Effective from June-2023
(NEP-2020)

Total Periods:60

Course Code	AEC-301	Title of the Course	Applied Analysis-II
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	<ul style="list-style-type: none"> To understand basic concepts of different ores, their properties and analysis of various elements present in ores by various methods. To understand basic concepts of finished product, their properties and analysis of various ions, and minerals present in finished product by various methods. To understand basic concepts of plastics, their properties and analysis of various additives present in plastics and analysis of different plastics by various methods. To understand basic concepts of natural and synthetic rubber, their properties and analysis of various elements present in natural and synthetic rubbers by various methods.
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Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1												
	CO2												
	CO3												
	CO4												

Course Content		
Unit	Description	Hours
1.	<p>ANALYSIS OF ORES-II</p> <p>Iron ore- Analysis of the Constituents – Moisture, loss of ignition, Total Iron, ferrous Iron, Ferric Iron, alumina, silica, Titania, Lime, Magnesia, Sulphur, phosphorous, manganese, alkalis, combined water, Carbon in blast furnace, flue dust and sinter.</p> <p>Phosphate rock Ore - Analysis of the Constituents - CaO, P₂O₅, F, SiO₂, CO₂, S, Na₂O, Al₂O₃, Fe₂O₃, MgO, K₂O, Cl, MnO. Organic carbon, Moisture, Loss of ignition</p> <p>Chromite Ore - Analysis of the Constituents – Chromium, SiO₂, FeO, Al₂O₃, CaO, & MgO.</p>	15

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2.	ANALYSIS OF FINISHED PRODUCTS (a) Analysis of steel for C, Si, S, P, Mn, Ni, Cr; Mg and analysis of blast furnace slag. (b) Analysis of refractory materials: fire clay, flour spar, and magnesite (c) Analysis of fluxes - limestone and dolomite	15
3.	ANALYSIS OF PLASTICS Introduction, Identification of Plastics by FTIR and Pyrolysis GC. Preparation of sample, additives in resin, molecular weight determination, refractive index of transparent plastics, specific gravity. Determination of various plastics like styrene, vinyl chloride, ethylene, acrylic, cellulose, vinylidene chloride.	15
4.	ANALYSIS OF NATURAL AND SYNTHETIC RUBBER Introduction, nature of rubber and rubber product, Analysis of Ash, copper, manganese, iron acetone extract, Dirt extract, isoprene content, protein content in natural rubber. Identification of Synthetic rubber, Analysis of bound styrene, nitrogen content, chloride content, volatile matter, total ash, water soluble ash, carbon black, organic acid, antioxidant in synthetic rubber.	15

Teaching-Learning Methodology	To meet the effective teaching and the learning requirements, teaching-learning methodology comprise classroom teaching, use of e-resources, library books, IT tools, encouraging students to participate in seminars/workshops, presentations by students, assignments etc.
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30 marks
2.	University Examination	70 marks

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand fundamental & theory of the sources and available contents in ores. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.
2.	Understand fundamental & theory of the sources and available minerals and metal ions in finished product. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.
3.	Understand fundamental & theory of the adulteration in plastics. Also learn the different approaches and classical as well as instrumental techniques used for

M. B. Mahide

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	the analysis.
4.	Understand fundamental & theory of the sources and available contents in natural and synthetic rubbers. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.

Suggested Reference Books:

1. Vogel's Text book Quantitative Chemical Analysis 5th edition by G.H.Jeffery, J. Bassett, J.Mendham, R.C. Denney.
2. Standard methods of chemical analysis, Sixth Edition, F.J. Welcher.
3. Quantitative Inorganic Analysis including Elementary Instrumental analysis, By A. I. Vogel, 3rd ed., ELBS, 1964.
4. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th 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. Standard Methods of Chemical Analysis: Vol. I & II (6th edition), D. Van Nostrand Co. Inc.(London).
8. Official Methods of Analysis: Published by Association of Official Analytical Chemists, Washington.

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Master of Science, Analytical Chemistry
 M.Sc. Analytical Chemistry, Semester-III
 Paper-V: Industrial Safety & Water Analysis Techniques
 (Skilled based Elective Paper)
 Proposed Syllabus To be Effective from June-2023
 (NEP-2020)

Total Periods: 30

Course Code	ASEC-301	Title of the Course	Skilled based Elective Paper
Total Credits of the Course	2	Hours per Week	2 hrs.

Course Objectives:	<ul style="list-style-type: none"> To teach safety parameters, health & welfare to the students. To create awareness among students regarding Industrial and laboratory accident, its causes & its prevention. To learn about various water analysis techniques. To develop advance analytical skills for Quality Checking and Assurance in Laboratories.
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Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1												
	CO2												
	CO3												
	CO4												

Course Content		
Unit	Description	Periods
1.	INDUSTRIAL SAFETY Classification of accident, Objectives of safety Management Risk Assessment: Process Risk Assessment, Industrial Hygiene Risk Assessment, Environmental Risk Assessment, Fire & Explosive Risk Management Chemical Storage Safety: Bulk storage, Solvent storage, Explosive chemical storage, Transportation storage Static electricity, its hazards, and control measures Hazard Identification, Communication and Symbol	15
2.	WATER ANALYSIS TECHNIQUES Introduction, Bacteriology Quality, Water Quality, Waste water treatment, Total Dissolved Solids (TDS) & Total Suspended Solids (TSS) determination, Fixed & Total Volatile Solids, Fixed Dissolved	15

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Solids, Mother Liquor Suspended Solids (MSS) & Mother Liquor Volatile Suspended Solids (MLVSS), Oil, Grease and phenol determination, Chloride and Fluoride determination, Kjeldahl's method for ammoniacal nitrogen determination, Nitrite and Nitrate determination, Phosphate Determination, Sulphide and sulphate determination, Sodium and Potassium determination, Chromium determination, Fenton process, Hydrodynamic Cultivation, Microorganism purification.
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Teaching-Learning Methodology	To meet the effective teaching and the learning requirements, teaching-learning methodology comprise classroom teaching, use of e-resources, library books, IT tools, encouraging students to participate in seminars/ workshops, presentations by students, assignments etc.
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30 marks
2.	University Examination	70 marks

Course Outcome: Having Completed this course, the learner will be able to	
1.	To get skilled to measure risk assessment for hazardous chemical reaction, its monitoring and preventive actions to avoid accidents.
2.	To get skilled for proper chemical segregation and Industrial hygiene management to maintain safety.
3.	To get skilled for analysis of water quality, its sampling, operational techniques, and to produce results.
4.	Students will be able to use the techniques and get skilled necessary for water resource management.

Suggested Reference Books:

1. Fundamentals of Industrial safety and health by Dr. K.U. Mistry, Vol-1&2.
2. Industrial accidental prevention, H. W. Heinrich
3. Encyclopedia of Occupational Health & Safety, ILO, Geneva, Switzerland
4. Accident, Prevention Manual for Industrial Operation, NSC, USA.
5. Analytical methods for drinking water, Advances in sampling and Analysis by Phillippe Quevauviller, K. Clive Thompson.
6. Industrial Water Analysis Handbook by Natrajan Manivasakan.

M.B. Mahida

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**Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Practical
Semester-III**

Course Code	AP-301	Title of the Course	Practical
Total Credits of the Course	6	Hours per Week	12 hrs.

Course Objectives:	<ul style="list-style-type: none"> • To impart basic knowledge for carrying out analysis of some ore and cements • Understand the importance of various instrumental techniques in analysis. • To learn about the calculation in analysis. • To learn about the stoichiometry used in analysis of compounds. • Preparation of solution used in determination of various compounds.
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Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1												
	CO2												
	CO3												
	CO4												

Course Content	
Major Exercise	3-Credit
Viva-Voce	
Minor Exercise	3-Credit
Minor Exercise	

- Major Exercise: (any Eight)**
1. Analysis of Dolomite ore for the major constitute.
 2. Analysis of Ultramarine sample for the major constitute.
 3. Analysis of Portland cement for the major constitute.
 4. Analysis of Zn-Chrome pigment for the major constitute.
 5. Analysis of white pigment for the major constitute.
 6. Potentiometric determination of Chloride, Bromide and Iodide in a mixture.
 7. Analysis of Ilmenite ore for the major constitute.
 8. Analysis of Hematite ore for the major constitute.
 9. Analysis of Pyrolusite ore for the major constitute.
 10. Separation and determination of total pigment in a paint sample.

M. B. Mahida

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Minor Exercise: (Any Eight)

1. Determination of fluoride in a given solution / tooth paste by Zirconyl-Alizarin red method colorimetrically.
2. Analysis of organic materials: Glycerol, Glycine.
3. Determination of Pb^{+2} as $PbCrO_4$ after precipitation from homogeneous solution.
4. Analysis of Chloride in bleaching material.
5. Determination of COD of water sample.
6. Determination of DO of water sample.
7. Determination of K_{a1} and K_{a2} of phosphoric acid.
8. Simultaneous determination of $Cr^{+3} + Co^{+2}$ in a mixture.
9. Determination of Nitrite spectrophotometrically.
10. Biuret in the sample of urea
11. Thin layer chromatographic separation.
12. Interpretation of IR, NMR, Mass Spectra (Dry lab)
13. Constant current Coulometric titration of (i) As_2O_3 (ii) Phenol (iii) $Na_2S_2O_3$.
14. Analysis of dye intermediate containing $-NH_2$ by Potentiometric titration.
15. Electrogravimetry determination of Cu^{+2} in brass.

Teaching-Learning Methodology	Introduction, interaction with students in calculation of mole ratios, carrying out experiments at each step according to the respective practical.
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Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the basics to carry out practical, calculation of mole and mole ratio.
2.	Done the titration or instrumental method for quantitative analysis.
3.	Done the stoichiometry of the reaction involved in titration.
4.	Draw the graph and find out the unknown concentration by comparison with known compound.
5.	Appreciate good laboratory practices.

M. B. Mahida

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Suggested Reference Books:

1. Vogel's Textbook of quantitative analysis fifth editions by Longman scientific and technical, UK.
2. Indian Pharmacopeia, Vol-I, II and III.
3. Standard methods of Chemical analysis sixth edition edited by Frank J. Welcher by D. VanNostrand Company, Inc.

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