



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-મગદલા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.

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-: પરિપત્ર :-

વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન અનુસ્નાતક અભ્યાસક્રમ ચલાવતી તમામ કોલેજોનાં આચાર્યશ્રીઓ તથા વિભાગીય વડાશ્રીને જણાવવાનું કે, શૈક્ષણિક વર્ષ ૨૦૨૩-૨૪ થી અમલમાં આવનાર M.Sc.Sem. 4 ના Pharmaceutical Chemistry, Organic Chemistry, Physical Chemistry, Enviornmental Chemistry અને Analytical Chemistry ના અભ્યાસક્રમ સંદર્ભે રસાયણશાસ્ત્ર વિષયની અભ્યાસ સમિતિની તા.૦૪/૧૨/૨૦૨૩ની સભાના ઠરાવ ક્રમાંક :૦૫ અન્વયે નીચે મુજબ કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાના અધ્યક્ષશ્રીએ વિદ્યાશાખાની મંજૂરીની અપેક્ષાએ વિદ્યાશાખાવતી મંજૂર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલની તા.૦૬/૧૨/૨૦૨૩ની સભાનાં ઠરાવ ક્રમાંક: ૪૬ થી મંજૂર કરેલ છે. જેનો અમલ કરવા આથી જાણ કરવામાં આવે છે.

રસાયણશાસ્ત્ર વિષયની અભ્યાસ સમિતિની તા.૦૪/૧૨/૨૦૨૩ ની સભાનાં ઠરાવ ક્રમાંક:૦૫

:: આથી ઠરાવવામાં આવે છે કે, શૈક્ષણિક વર્ષ ૨૦૨૩-૨૪ થી અમલમાં આવનાર M.Sc.Chemistry Sem.-4 નો Pharmaceutical Chemistry, Organic Chemistry, Physical Chemistry, Enviornmental Chemistry અને Analytical Chemistry નો અભ્યાસક્રમ સર્વાનુમતે મંજૂર કરી વિજ્ઞાન વિદ્યાશાખાને ભલામણ કરવામાં આવે છે.

એકેડેમિક કાઉન્સિલની તા.૦૬/૧૨/૨૦૨૩ની સભાનાં ઠરાવ ક્રમાંક: ૪૬

:: આથી ઠરાવવામાં આવે છે કે, શૈક્ષણિક વર્ષ ૨૦૨૩-૨૪ થી અમલમાં આવનાર M.Sc. Chemistry Sem.-4 ના Pharmaceutical Chemistry, Organic Chemistry, Physical Chemistry, Enviornmental Chemistry અને Analytical Chemistry ના અભ્યાસક્રમ સંદર્ભે રસાયણશાસ્ત્ર વિષયની અભ્યાસ સમિતિની તા.૦૪/૧૨/૨૦૨૩ ની સભાના ઠરાવ ક્રમાંક :૦૫ અન્વયે કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાના અધ્યક્ષશ્રીએ વિદ્યાશાખાની મંજૂરીની અપેક્ષાએ વિદ્યાશાખા વતી મંજૂર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ સ્વીકારી મંજૂર કરવામાં આવે છે.

બિડાણ: ઉપર મુજબ

ક્રમાંક : એસ./સાયન્સ/પરિપત્ર/૩૦૫૧૮/૨૦૨૩

તા.૦૭-૧૨-૨૦૨૩

Wifesa
કુલસચિવ

પ્રતિ,

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

Veer Narmad South Gujarat University, Surat

Syllabus

M.Sc. Analytical Chemistry

Semester IV

To be effective from June-2023

NEP-2020



M-13 - malhotra
Page

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.

	<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												

m-b-mahide

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

Theory Paper/ Practical	Teaching schedule Hrs./Week	Exam Schedule			Total Marks	Credit
		Duration (Hrs.)	Internal Marks	External Marks		
Theory Paper						
1. Advanced Analytical Techniques (ACC-401)	4	3	30	70	100	4
2. Atomic Spectroscopy (ACC-402)	4	3	30	70	100	4
3. Separation Techniques (ACC-403)	4	3	30	70	100	4
4. Inter/multidisciplinary (AEC) Elective Paper-1 (AEC-401) Applied Analysis-I or Elective Paper-2 (AEC-402) Applied Analysis-II	4	3	30	70	100	4
5. Skilled Based elective Paper/Swayam/other MOOC courses (ASEC-401)	2	2	15	35	50	2
6. Practical (AP-401)	12	12	60	140	200	6
Total	30	26	195	455	650	24

m.B-murthy

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

Total Periods:60

Course Code	ACC-401	Title of the Course	Advance analytical techniques
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	<ul style="list-style-type: none"> To learn the basic concept, theory, principles and instrumentation of electron spectroscopy and microscopic techniques which is applied for characterization of alloys and surface morphology of compounds. To understand the principles, instrumentation of advanced chromatography and extraction techniques and also learn the comparison and application in the various fields. Role of various electrophoresis techniques in the separation of ions in analytical chemistry, importance of micellar electrokinetic chromatography and application in separation of protein and amino acids. Study of combination of two techniques and their advantages over single techniques and their application in various fields. 												
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>ELECTRON SPECTROSCOPY AND MICROSCOPY</p> <p>Introduction, Types of surface measurements; General techniques in surface spectroscopy, Sampling surfaces, Surface contamination, X-ray Photo electron spectroscopy- Principle, instrumentation and Application. Auger electron Spectroscopy- Principles, Instrumentation, application. Ion, laser and electron microprobe spectrometry, Application, Electron Microscope, SEM, STM and</p>	15

	AFM, Numerical.	
2.	<p>ADVANCED CHROMATOGRAPHY AND EXTRACTION</p> <p>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.</p> <p>Chiral Chromatography: Instrument, theoretical aspects, mobile phase, application.</p> <p>Super Critical fluid extraction: Introduction, Advantages, Instrumentation, Choice of SFC, Offline and Online Extraction, Application, Numerical.</p>	15
3.	<p>ELECTROPHORESIS AND ELECTROCHROMATOGRAPHY</p> <p>Definition, types, Free solution electrophoresis, Moving boundary electrophoresis, Zone electrophoresis, paper electrophoresis, types of stabilizing medium, location of components, electrode, source of current, requirement of electrophoretic chamber, Immunoelectrophoresis Continuous (Curtain) flow electrophoresis, Gel electrophoresis. Capillary Electrophoresis, Column, Electro Chromatography, Field Flow Fraction (FFF), Micellar electrokinetic capillary Chromatography, Application.</p>	15
4.	<p>HYPHENATED TECHNIQUES AND AUTO ANALYSER</p> <p>Preliminary idea and application of MS-FTIR, ICP-MS, GC-MS, LC-MS, MS-MS, Tandem Mass Spectra, GC-FTIR, TG- FTIR, TG-MS. Auto analyser: Need for auto analyser, Instrument used in clinical laboratory, Flow Injection Analysis, Micro Fluid Disk, Discreet Automatic System, Oxygen Analyser.</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 electron spectroscopy and microscopy. Learn the interaction of electron with matter, with different surfaces and its contaminations. Understand the working of microscope to find out the morphology of surfaces.
2.	Learn the advancement in chromatography with use of supercritical fluid CO ₂ , learn selection of stationary phase as well condition in operating, understand the online and offline extraction with super critical fluid.
3.	Understand fundamental concepts of the separation of charged particles, amino acids, ions with different electrophoresis techniques, learn the separation of molecules with the help of Field Flow Fraction.
4.	Understand limitation of single technique and advantages of hyphenated techniques over it, learn the need or types of auto analyser for clinical analysis.

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. 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. Kolthoff & P. J. Elving (John Wiley & Sons, New York).
9. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
10. Basic concepts of Analytical Chemistry by S.M. Khopkar
11. Instrumental Methods of Chemical Analysis: B. K. Sharma (Goel Publishing House, Meerut).
12. Inorganic Quantitative Analysis: A. I. Vogel (Orient Longman).
13. Principles of Instrumental Analysis (5th ed.) by Skoog, Holler and Nieman (Saunders College Publishing's).
14. Undergraduate Instrumental Analysis (5th ed.), J. W. Robinson (Marcel Dekker Inc.).
15. Fundamentals of Molecular Spectroscopy, by Banwell.
16. Electronic Absorption Spectroscopy and related techniques. D.N. Sathyanarayan, (New Age International ND. 1996) Uni. Press, Hyderabad.
17. Introduction to Spectroscopy (3rd ed.) by Pavia Lampman Kriz, Cengage Learning Harcourt College Publishers

m. B. mahide

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

Total Periods: 60

Course Code	ACC-402	Title of the Course	Atomic Spectroscopy
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	<ul style="list-style-type: none"> • 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. • To understand and familiarize the basic principles, theory and instrumentation of absorption and emission spectroscopy, to impart knowledge in theory and principles of spectroscopy, spectroscopic technique for characterization and differentiation of various elements/ions. • To understand and familiarize the basic principles, theory and instrumentation of ESR spectroscopy, to impart knowledge in theory and principles of spectroscopy, spectroscopic technique for characterization and differentiation of various elements/ions. • To understand and familiarize the basic principles, theory and instrumentation of emission and fluorescence, to impart knowledge in theory and principles of spectroscopy, spectroscopic technique for characterization and differentiation of various elements/ions.
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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.	ATOMIC X-RAY SPECTROSCOPY	15

M. B. Mahidee

	Emission of X-ray, continuum and line spectra, X-ray absorption, absorption spectra, Apparatus, Source (monochromatic X-ray), Sample handling, Wavelength and energy dispersive device, Detector, Chemical analysis by X-ray absorption, X-ray fluorescence: Theory, instrumentation and applications, X-ray diffraction: Theory, instrumentation and applications for crystalline materials.	
2.	<p>ATOMIC ABSORPTION AND FLAME EMISSION SPECTROSCOPY</p> <p>a) Atomic Absorption Spectroscopy (AAS) Principle of AAS, Instrument, Continuous sources and line sources, Flames, Flame atomizers, Non flame atomizers (furnaces), Monochromator and Detector, Interference with AAS Quantitative Analysis with AAS, Applications, Numerical.</p> <p>(b) Flame Emission Spectroscopy (FES) Flame as a source of atomic vapour, Flame atomization, Flame photometer, Applications and limitations comparison with AAS</p>	15
3.	<p>ELECTRON SPIN RESONANCESPECTROSCOPY</p> <p>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, The spin Hamiltonian, Quantitative analysis, Sensitivity, Choice of solvent, applications of ESR, Study of free radicals, Electronic and Hyperfine splitting, Triplet states- zerofield splitting and Kramer's degeneracy, Analytical applications of ESR, Structural determination by ESR, Study of inorganic and organic compounds by ESR, Transition elements, Biological systems</p>	15
4.	<p>ATOMIC EMISSION AND FLUORESCENCE SPECTROSCOPY</p> <p>Atomic Emission Spectroscopy: Emission spectroscopy with plasma sources, Instrument, AES with electrical discharge, Electrodes of AES, DC- arc. spark, Laser microprobe, Salient features of the emission spectrograph, Qualitative and Quantitative analysis applications,</p> <p>Fluorescence Spectroscopy: Atomic fluorescence, apparatus for AFS, EMR source for AFS, LASERS, Cells for AFS, Plasmas, Wavelength selection for AFS, Detectors for AFS, Theory of AFS, Analysis with AFS, Interference with AFS.</p>	15

M. B. Mahtab

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 atomic x-ray spectroscopy, learn the interaction of x-ray with matter, understand the difference between two techniques. Understand the use of x-ray spectroscopy for qualitative and quantitative analysis.	
2.	Understand fundamental & theory of atomic absorption and emission spectroscopy, learn the phenomenon involved in absorption and emission, understand the use of absorption and emission spectroscopy for qualitative and quantitative analysis.	
3.	Understand fundamental & theory of ESR spectroscopy, learn the difference between ESR and NMR, coupling constant and spin of signal, application in inorganic chemistry.	
4.	Understand fundamental & theory of atomic fluorescence and emission spectroscopy, learn the phenomenon involved in fluorescence and emission, understand the use of fluorescence and emission spectroscopy for qualitative and quantitative analysis.	

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. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
7. Basic concepts of Analytical Chemistry by S.M. Khopkar

M.B. Mahide

8. Instrumental Methods of Chemical Analysis: B. K. Sharma (Goel Publishing House, Meerut).
9. Instrumental methods of Chemical Analysis by H. Kaur.
10. Undergraduate Instrumental Analysis (5th ed.), J. W. Robinson (Marcel Dekker Inc.).
11. Fundamentals of Molecular Spectroscopy, by Banwell.
12. Introduction to Spectroscopy (3rd ed.) by Pavia Lampman Kriz, Cengage Learning
Harcourt College Publishers

M-B. Mehrotra

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

Total Periods: 60

Course Code	AC-403	Title of the Course	Separation Techniques
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	<ul style="list-style-type: none"> To understand the distribution of liquid in two immiscible liquids, to impart the knowledge of doing extraction of different compounds and their application. To understand the theory behind the separation of molecules by chromatography, various factors affecting separation and their solution, application the theory in validation of the results obtained. To learn principles, theory and instrumentation of various liquid chromatography techniques such as gel and ion exchange, adsorption and affinity, their application in identification/separation of compounds. To learn theory and concepts of the extraction of molecules from solid surfaces as well as their application and limitation.
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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>SOLVENT EXTRACTION</p> <p>Principal of solvent extraction, Nernst distribution law, Distribution coefficient, Equations for the solute dissociating or associating in one phase, limitations of distribution law, Application : partition chromatography, Distribution ratio, selectivity ratio, Successive extractions, Extraction of metal ion with chelating agent with necessary equation, Extraction involving association of ion pairs, extraction by</p>	15

M.B. Mahid

	<p>solvation, types of Multiple extractions, multiple extraction with successive portion, basic concept, Apparatus and binominal distribution for Craig pseudo/ continuous counter current extractions. Truecounter current extraction: Fractional distillation, Use of crown ethers and Cryptands for extraction, extraction equilibria with crown ethers, factors affection extraction with crown ether, numerical of distribution coefficient and multiple extraction.</p>	
2.	<p>THEORY OF CHROMATOGRAPHY</p> <p>Methods of elution, Ideal and non-ideal chromatography. Plate theory, Rate theory, Reasons for broadening of peaks. Van Deemter equation and significance of terms involved, Optimum velocity, Resolution, Methods to improve resolution, GLC, Supports for liquid stationary phases, Selection of columns, FSOT, Selective Detectors- FPB, TID, Temperature programming in GC. Derivatization, in GC, Qualitative analysis from retention parameters, Quantitative analysis, Headspace Analysis, Thermal Desorption.</p>	15
3.	<p>LIQUID CHROMATOGRAPHY</p> <p>a. Ion-exchange Chromatography: Resins used, Principle of exchange, Factors affecting the exchange, Capacity of resin and its determination, Techniques, IEC with eluent suppressor columns, Applications.</p> <p>b. Gel-permeation Chromatography: Principle, Types of gels, Theoretical principles, Techniques and applications.</p> <p>c. Adsorption Chromatography: Principle, column packings, adsorbents, mobile phase, technique of separation, detectors, identification of compounds, applications, Chiral Chromatography.</p> <p>d. Affinity Chromatography: Introduction, classification, column matrices, affinity ligands, elution methods, applications.</p>	15
4.	<p>SOLID PHASE EXTRACTION AND MICROEXTRACTION</p> <p>a) Solid Phase extraction (SPE): Introduction, Types of SPE media, SPE formats and apparatus, method for SPE operation, solvent selection, factors affecting SPE, selected methods of analysis for SPE, Automation and On-Line SPE.</p> <p>b) Solid phase micro-extraction (SPME): Introduction, theoretical considerations. experimental, Methods of analysis: PMEGC, Methods of analysis: SPME-HPLC-MS,</p>	15

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	Automation of SPME, New development in micro extraction (liquid micro extraction, membrane micro extraction).	
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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.	Understand fundamental and principles of solvent extraction, basic theory of distribution law, use of the extraction techniques for cryptands and crown ethers, working of Craig vessels extractions.
2.	Understand fundamental & theory involved in the separation of compound by chromatographic techniques, reason behind the band broadening and their resolution, use of chromatography for qualitative and quantitative analysis.
3.	Understand the separation of different types of molecules with the help of different chromatographic techniques, choice of different stationary phase and mobile phase and application of chromatography.
4.	Understand fundamental & theory of solid phase extraction, factors affecting the extraction, techniques involved in extraction and their application.

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. Introduction to Modern Liquid Chromatography: L. R. Snyder & J. J. Kirkland (John Wiley & Sons, New York).

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

Total Periods: 60

Course Code	AEC-401	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 soaps, detergents and alloys, their properties and analysis of various elements present in them by various methods. • To understand basic concepts of pesticides and fertilizer, their properties and analysis of various compounds and elements present in pesticides and fertilizer by various methods. • To understand basic concepts of drug products, types of drugs and capsules, their properties and analysis of various drug present in markets by various methods. • To understand basic concepts of vitamins, their properties and analysis of various vitamins by different 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	Periods
1.	<p>ANALYSIS OF SOAPS, DETERGENTS AND ALLOYS</p> <p>Soaps and Detergents: Classification of detergents, Action of detergents, Determination of alcohol soluble materials, moisture, active constituents, silicates, phosphates, borates etc.</p> <p>Alloys: Analysis of brass, German silver, stainless steel. Bronze, Ferromanganese, Alloys of Al, Mg and Ti (Emphasis should be given on major constituent and instrumental methods such as AAS, molecular spectrophotometry, fluorescence, emission, spectroscopy for analysis of trace elements).</p>	15

2.	ANALYSIS OF PESTISIDE AND FERTILIZER Pesticides: Analysis of Benzene hexachloride, Analysis of DDT in mixture by colorimetric methods, Determination of Dieldrin in formulation by partition chromatography, Total phosphorous in phosphorous containing pesticides, Determination of traces of pesticides using GC and HPLC, Determination of Aldrin using IR spectrophotometry. Fertilizer: Sampling and sample preparation, water, total nitrogen by Kjeldahl method, total nitrogen by reduced iron method, Urea nitrogen by urease methods, Total phosphorous by differential spectroscopic methods, water soluble phosphorous, Potassium: potassium by flame photometric methods, Acid –base forming quantity of Fertilizer.	15
3.	ANALYSIS OF DRUG PRODUCT Analytical methods for the following- Tablets, different types of tablets, uniformity in weight (aspirin) additives used in tablet manufacture, capsules, types of capsules, Identification, assay and Test: Rifampicin capsule, Sodium benzoate Powders, Sodium Chloride Injection, barium sulphate Suspensions, Mouthwashes (Ointments (salicylic acid) and creams Dimethicone by IR) Mannitol Injections, Sulphacetamide Eye Drops, Salbutamol Inhalation, Penicillin, Problems based on assay of these materials.	15
4.	ANALYSIS OF VITAMINS Carr-price method of Vitamin A, Spectroscopic method for Vitamin D, Determination of total assay Vitamin E, Stability study of Vitamin K ₃ , Determination of Vitamin B ₁ , Determination of Assay of Vitamin B ₂ by fluorometric method, Determination of Nicotinic Acid by cyanogen bromide method, Determination of Nicotinamide by cyanogen bromide method, Determination of Pyridoxine by Non-aqueous titration method, Spectroscopic determination of Vitamin B ₁₂ , Folic Acid by colorimetric method, Ascorbic Acid by iodate titration method.	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	30 marks

	CBCS R.6.8.3)	
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 alloys and surfactants. 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 contents in fertilizer and pesticides. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.
3.	Understand fundamental & theory of the drugs and capsules. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.
4.	Understand fundamental & theory of the sources of vitamins. 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. Indian Pharmacopeia Volume I and II.
3. Standard methods of chemical analysis, Sixth Edition, F.J. Welcher.
4. Quantitative Inorganic Analysis including Elementary Instrumental analysis, By A. I. Vogel, 3rd ed., ELBS, 1964.
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. Kolthoff & P. J. Elving (John Wiley & Sons, New York).
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. Instrumental methods of Chemical Analysis by H. Kaur.
15. Environmental Chemistry: B. R. Sharma, H. Kaur (Goel Publishing House, Meerut).
16. Inorganic Quantitative Analysis: A. I. Vogel (Orient Longman).

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

Total Periods: 60

Course Code	AEC-401	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 rubber compounds, their properties and analysis of various elements present in them by various methods. • To understand basic concepts of Glass, their properties and analysis of various compounds and elements present in Glass by various methods. • To understand basic concepts of drug products, types of drugs and capsules. their properties and analysis of various drug present in markets by various methods. • To understand basic concepts of organic functional group, their properties and analysis of various organic groups by different 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	Periods
1.	ANALYSIS OF RUBBER COMPOUND Introduction, Identification, Isoprene and styrene content, acetone extract, Chloroform extract, Total Extract, alcoholic potash extract, unsaponifiable acetone extract, waxy hydrocarbon, mineral oil, sulfur, total inorganic sulfur, total inorganic filler, total ash, iron and aluminum oxide, calcium oxide, magnesium oxide, zinc oxide, total barium, titanium dioxide, free carbon, cellulose.	15
2.	ANALYSIS OF GLASS	15

	Introduction, silica, sulfate, barium, arsenic, antimony, total oxide such as Fe ₂ O ₃ , Calcium, Magnesium, total alkalis, chloride, Al ₂ O ₃ , Chromium, Cobalt, Manganese, Nickel, Lead, Cerium, Titanium, Zirconium, Arsenic, Boron, and Floride.	
3.	ANALYSIS OF DRUGS-II Identification, Test and Assy of following drug: Aceclofenac tablets, Azithromycin oral suspension, Bleomycin Injection, Cetirizine tablets, Ciprofloxacin eye drop, Dicyclomine Injection, Domperidone Tablets, Levofloxacin Tablets, Levocetirizine Hydrochloride, Ofloxacin Tablets, Paclitaxel Injection. Rifampicin and Isoniazid Tablets, Ritonavir Capsules	15
4.	ORGANIC FUNCTIONAL GROUP ANALYSIS Classification of functional groups with suitable examples. Determination of: 1) Functional groups imparting acidic nature – thiol, enediol, phenolic hydroxyl. 2) Functional groups imparting basic nature – Aliphatic and Aromatic primary, secondary and tertiary amines – hydrazine derivatives. 3) Functional groups which impart neither acidic nor basic nature – Aldehydes, Ketones, Nitro, Methoxy, Olefinic.	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 rubber compound. 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 contents in glass. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.

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3.	Understand fundamental & theory of the drugs. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.
4.	Understand fundamentals & theory of organic functional groups. 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. Indian Pharmacopeia Volume I and II.
3. Standard methods of chemical analysis, Sixth Edition, F.J. Welcher.
4. Quantitative Inorganic Analysis including Elementary Instrumental analysis, By A. I. Vogel, 3rd ed., ELBS, 1964.
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. Kolthoff & P. J. Elving (John Wiley & Sons, New York).
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. Environmental Chemistry: B. R. Sharma, H. Kaur (Goel Publishing House, Meerut).
14. Inorganic Quantitative Analysis: A. I. Vogel (Orient Longman).
15. Organic functional groups – S. Siggia
16. Quantitative Chemical Analysis – I.M Kolthoff, E.B Sandel, E.J Meehan, S. Bruckenstein, Macmillan Company, London
17. Decomposition Techniques in Inorganic Analysis – J.Dolezal, P.Povondra, Z.Sulcek

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Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester-IV
Paper-V: Green Chemistry (Skill based Elective Course)
Proposed Syllabus To be Effective from June-2023
(NEP-2020)

Total Periods: 30

Course Code	ASEC-401	Title of the Course	Green Chemistry (Skilled based Elective Course)
Total Credits of the Course	2	Hours per Week	2 hrs.

Course Objectives:	<ul style="list-style-type: none"> ● To provide knowledge on green and sustainable chemistry ● To learn and introduce various principles of green chemistry. ● To learn about the replacement of toxic chemicals with environment friendly green compounds and benefits of utilizing concept of green reagents and green catalyst. ● To create awareness among students regarding to, develop skills to develop an understanding of social and environmental responsibilities within the broad area of Green Chemistry 												
Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1												
	CO2												
	CO3												
	CO4												

Unit	Description	Periods
1.	<p>BASICS CONCEPTS OF GREEN CHEMISTRY & GREEN REAGENTS</p> <p>A. BASICS CONCEPTS OF GREEN CHEMISTRY:</p> <p>Basic principles of green chemistry: (i) Waste minimization (ii) Atom economy (iii) Hazardous products minimization (iv) Designing safer chemicals (V) Planning for minimum energy requirement for synthesis (vi) Proper Solvent selection (vii) Proper starting material selection (viii) Use of Protecting groups (ix) Use of Catalysts (x) Biodegradable product designing (xi) Proper designing of manufacturing plants (xii) Strengthening analysis techniques.</p>	15

	B. GREEN REAGENTS AND WATER BASED GREEN SYNTHESIS: Polymer Based Green Reagents, Water Based Reactions: Diels-Alder Reaction, Claisen Rearrangement, Michael Reaction, Aldol Condensation, Knoevenagel Reaction, Benzoin Condensation, Claisen-Schmidt Condensation and Heck Reaction	
2.	GREEN CATALYSTS (i) Acid Catalysts (ii) Oxidation Catalysts (iii) Basic Catalysts (iv) Polymer Supported Catalysts (v) Polystyrene-aluminium Chloride (vi) Polymeric Super Acid Catalysts (vii) Polystyrene-metalloporphyrins (viii) Polymer Supported Photosensitizers (ix) Polymer Supported Phase Transfer Catalysts and (x)Phase Transfer Catalyst in Green Chemical Reaction(xi) Miscellaneous Illustration catalysts like TiO ₂ Photocatalyst in Green Chemistry, Solid Support Reagents, Synthesis of Bromo organics: Development of Newer and Ecofriendly Bromination Protocols and Brominating Agents, Synthesis of Pyridinium Fluorochromate (PFC) and Synthesis of Isooctane	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	15 Marks
2.	University External Written Examination	35 Marks

Course Outcome: Having Completed this course, the learner will be able to	
1.	To get the basic concept, background and significance of green chemistry, various tools and twelve principles of green chemistry.
2.	To get the design and development of green synthetic methods by using principles of green chemistry that reduces the generation of waste and hazardous substances.
3.	To get basic concepts to Identify and differentiate between green reagents and conventional reagents and to find suitable green alternatives in chemical processes.
4.	To differentiate and critically evaluate the green catalysts against conventional catalysts and applications of these green catalysts.

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Suggested Reference Books:

1. V.K.Ahluwalia, M. Kidwai, New Trends in Green Chemistry, Kluwer Academic Publishers, Boston, London, 2012, pp. 5-36 and the reference cited there in.
2. Paul T. Anastas and John C. Warner, Green Chemistry, Theory and Practice, Oxford University Press, New York, 1998.
3. Colin Baird, Environmental Chemistry, W.H. Freeman, New York, 1999.
4. V.K. Ahluwalia and Renu Aggarwal, Organic Synthesis: Special Techniques, Narosa Publishing House, New Delhi, 2001, pp. 150-190 and the references cited therein.
5. P. T. Anastas and J.C. Warner, 'Green Chemistry, Theory and Practice', Oxford University Press (1998).

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Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester-IV
 To be effective from June 2023
Practical
 (NEP-2020)

Course Code	AP-401	Title of the Course	Practical
Total Credits of the Course	4	Hours per Week	12 hrs.

Course Objectives:	<ul style="list-style-type: none"> • Able to identify the elements presents in various alloys, soap and detergents. • 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												
	CO5												

Course Content	
Major Exercise	4-Credit
Viva-Voce	
Minor Exercise	4-Credit
Minor Exercise	

<p>Major Exercise:</p> <ol style="list-style-type: none"> 1. Analysis of brass alloys for Copper, Zinc and Iron Content. 2. Analysis of German silver for Copper, Nickel and Zinc Content. 3. Analysis of stainless steel for simultaneously determination of Cr and Mn content. 4. Ion exchange separation of (Fe⁺³ + Co⁺²) and determination of Fe⁺³ colorimetric. 5. Determination of total salt content by ion exchange chromatography. 6. Ion exchange separation of (Zn⁺² and Mg⁺²) and determination of Zn⁺² by EDTA titration. 7. Determination of pK_{In} of Methyl red indicator. 8. Determination of pK_{In} of Bromo Phenol Blue Indicator.
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Minor Exercise (Any eight):

1. Analysis of Drugs (any three):
 - a) Sulpha drugs by non-aqueous titration and argentometric titration.
 - b) Analysis of Penicillin
 - c) Iron formulation for iron content.
 - d) Aspirin tablet
 - e) Analysis of APC tablets for its aspirin and phenacetin content using UV spectrophotometry.
2. Analysis of Insecticides: Analysis of BHC.
3. Determination of Protein content of wheat flour by Kjeldahl Method.
4. Analysis of Detergent sample for PO₄ and other constituents.
5. Analysis of fertilizers by determination of nitrogen content.
6. Analysis of fruit juice for Vitamin-C.
7. Determination of saponification value of Oil and fat.
8. Spectroscopic determination of Ni⁺² with D.M.G.
9. Conductometric determination of vanillin in Vanilla.
10. Photometric titration of (Cu⁺²+ Ca⁺²) in a mixture
11. Determination of Metal: Ligand ratio in complex.
12. Flame photometric determination of Na⁺ and K⁺.
13. Colorimetric estimation of titanium in the given solution by hydrogen peroxide.
14. Estimation of amino acids by colorimetry.
15. TLC separation.

Teaching-Learning Methodology	Introduction, interaction with students in calculation of solution preparations, carry out experiments at each step according to the respective practical. stoichiometry calculation.
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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.	Performing mole and mole ratio calculations in practice requires an understanding of the fundamentals.
2.	Understanding the basics is essential for performing practical calculations of mole.
3.	Prepared the stoichiometry of the reaction involved in the titration.
4.	Observe, chart, and compare unknown and known concentrations.
5.	Recognize proper lab procedures.

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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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