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, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
Tel : +91 - 261 - 2227141 to 2227146, Toll Free : 1800 2333 011, Fax : +91 - 261 - 2227312
E-mail : info@vnsgu.ac.in, Website : www.vnsgu.ac.in

-: 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 ક્રમાંકઃ ૪૬ થી મંજૂર કરેલ છે. જેનો અમલ કરવા આથી જાણ કરવામાં આવે છે.

રસાયણશાસ્ત્ર વિષયનીઅભ્યાસ સમિતિની તા.૦૪/૧૨/૨૦૨૩ ની સભાનાં ઠરાવ ક્રમાંકઃ૦૫

:: 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 ક્રમાંકઃ ૪૬

:: આથી ઠરાવવામાં આવે છે કે, શૈક્ષણિક વર્ષ ૨૦૨૩–૨૪થી 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.

બિડાણઃ ઉપર મુજબ

ક્રમાંક : એસ./સાયન્સ/પરિપત્ર/૩૦૫૧૯/૨૦૨૩
તા.૦૭–૧૨–૨૦૨૩

કુલસચિવ

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.

Veer Narmad South Gujarat University, Surat

Syllabus

M.Sc. Physical Chemistry
Semester IV

To be effective from December-2023

NEP-2020

Name of Program	**Master of Science(Chemistry) and M.Sc. Organic Chemistry (Evening)**
Abbreviation	**M.Sc.**
Duration	**2 Years**
Eligibility Criteria	**M.Sc. (Organic Chemistry)** Eligibility: Graduation in Science with Chemistry or any subject equivalent to or allied to Chemistry. **M.Sc. (Inorganic Chemistry)** Eligibility: Graduation in Science with Chemistry or any subject equivalent to or allied to Chemistry. **M.Sc. (Physical Chemistry)** Eligibility: Graduation in Science with Chemistry or any subject equivalent to or allied to Chemistry. **M.Sc. (Analytical Chemistry)** Eligibility: Graduation in Science with Chemistry or any subject equivalent to or allied to Chemistry. **M. Sc . Environmental Chemistry** Eligibility: Graduation in Science with Chemistry or any subject equivalent to or allied to Chemistry. **M.Sc. (Pharmaceutical Chemistry)** Eligibility: Graduation in Science with Chemistry or any subject equivalent to or allied to Chemistry. **M.Sc. Organic Chemistry (Evening)** Eligibility: Graduation in Science with Chemistry or any subject equivalent to or allied to Chemistry.
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.

M. B. Mahides

Program Outcome	PO1: To enhance the knowledge of chemistry domains and become master in respective branch of chemistry. To be able to communicate clearly and effectively with in and across disciplinary lines. PO2: Built up entrepreneurship ability by taking advantage of industrial hub in periphery of our university. PO3: Establishment of research center with the aid of interdisciplinary subject being run in university. PO4: Persuasion of doctoral degree in the concern subject and further study. PO5 : Development of related short term courses related to demanded subject in anticipation of strengthening knowledge and application PO6: Training/internship of students for employment in public sector, private sector and national laboratories. PO7: Participation in scientific discussions showing respect and lead interdisciplinary work with experts from other fields. PO8: To understand and adopt the best safety practices in chemical research. PO9: Participation in scientific discussions showing respect and lead Interdisciplinary work with experts from other fields. PO10: To understand and adopt the best safety practices in research.

M.B. Mahide

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. PSO1 : Develop scientific temper, communicate scientific information in a clear, concise and precise manner. PSO2 : Find job opportunities at all level of chemical industries(dyes & pharmaceutical), national laboratories & research centers. PSO3 : Apply the knowledge in sustainable and eco friendly technologies. PSO4 : Inculcate logical thinking to addressess the problem and become result oriented. PSO5 : Development of research culture in persuasion of Ph.D. program at national & international institute/university. PSO6 : Participate in specific competitive examination conducted by various public service commission and other public sector. PSO7 : Develop and apply the fundamental knowledge to build small scale industry in context to Atma Nirbhar Bharat. PSO8 : Scale up the synthetic product to a pilot level plant and gradually to bulk. PSO9 : Enhance the scientific temperament among the students in anticipation of developing research culture and implementation of policies at global & local level. PSO10 : Communicate scientific information clear in both writing and orally. PSO11 : Students shall start to become better readers, thinkers and learners in their discipline by processing their ideas through writing. 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.

M.B. Mahida.

Mapping between POs and PSOs													
		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	PO1												
	PO2												
	PO3												
	PO4												
	PO5												
	PO6												
	PO7												
	PO8												
	PO9												
	PO10												
Medium of Instruction	English												

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%

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

Structure of M. Sc Syllabus

M.Sc. Semester-IV

(PHYSICAL CHEMISTRY)

To be effective from December 2023

Sr. No.	Course Title	L	Credit
1	Advanced Chemical Kinetics	4	4
2	Polymer Chemistry	4	4
3	Separation Techniques	4	4
4	Atomic Spectroscopy (Elective I) OR Selected topics in Physical Chemistry –II (Elective II)	4	4
5	Skill enhancement	2	2
6	Practicals	12	6
		30	24

External Examination Time Duration: 03 hrs

Name of Exam	Semester	Paper No.	Course group	Credit	Internal Marks	External Marks	Total Marks
M.Sc.	III	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Elective I OR Elective II	04	30	70	100
		V	Skill enhancement	02	15	35	50
			Practical	06	60	140	200
			Total	24	215	435	650

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

Master of Science, Physical Chemistry
M.Sc. Physical Chemistry, Semester IV PAPER-I
(Advanced Chemical Kinetics)
To be effective from June 2023
(NEP-2020)

Course Code	PCC 1	Title of the Course	**Advanced Chemical Kinetics**
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	• To learn theories of kinetics, statistical thermodynamic approach to theories of rate of reaction. • To learn kinetics of various complex reaction. • Factors affecting kinetics of solution and gas phase reactions. • Study of concept of catalytic mechanism in terms of kinetics.

Course Content	
Unit	Description
I	**Theories of Reaction Rates** **(15Hrs)** Arrhenius theory of reaction rates, **Non-conventional equilibrium between reactants and activated complexes. Potential energy surfaces and reaction coordinate.** collision theory of bimolecular gaseous reaction, limitations and extension of collision theory, Rate theories based on thermodynamics, rate theories based on statistical mechanics, conventional transition-state theory (CTST), statistical mechanics and chemical equilibrium, Derivation of the rate equation, Thermodynamic formulation of CTST, few Applications of CTST, Assumptions and limitation of CTST, Extension of CTST: Vibration CTST
II	**Reactions in Solution Phase and Gas Phase** **(15Hrs)** Solution Phase Reaction: Solvent effects on reaction rates, factorsdetermining reaction rates in solution, reaction between ions, ion dipole and dipole-dipole reactions. Effect of ionic strength. Substituent and correlation effects – Hammett equation. Linear free energy relationship. Gas Phase Reaction: Theories of unimolecular gaseous reaction: Lindmann-Christiansen hypothesis, Hinselwood treatment, Rice Ramsperger Kassel (RRK) theory, RRKM theory

M.B. Mahida

III.	**Kinetics of Catalysis and Adsorption** **(15Hrs)** Catalysis Characteristic and types of catalyst, Homogeneous and heterogeneous catalysis and their commercial processes, Activation energies for catalysed reaction, General catalytic mechanisms: Equilibrium treatment (Arrhenius Intermediates), Steady state treatment (Van't Hoff intermediates), Acid-base catalysis, General acid base catalysis, Mechanism of acid catalysis : **Equilibrium and steady state treatment (when proton is transferred to water and solvent)**, Mechanism of acid catalysis **(when proton is transferred to water), catalytic constant**, Bronsted catalysis law and acidity functions. Kinetics of Adsorption: Isotherm for simple, Dissociation, competitive adsorption, statistical thermodynamics of Adsorption, mechanism for unimolecular and bimolecular surface reaction.
IV.	**Kinetics of Complex Reactions** **(15Hrs)** Kinetics of (I) Reversible reaction: when first order reaction opposed by second order reaction, when second order reaction opposed by first order reaction, Second order reaction opposed by one of the same order (II) Parallel reaction (III) Feedback, non-linearity and Oscillation reactions: (i) The Lotka - Volterra mechanism (ii) The Brusselator and **the oregonator) (iii) Belousov-Zhabotinsky reaction** (V) Explosion (VI) Photochemistry: Photo physical Processes, Fluorescence and Fluorescence Quenching, (V) Electron transfer, Kinetic Model of Electron Transfer **Fast reactions: General features of fast reactions, Stopped flow method, relaxation method, flash photolysis, pulse methods, pulse radiolysis**

Teaching Learning Methodology	classroom teaching, use of e-resources, library, IT tools,, encourages students to participate in seminars/ workshops, presentations by students, assignments etc.

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%

M.B. Mahida.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the contribution of different partition function to the assigned system. Calculation of thermodynamic functions for the systems
2.	Understand sets of partition functions and calculation for various gaseous systems. The fluctuations in calculation of thermodynamic functions
3.	To learn different types of interactions in liquid mixtures the derivation of empirical equation for excess thermodynamic functions for liquid mixtures
4.	To understand critical phenomena of gaseous systems.

Reference Books Recommended:

1. Chemical Kinetics, Laidler K.J. TATAMcGRAW-HILL PUBLISHING COMPANY LTD
2. Principles of Chemical Kinetics, James E. House, Elsevier Publication
3. Kinetics and Mechanism of Chemical Transformations, Rajaraman, J. and Kuriacose, J., McMillan (2008)
4. Kinetics of chemical reactions, S.K. Jain, Vishal Publications
5. Engel, T. & Reid, P. Physical Chemistry, Pearson
6. Maron, S. & Prutton Physical Chemistry

On-line resources to be used if available as reference material

On-line Resources

M.B. Mahida

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. Physical Chemistry, Semester IV

PAPER-II (Polymer Chemistry)

To be effective from December 2023

Course Code	PCC 402	Title of the Course	**Polymer Chemistry**
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	• To understand thermodynamics of polymer dissolution, theories of dissolution, factor affecting dissolution of polymer. • To learn about crystalinity and structure of polymer in solution. • To understand fractionalization and synthesis of polymers • To understand degradation of polymer.

Course Content

Unit	Description
I	**Solution Behaviour of Polymer Solution (15Hrs)** Criteria for polymer dissolution, Factors affecting swelling and dissolution: Effect of molecular weight and degree of crystallinityon dissolution, Size and shape of polymer molecules in solution, Thermodynamics aspects of polymer dissolution, cohesive energydensity, Solubility parameter and its uses and determination, Flory-Huggins theory, Enthalpy of mixing, ΔS, ΔH and ΔG of mixing, Thermodynamics of dilute polymer solution, vapour pressure, Phase equilibria and phase separations in polymer solutions, Flory interaction parameter and determination. Unperturbed dimensions of polymer coil, Good/poor/theta and non-solvents, Viscosity of polymer solutions and the size of polymer coil, Effect of molecular weight on viscosity, determination of intrinsic viscosity in theta conditions.
II	**Characterisation of Amorphous and Crystalline Polymers (15Hrs)** Thermal stability and thermal transitions in polymers, Meltingversus glass transition, Glass transition temperature, its cause andimportance, Relation between Tg and Tm, Factors affecting glasstransition temperature: Chain flexibility, effect of plasticizers, blending and copolymerization of Tg, Determination of glasstransition method by dialatometry, Crystalline polymers, Fringemicelle model, Factors affecting polymer crystallinity, Degree ofcrystallinity in polymers, Polymer crystallization, Spherulites and crystallites, Polymer single crystals, Chain folding during crystal formation, Crystallizability and crystallinity, Effect ofcrystallinity on properties of polymer

M. B. Mahida

III	**Copolymerization and Fractionation** **(15Hrs)** Kinetics of free radical copolymerization, reactivity ratios and their determination, Mayo-Lewis method, Fineman-Ross method,Disadvantages of F-R method , Kelen-Tudos (K-1) method Reactivity in copolymerization: Alfrey& Price method, Prediction of copolymer composition, Ionic co polymerization, copolycondensation, Ideal, alternate & azeotropic copolymerization, Graft and block copolymers, Polymer mixtures: IPNs, Composites, Blends and Alloys Polymer Fractionation: fractional precipitation techniques, partial dissolution technique, gradient elution technique, GPC technique
IV	**Polymer Degradation and Reactions** **(15Hrs)** Polymer degradation: Definition, Types: thermal, mechanical, degradation by ultrasonic waves, photo degradation, degradation by high-energy radiations, oxidative and hydrolytic degradation Polymer reactions: Hydrolysis, acetolysis, aminolysis, hydrogenation, addition and substitution reaction, reaction of fvarious specific groups, cyclation reaction and cross linked reactions, reaction leading to graft and block copolymers, miscellaneous reactions

Teaching Learning Methodology	classroom teaching, use of e-resources, library, IT tools,, encourages students to participate in seminars/ workshops, presentations by students, assignments etc.

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 Outcomes: Having completed this course, the learner will be able to	
1.	Understand various thermodynamic function responsible for dissolution of polymer. Flory parameter for solubility and Flory Huggins theory of dissolution.
2.	Learn the techniques for polymer fractionation. Understand the kinetics of copolymerization for their synthesis.
3.	Learn life cycle of various polymers, types of polymer degradation and factors affecting polymer degradation.
4.	Synthesis of different polymers.

M.B. Mahida

Suggested Reference books:

1. Principles of Polymer Science: P. Bahadur & N. V. Sastry, Narosa.
2. Polymer Science – Gowarikar et al New Ages International
3. Seymour/Carraher's Polymer Chemistry Charles E. Carraher Jr Marcel Dekker
4. Textbook of Polymer Science, J. W. Billmeyer, John Wiley & Sons.
5. Physical Chemistry of Macromolecules, C. Tanford, John Wiley & Sons.
6. Macromolecules in Solution, H. Morowitz, Interscience Publ.
7. Introduction to Polymer, R. J. Young, Chapman & Hall.
Online resources to be used if available as reference materials
Online Recourses

M. B. Mahida

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. Physical Chemistry, Semester IV

PAPER-III (Electro AnalyticalTechniques)

To be effective from December 2023

(NEP-2020)

Course Code	PCC 403	Title ofthe Course	**Separation Techniques**
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	• To understand the distribution law for separation of compound form solution. • To understand the types of chromatographic techniques. • To learn types and applications of liquid chromatography. • To learn about basics of solid phase extraction.

Course Content	
Unit	**Description**
I	**Solvent Extraction** **(15Hrs)** 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 solvation, types of Multiple extractions, multiple extraction with successive portion, basic concept, Apparatus and bi nominal distribution for Craig pseudo/ continuous counter current extractions. True counter current extraction: Fractional distillation, Use of crown ethers and Cryptans for extraction, extraction equilibria with crown ethers, factors affection extraction with crown ether, Numerical of distribution coefficient and multiple extraction.
II	**Theory of Chromatography** **(15Hrs)** Methods of elution, Ideal and non-ideal chromatography, Plate theory, Rate theory, Reasons for broadening of lands, 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, Derivatisation in GC, Qualitative analysis from retention parameters, Quantitative analysis, Headspace Analysis, Thermal Desorption.

M. B. Mahider

III	**Liquid Chromatography** **(15Hrs)** (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. (b) Gel-permeation Chromatography:Principle, Types of gels, Theoretical principles, Techniques and applications. (c) Adsorption Chromatography: Principle, column packings, adsorbents, mobile phase, technique of separation, detectors, identification of compounds, applications, Chiral Chromatography. (d) Affinity Chromatography: Introduction, classification, column matrices, affinity ligands, elution methods, applications.
IV	**Solid Phase Extraction and Micro Extraction** **(15Hrs)** (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 (b) Solid phase micro-extraction (SPME): Introduction, theoreticalconsiderations, experimental, Methods of analysis: PMEGC, Methods of analysis: SPME-HPLC-MS, Automation of SPME, New development in micro extraction (liquid micro extraction, membrane micro extraction). Development in micro extraction (liquid micro extraction, membrane micro extraction)

Teaching Learning Methodology	classroom teaching, use of e-resources, library, IT tools,, encourages students to participate in seminars/ workshops, presentations by students, assignments etc.

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%

M. B. Mahida.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

Course Outcomes: Having completed this course, the learner will be able to	
1.	The concept of separation of compounds from solution using the partition law. Application of extracting agents and use of various solvents for the same
2.	Understand the basics of chromatography, factors affecting chromatography and Its application in separation and purification of compounds
3.	Learn the principle and application of liquid chromatography for separation of proteins, small organic compounds. Choice of mobile and stationary phases
4.	Learn the concept of micro extraction for the separation of compounds

Suggested Reference books:

1. Introduction to instrumental analysis R.D.Broun, McGraw Hill (1987)
2. D. A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, Fundamentals of Analytical Chemistry, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004
3. Vogels Textbook of Quantitative Chemical Analysis, 6th Edn. Pearson Education Ltd.
4. Beginners Guide to Liquid Chromatography by Waters Corporation
5. Instrumental methods of chemical analysis – H.Willard, L.Merrit, J.A. Dean and
6. F.A. Settle. Sixth edition CBS (1986)
7. Introduction to Modern Liquid Chromatography, Lloyd R. Snyder, Joseph J. Kirkland, John W. Dolan
8. Chemical Separations: Principles, Techniques and Experiments, by Clifton E. Meloan

Online resources to be used if available as reference materials

Online Recourses

m.B. mahider

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc. Physical Chemistry, Semester IV

PAPER-IV (Elective I) Atomic Spectroscopy

To be effective from December 2023

(NEP-2020)

Course Code	PEC 401	Title of the Course	**Atomic Spectroscopy**
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	• To understand the basic principles, theory and instrumentation of X ray Diffraction. • To understand the concept of atomic absorption spectroscopy and Flame emission spectroscopy. • To understand basic concept of Electron Spin Resonance Spectroscopy • To provide basic theoretical understanding of Atomic Emission and Fluorescence Spectroscopy

Course Content	
Unit	**Description**
I	**Atomic X-RAY Spectroscopy** **(15Hrs)** 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.
II	**Atomic Absorption and Flame Emission Spectroscopy** **(15Hrs)** (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. (b) Flame Emission Spectroscopy (FES)Flame as a source of atomic vapour, Flame atomization, Flame photometer, Applications and limitations comparison with AAS
III	**Electron Spin Resonance Spectroscopy** **(15Hrs)** Introduction, Factors affecting the g-value, Limitations of ESR, Difference between ESR and NMR, Instrumentation, Electronnucleus 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- zero field splitting and Krammer's

M. B. Mahida

	degeneracy,Analytical applications of ESR, Structural determination by ESR,Study of inorganic compounds by ESR, Transition elements, Biological systems
IV	**Atomic Emission and Fluorescence Spectroscopy (15Hrs)** 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, 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

Teaching Learning Methodology	classroom teaching, use of e-resources, library, IT tools,, encourages students to participate in seminars/ workshops, presentations by students, assignments etc.

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 Outcomes: Having completed this course, the learner will be able to	
1.	Understand the theory, instrumentation and important terms of Atomic X-RAY Spectroscopy. Identification of compound from X ray pattern
2.	Learn instrumentation and important terms of AAS and FES in identification of metal ions in industrial effluents.
3.	To learn concept of Electron Spin Resonance Spectroscopy and Qualitative and quantitative applications of EPRS.
4.	To learn instrumentation, application of Atomic Emission and Fluorescence Spectroscopy

M. B. Mahida

Reference Books Recommended:

1. Photometric and Fluorometric Methods of Analysis: F. D. Snell (John Wiley & Sons Inc., New York).
2. Instrumental Methods of Chemical Analysis: B. R. Sharma (Goel Publishing House, Meerut).
3. Electronic Absorption Spectroscopy and related techniques, D.N. Sathyanarayan, (New Age International ND. 1996) Uni. Press, Hyderabad.
4. Introduction to Spectroscopy (3rd ed.) by Pavia Lampman Kriz, Cengage Learning, Harcourt College Publishers.
5. Spectroscopyof OrganicCompounds,P.S.Kalsi,5thedition(NewAgeInternational Publishers)
6. Flame Emission and Atomic Absorption Spectrometry by Theodore C. Rains, John A. Dean
7. Atomic Absorption Spectrometry, Third Edition, Dr. Bernhard Welz, Dr. Michael Sperling

Online resources to be used if available as reference materials

Online Recourses

M.B. Mahida.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

Master of Science, Physical Chemistry

M.Sc.Physical Chemistry, Semester IV

PAPER-IV (Elective II)

Selected topics in Physical Chemistry -II

To be effective from December 2023

(NEP-2020)

Course Code	PEC -402	Title of the Course	**Selected topics in Physical Chemistry**
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	• To understand the chemical equilibria and condition of thermodynamics of chemical reactions • To impart knowledge in the theory & principals of Nuclear chemistry. • To impart knowledge on physical phenomena of phase equilibria

Course Content	
Unit	**Description**
I	**Kinetics of reactions on surface** **(15 Periods)** Adsorption isotherm, simple Langmuir isotherm, adsorption with dissociation, competitive adsorption, non-ideal adsorption, thermodynamics and statistical thermodynamics of adsorption, Structure of solid surface and adsorbed layer, detailed structural studies, induced heterogeneity, Mechanism, of Surface reactions, Kinetics effects of surface heterogeneity, Kinetics effects of interactions, Unimolecular and bimolecular surface reactions, Reaction between two associated molecules, gas molecules and adsorbed molecules, Activation energy, Exchange reaction

M. B. Mahida

II	**The Equilibrium Condition in Phase Equilibria**	**(15 Periods)**
	Phase Equilibria for Pure Substances, The Phase Diagram and the Gibbs Phase Rule Solid + Liquid Equilibrium, Equilibrium Involving a Condensed Phase and the Vapor Phase, Vapor + Liquid Equilibrium: The Critical Point, Solid + Solid Phase Transitions, The Clausius-Clapeyron Equation,First-Order Phase Transitions, Phase Equilibria for Mixtures, Vapor + Liquid Equilibrium, Liquid + Liquid Equilibrium, Solid + Liquid Equilibrium, Effect of Pressure on Solid + Liquid Equilibrium, Solid + Liquid Equilibria in Less Ideal Mixtures	
III	**Nuclear Reactor Chemistry**	**(15 Periods)**
	Introduction, Fission product chemistry, Radiochemistry of uranium, Uranium isotopes, Metallic uranium, Uranium compounds, Uranium solution chemistry, Nuclear Fuel Cycle—The front end, Mining and milling, Refining and chemical conversion, Enrichment, Fuel fabrication, Nuclear fuel cycle. Properties of spent fuel, Fuel reprocessing, Radioactive waste disposal, Classification of radioactive waste, Amounts and associated hazards, Storage and disposal of nuclear waste, Chemistry of operating reactors, Radiation chemistry of coolants	
IV	**Bioelecrochemistry**	**(15 Periods)**
	Introduction, The electrochemical interface between biomolecules: cellular membranes, trans membrane potentials, bilayer lipid membranes, electroporation Nerve impulse and cardiovascular electrochemistry, the nerve impulse, cardiovascular problems, Oxidative phosphorylation, Bioenergetics, Bio-electrocatalysis, Bio-electroanalysis	

Teaching Learning Methodology	classroom teaching, use of e-resources, library, IT tools,, encourages students to participate in seminars/ workshops, presentations by students, assignments etc.

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%

M.B. Mahider

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand fundamental & basic terms involved in Irreversible thermodynamics to under the reactions
2.	Concept of Nuclear chemistry and to understand the calculation of various parameters related to nuclear reactions.
3.	The physical parameter to understand the photo physical chemistry
4.	Understand the molecular interactions exist in mixtures of solid liquid and gas

Suggested Reference books:

1. J. Bevan Ott & Juliana Boerio-Goates, "Chemical Thermodynamics: Principles and Applications" Elsevier
2. Walter D. Loveland, David J. Morrissey, Glenn T. Seaborg, Morden Nuclear Chemistry, John Wiley & Sons, 8 Nov 2005.
3. J.O.M.Bokris and A.K.N.Reddy, "Modern Elcrtrochemistry". Wiley
4. Essentials of Nuclear Chemistry: H. J. Arnikar (Willey Eastern Ltd)
5. Substoichiometry in Radioanalytical Chemistry: J. Ruzicka and J Stary (Pergamon Press)
6. Introduction to Radiation Chemistry: J. W. T. Spinks and R. J. Woods
7. Joe Mauk Smith, H. C. Van Ness, Michael M. Abbott, Mark T. Swihart, Introduction to Chemical Engineering Thermodynamics, Mc Graw Hill.

Online resources to be used if available as reference materials

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

M.Sc.Physical Chemistry, Semester IV

PAPER-V (Green Solvent: Ionic Liquid)

(Skill Enhancement Course)

To be effective from December 2023

(NEP-2020)

Total Periods: 30

Course Code	PSEC-401	Title of the Course	Green Chemistry
Total Credits of the Course	2	Hours per Week	2 hrs.

Course Objectives:	• To provide knowledge on green and sustainable chemistry • To learn and introduces various principle of green chemistry. • To learn about the replacement of toxic solvents with environment friendly green compounds • 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

Unit	Description
1.	**Introduction to Green Solvents** **15 hrs** Importance of solvents in industry, limitations of commonly used volatile organic solvents (VOC) , need of replacement of VOC, concept of green chemistry, 12 principle of green chemistry, Green solvents, Types of green solvents, introduction to Ionic liquids (ILs), definition of ILs, development in the field of ILs, types of ILs: Protic and aprotic ILs, Task specific ILs, nomenclature of ILs, possibility of ILs formation, superior qualities of ILS over VOC, preparation of ILs, Properties of ILs important at industrial application, Interaction of ILs with water/organic solvents
2.	**Application of Ionic Liquids in industry** **15 hrs** Application of ILs In extraction and separation of compounds/Biomolecules In environmental protection :Gas absorption In electrochemistry : sensor, Fuel cell In pharmaceutical industry In analytical chemistry

M.B. Mahider

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.

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
2.	To get the design and development of green solvents by using principles of green chemistry that reduces the generation of waste and hazardous substances.
3.	To get basic Identification of ILs
4.	To differentiate and critically evaluate applications of ILs in various field of science.

Suggested Reference Books:

1. P. Wasserscheid. T. Welton, Tonic Liquids in Synthesis, 2nd Edition, Wiley-VCH Verlag GmbH & Co. KGaA, 2008.
2. R. D: Rogers, K. R.. Seddon, Ionic: Liquids as Green Solvents: Progress and Prospects, American Chemical Society: Washington, DC (Distributed by Oxford University Press), 2003
3. Paul T. Anastas and John C. Warner, Green Chemistry, Theory and Practice, Oxford University Press, New York, 1998.
4. Ken Seddon and Dr Natalia Plechkova, Ionic Liquids Completely UnCOILed, Wiley 2010
5. Douglas R. MacFarlane, Mega Kar, Jennifer M. Pringle, Fundamentals of Ionic Liquids: From Chemistry to Applications, Wiley VCH 2017

M. B. Mahida

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

Master of Science, PhysicalChemistry
M.Sc.Physical Chemistry, Practicals
Semester - IV

Course Code	PP -401	Title of the Course	**Practicals**
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	• To impart basic knowledge for preparation of solution and instrumental set up for the experiments. • Understand theories of the experiments • To learn about the interpretation of results and graphical representation of results. • To understand the purpose of experiments to meet the objectives of the experiments.

1	Full Experiment (instrumental/ non-instrumental)	4- Credit
2	Half experiment (instrumental)	
3	Half experiment (non-instrumental)	4- Credit
4	Viva-Voce	

FULL EXPERIMENT (Any Seven)

1	Determination of the primary salt effect on the kinetics of ionic reactions (Persulphate-iodide reaction) by isolation method.
2	To calculate the surface area of adsorbed molecule in a monolayer, CMC, effectiveness from surface tension measurements of aqueous solutions of surfactant.
3	Determinations of pKa value of acid-base Methyl red indicator by spectrophotometry.
4	To carryout fractionation of a polydispersed polymer by viscosity method
5	Ion exchange separation of Fe^{+3} and Co^{+2} and determination of Fe^{+3}spectrophotometrically.

M. B. Mahida

6	Determine partition function of two organic compounds in ether – water system and findout molecular condition of organic compound in ether.
7	Determine equilibrium constant of reversible reaction between Ag^{+2} and $CaSO_4$
8	Determine relative strength of two acids (HCl and H_2SO_4) and study hydrolysis ofester.
9	Potentiometric titration of halide mixture of KCl, KBr, KI against std. $AgNO_3$ solution

HALFEXPERIMENT (Any Seven)

1	Determination of rate constant, order of reaction and energy of activation forsaponification of ethyl acetate by sodium hydroxide conductometrically.
2	Spectrophotometric determination of - Cobalt and Chromium
3	Photometric titration of iron-EDTA
4	Investigate the formation of complex between nickel and o-phenantroline using spectrophotometer.
5	Determination of dissociation constant of a buffer pH-metrically
6	To determine the degree of hydrolysis and hydrolysis constant for the hydrolysis of aniline hydrochloride by conductance method.
7	Determination of Ca^{+2} and Cu^{+2} in a mixture using EDTA titration spectrophotometrically.
8	To determine the % purity of aspirin sample tablet
9	Estimate concentration of H_2SO_4, CH_3COOH and $CuSO_4\,5H_2O$ by conductometric titration with NaOH Solution

Teaching-Learning Methodology	Introduction, explanation of theory and procedure of the experiments and interpretation of results

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%

M.B. Mahida

Course Outcomes: Having completed this course, the learnerwill be able to	
1.	Understand preparation of solutions.
2.	Qualitative analysis of compound
3.	Calculate the concentration of unknown solution by pH, potentiometer and Colorimeter
4.	Understand behaviour of surfactant and polymer
5.	Separation of compounds using different solvent systems
6.	Theories of indicators

Reference Books Recommended:

1. Advanced Practical Physical Chemistry by Yadav J. B., Krishna Prakashan Media
2. Practical Physical Chemistry, Dr. M. Satish Kumar Sankalp Publication
3. Gurtu, J. N., Kapoor, R., Advanced Experimental Chemistry S. Chand & Co. Ltd.
4. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson

On-line resources to be used if available as reference material

On-line Resources