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.
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-:પરિપત્ર:-

યુનિવર્સિટીના વિજ્ઞાન વિદ્યાશાખા હેઠળના તમામ શૈક્ષણિક વિભાગોના વડાશ્રીઓ અને યુનિવર્સિટી સંલગ્ન વિજ્ઞાન વિદ્યાશાખા હેઠળની તમામ કોલેજોનાં આચાર્યશ્રીઓને જણાવવાનું કે, NEP-2020 અંતર્ગત શૈક્ષણિક વર્ષ ૨૦૨૬–૨૭ થી અમલમાં આવનાર 2 Years PG - M.Sc. Chemistry Sem.-1 & 2 નો અભ્યાસક્રમ રસાયણશાસ્ત્ર વિષયની અભ્યાસ સમિતિની તા.૩૦/૦૪/૨૦૨૬ની સભાના ઠરાવ ક્રમાંક:૦૪ થી સુધારા વધારા સાથે મંજૂર કરવા વિજ્ઞાન વિદ્યાશાખાને કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાની તા.૦૪/૦૬/૨૦૨૬ ની સભાના ઠરાવ ક્રમાંક :૧૨ થી મંજૂર કરવા એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલની તા.૧૮/૦૬/૨૦૨૬ ની સભાના ઠરાવ ક્રમાંક:૧૦ થી મંજૂર કરેલ છે. જેનો અમલ કરવા આથી જાણ કરવામાં આવે છે.

(બિડાણ: ઉપર મુજબ)

ક્રમાંક:ઓથો./પરિપત્ર/૧૩૬૩૮/૨૦૨૬
તા.૧૯/૦૬/૨૦૨૬

કુલસચિવ

પ્રતિ,
(૧) યુનિવર્સિટીના વિજ્ઞાન વિદ્યાશાખા હેઠળના તમામ શૈક્ષણિક વિભાગોના વડાશ્રીઓ.
(૨) યુનિવર્સિટી સંલગ્ન વિજ્ઞાન વિદ્યાશાખા હેઠળની તમામ કોલેજોનાં આચાર્યશ્રીઓ.
... આપશ્રીના વિભાગ/કોલેજના સંબંધિત શિક્ષકો/વિદ્યાર્થીઓને જાણ કરી અમલ કરવા સારૂ.
(૩) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.
(૪) પરીક્ષા નિયામકશ્રી,પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.
.....તરફ જાણ તેમજ અમલ સારૂ.

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

A Proposed Syllabus for

2 years PG Programme After 3 years U.G

SEM - I

M.Sc. Chemistry Programme

Effective from

Academic Year: 2026-27

VEER NARMAD SOUTH GUJRAT UNIVERSITY, SURAT

M. Sc. (Chemistry)

Name of Program	**Master of Science (Chemistry)**
Program Abbreviation	**M. Sc.**
Duration	**2 Years**
Eligibility Criteria	**M.Sc. Chemistry** **(Organic/Inorganic/ Physical/ Analytical)** ELIGIBILITY:(SC/ST- 35%, OPEN/SEBC-40%), A candidate who has obtained his/her Bachelor's Degree with chemistry shall be considered eligible for admission in M.Sc. Chemistry **M. Sc. (Organic/ Pharmaceutical/ Environmental Chemistry) (SF)** ELIGIBILITY :(SC/ST- 35%, OPEN/SEBC-40%) A candidate who has obtained his/her Bachelor's Degree with chemistry shall be considered eligible for admission in M.Sc.- Chemistry/Organic Chemistry (S.F.)/ Pharmaceutical Chemistry (S.F.)/ Environmental Chemistry (S.F.) Course. **M.Sc. Organic Chemistry (Evening) SF** ELIGIBILITY: (SC/ST- 35%, OPEN/SEBC-40%) A candidate who has obtained his/her Bachelor's Degree with chemistry shallbe considered eligible for admission in M. Sc (Organic Chemistry (Evening) (S.F.)
Medium of Instruction	English
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	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. **PO-01**: Advanced Knowledge & Conceptual Understanding: Demonstrate in-depth knowledge of core principles and emerging trends in the chosen scientific discipline. Integrate multidisciplinary scientific concepts to address real-world challenges in research and industry.

	PO-02: Research & Analytical Skills: Develop critical thinking, problem-solving and researchoriented skills for innovation and scientific advancements. Apply modern experimental, computational and statistical tools for data analysis and evidence-based conclusions. **PO-03:** Technological Proficiency & Instrumentation: Gain expertise in advanced laboratory techniques, computational modelling and high-end scientific instrumentation. Utilize cuttingedge technologies such as artificial intelligence, bioinformatics and nanotechnology for scientific exploration. **PO-04:** Environmental & Societal Impact: Understand the role of science in addressing environmental sustainability, public health and resource management. Contribute to biodiversity conservation, sustainable agriculture and climate change mitigation through scientific solutions. **PO-05:** Innovation & Entrepreneurship: Apply scientific knowledge for the development of innovative products, processes and services in industry & start-ups. Promote entrepreneurship in science and technology, healthcare, analytics and environmental sciences through technology transfer. **PO-06:** Communication & Collaborative Research: Develop proficiency in scientific communication, technical writing and effective dissemination of research findings. Engage in interdisciplinary collaborations, industry-academic partnerships and global research networks. **PO-07:** Ethical & Value-Based Scientific Practices: Uphold scientific integrity, ethical research practices and social responsibility in professional and academic endeavours. Apply knowledge with a strong ethical framework, considering societal, legal and environmental implications. **PO-08:** Lifelong Learning & Career Readiness: Cultivate a mind-set for lifelong learning, professional growth and adaptability to new scientific developments. Prepare for higher education, research careers, competitive exams and industry-oriented roles in science and technology.

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:** Core Chemical Knowledge: Demonstrate comprehensive understanding of advanced concepts in Organic, Inorganic, Physical, and Analytical Chemistry, and interpret chemical principles governing reactions, structures, and properties. **PSO2:** Laboratory and Instrumentation Proficiency: Apply standard and advanced laboratory techniques and operate modern analytical instruments to perform experiments, analyze results, and validate outcomes accurately. **PSO3:** Problem Solving and Critical Analysis: Analyse complex chemical problems using theoretical models, quantitative methods, and experimental data, and evaluate results to draw scientifically valid conclusions. **PSO4:** Research and Scientific Inquiry: Design and execute research-oriented experiments, review scientific literature, and formulate hypotheses leading to original findings in chemistry and interdisciplinary areas. **PSO5:** Ethics, Safety and Sustainable Practices: Demonstrate professional ethics, laboratory safety awareness, and apply green and sustainable chemistry principles in academic, research, and industrial practices. **PSO6**: Communication, Employability and Lifelong Learning: Communicate chemical knowledge and research outcomes effectively in written and oral forms, work collaboratively in multidisciplinary environments, and develop skills for employment, higher studies, and lifelong learning.

Mapping between POs and PSOs

PO–PSO Mapping (✓ indicates strong correlation)

PO/PSO	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
PO-1 Advanced Knowledge & Conceptual Understanding	√	√	√	√		
PO-2 Research & Analytical Skills	√	√	√	√		
PO-3 Technological Proficiency & Instrumentation	√	√		√		
PO-4 Environmental & Societal Impact					√	
PO-5 Innovation & Entrepreneurship				√		√
PO-6 Communication & Collaborative Research		√		√		√
PO-7 Ethical & Value-Based Scientific Practices						
PO-8 Lifelong Learning & Career Readiness						√

Structure of M. Sc. Syllabus
Semester-I

Sr. No	Paper Code	Course Category	Course and Marksheet Title	Teaching Hours/ Week		Exam Duration		Credit		Internal Marks		External Marks		Total Marks	
				Th.	Pr.	Th.	Pr.	Th.	Pr.	Th.	Pr.	Th.	Pr.	Th.	Pr.
1	CH-1001	Major Course	Inorganic Chemistry	2	--	1	--	2	--	25	--	25	--	50	--
2	CHP-1001	Major Course	Inorganic Chemistry Practical	--	4	--	4	--	2	--	25		25	--	50
3	CH-1002	Major Course	Organic Chemistry	2	--	1	--	2	--	25	--	25	--	50	--
4	CHP-1002	Major Course	Organic Chemistry Practical	--	4	--	4	--	2	--	25		25	--	50
5	CH-1003	Major Course	Physical Chemistry	2	--	1	--	2	--	25	--	25	--	50	--
6	CHP-1003	Major Course	Physical Chemistry Practical	--	4	--	4	--	2	--	25		25	--	50
7	CH-1004 (Organic) **OR** CH-1004 (Inorganic) **OR** CH-1004 (Physical) **OR** CH-1004 (Analytical)	Major Course	Integrated Organic Chemistry **OR** Integrated Inorganic Chemistry **OR** Integrated Physical Chemistry **OR** Integrated Analytical Chemistry	4	--	2	--	4	--	50	--	50	--	100	--
8	CH-BKS-1005	Bharatiya Knowledge System	Bharatiya Knowledge System in Chemistry: Ancient Dyes, Cosmetics, and Eco-Friendly Technologies	4	--	2	--	4	--	50	--	50	--	100	--
9	CH-SEC-1006	Skill Enhancement Course	Chemicals: Solution and Safety	2	--	1	--	2	--	25	--	25	--	50	--

Structure of M. Sc. Syllabus
Semester-II

Sr. No	Paper Code	Course Category	Course and Marksheet Title	Teaching Hours/ Week		Exam Duration		Credit		Internal Marks		External Marks		Total Marks	
				Th.	Pr.	Th.	Pr.	Th.	Pr.	Th.	Pr.	Th.	Pr.	Th.	Pr.
1	CH-2001	Major Course	Inorganic Chemistry	2	--	1	--	2	--	25	--	25	--	50	--
2	CHP-2001	Major Course	Inorganic Chemistry Practical	--	4	--	4	--	2	--	25		25	--	50
3	CH-2002	Major Course	Organic Chemistry	2	--	1	--	2	--	25	--	25	--	50	--
4	CHP-2002	Major Course	Organic Chemistry Practical	--	4	--	4	--	2	--	25		25	--	50
5	CH-2003	Major Course	Physical Chemistry	2	--	1	--	2	--	25	--	25	--	50	--
6	CHP-2003	Major Course	Physical Chemistry Practical	--	4	--	4	--	2	--	25		25	--	50
7	CH-2004 (Organic) **OR**	Major Course	Integrated Organic Chemistry **OR**	4	--	2	--	4	--	50	--	50	--	100	--
	CH-2004 (Inorganic) **OR**		Integrated Inorganic Chemistry **OR**												
	CH-2004 (Physical) **OR**		Integrated Physical Chemistry **OR**												
	CH-2004 (Analytical)		Integrated Analytical Chemistry												
8	CH-VOC-2005	Vocational Paper	Analytical Techniques	4	--	2	--	4	--	50	--	50	--	100	--
9	CH-SEC-2006	Skill Enhancement Course	Perfumes and Cosmetics	2	--	1	--	2	--	25	--	25	--	50	--

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS						
Program Name	**M. Sc. (Chemistry)**					
Semester	**I**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-1001**					
Course Level	**400-499**					
Course Tittle	**Inorganic Chemistry**					
Credit	**Theory:**	**02**	**Practical:**	**02**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1:** Recall and explain the fundamental concepts of symmetry elements, symmetry operations, point groups, boranes, and metal clusters. **CO2:** Classify molecules into appropriate point groups and interpret character tables for chemical applications **CO3:** Apply group theory to predict molecular properties such as bonding, hybridization, IR and Raman activity, and electronic transitions. **CO4:** Analyze the structure and bonding of boron hydrides and metal clusters using Wade's rules and molecular orbital concepts. **CO5:** Evaluate the role of symmetry and cluster chemistry in organometallic, inorganic, and bioinorganic systems. **CO6:** Design and solve advanced chemical problems involving symmetry operations, spectral interpretation, and cluster electron counting.					

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√		√			
C02	√	√	√			
C03	√	√	√		√	
C04	√		√	√		
C05	√		√	√	√	
C06		√	√	√	√	√

Course Content		
Unit	Description	Hours
1.	**SYMMETRY AND GROUP THEORY IN CHEMISTRY AND ITS APPLICATIONS** **Representation of Group:** Preparation of matrices and vectors, similarity transformations and Classes for C_2v, C_2h and C_3v point groups, matrix notation for geometric transformation, Orthogonality theorem and its consequences, reducible and irreducible representation and their relation, preparation of character table for C_{2v} and C_{3v} point groups. **Applications of group theory to** Transformation properties of atomic orbitals and Hybridization of σ-bond for H_2O and NH_3 molecules.	15 Hrs.
2.	**(A) Boron Hydride** Boron hydride and its classification, Wade's Rule, Bonding in boron hydrides. Preparation, Structure and bonding in Diborane, Tetraborane (10), Penta borane (9), Penta borane (10) and dodeca borane (11) Anion. **(B) Metal Clusters** Introduction, Classification, carbonyl cluster, Low nuclearity carbonyl clusters, high nuclearity carbonyl clusters, electron counting scheme for HNCCS, Halides types clusters: dinuclear clusters, trinuclear clusters, tetranuclear clusters, hexanuclear cluster.	15 Hrs.

References Books:	
1.	Chemical Applications of Group Theory by F. A. Cotton (Second Edition), Wiley Eastern Limited, New Delhi, 1976.
2.	Group Theory and Its Application by P. K. Bhattacharya, Himalaya Publishing House, Mumbai, 1986.
3.	Group Theory and Symmetry by L. R. Hall, McGraw Hill, New York, 1989.
4.	Advanced Inorganic Chemistry by F. A. Cotton and R. G. Wilkinson, John Wiley & Sons, New York.
5.	Principles of Inorganic Chemistry by Puri, Sharma, and Kalia (33rd Edition), Vishal Publishing Co., Jalandhar, Delhi, 2017.
6.	Advanced Inorganic Chemistry by S. K. Agarwala and Keemtilal, Pragati Prakashan, Meerut.
7.	Advanced Inorganic Chemistry, Volume II by Gurdeep Raj, Krishna Prakashan Media Ltd., Meerut.
8.	Application to Group theory by K. Veera Reddy.

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	External Examination	25

Course Code	**CHP-1001**
Course Level	**400-499**
Course Tittle	**Inorganic Chemistry Practical**
Course Outcomes:	**CO1:** Identify and analyze common acidic and basic radicals present in inorganic mixtures using systematic qualitative analysis techniques. **CO2:** Perform preliminary tests, dry tests, and wet tests for the detection of various inorganic ions. **CO3:** Apply principles of selective precipitation, complex formation, and redox reactions in qualitative inorganic analysis. **CO4:** Detect and confirm the presence of six inorganic elements, including one rare earth element, using standard analytical procedures. **CO5:** Interpret experimental observations accurately and record analytical results systematically. **CO6:** Demonstrate safe laboratory practices and proper handling of chemicals and analytical reagents during qualitative analysis.

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√	√				
C02	√	√	√	√	√	
C03	√	√	√			
C04	√	√	√		√	
C05		√	√	√		√
C06		√	√	√	√	√

Course Content
Inorganic Qualitative Analysis **(Minimum Eight)**: Six elements including ONE rare earth element.

Reference Books:	
1.	Text book of Practical Inorganic chemistry – A. I. Vogel.
2.	Practical Chemistry by Dr. O. P. Pandey, D. N. Bajpai, Dr. S. Giri.
3.	Advance inorganic analysis by Agrawal, Keemtilal.
4.	Qualitative Inorganic Analysis – Vogel.
5.	Inorganic Practical by Chatwal and Anand.

Teaching-Learning Methodology	Demonstration, guided laboratory experimentation, problem-solving exercises, and collaborative learning methods are employed to develop students' skills in systematic semi-micro inorganic qualitative analysis of six elements including one rare earth element through observation, identification, separation, and confirmatory tests.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	External Examination	25

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS						
Program Name	**M. Sc. (Chemistry)**					
Semester	**I**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-1002**					
Course Level	**400-499**					
Course Tittle	**Organic Chemistry**					
Credit	**Theory:**	**02**	**Practical:**	**02**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Recall and explain the fundamental concepts of organic reaction mechanisms, reactive intermediates, stereochemistry, and conformational analysis. **CO2 :** Illustrate the formation, stability, and reactivity of carbocations, carbanions, free radicals, carbenes, and nitrenes in organic reactions. **CO3 :** Apply mechanistic principles to predict the course and products of substitution, elimination, addition, and rearrangement reactions. **CO4 :** Analyze stereochemical outcomes of organic reactions using concepts of chirality, optical activity, stereoisomerism, and stereoselectivity. **CO5 :** Evaluate conformational stability and reaction behavior of cyclic and acyclic systems using conformational analysis. **CO6 :** Design and solve advanced problems involving reaction mechanisms, stereochemical interpretation, and conformational effects in organic molecules.					

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√		√			
CO2	√		√			
CO3	√	√	√			
CO4	√		√	√		
CO5	√		√	√	√	
CO6		√	√	√	√	√

Course Content		
Unit	Description	Hours
1.	**REACTION MECHANISM & REACTIVE INTERMEDIATES** Detailed study of organic reaction intermediates. Generation, structure, stability and reactions of **Carbocations (Classical and non-classical): N**orbornyl system, common carbocation rearrangements-Demjanov, Dienone-Phenol, Rupe. **Carbanions:** Mechanism of condensation involving enolates - Aldol, Dieckmann, Michael and Shapiro reactions. **Carbenes:** Mechanism of Arndt-Eistert reaction, Wolf rearrangement and Bamford Steven's rearrangement reaction. **Free Radicals: C**oupling of alkenes and arylation of aromatic compounds by diazonium salts. Sandmeyer reactions. Free radical rearrangements, Hunsdiecker reaction.	15 Hrs.
2.	**STEREOCHEMISTRY AND CONFIRMATIONAL ANALYSIS** **(A) Stereochemistry:** Stereo chemical principles; Enantiomeric relationships; Distereomeric relationship; R-S and E-Z nomenclature; Dynamic stereochemistry: Stereo selective and Stereo specific reactions, Chiral-Prochiral relationships, Resolution of racemic modification, Optical activity in the absence ofchiral carbons biphenyl, allenes, spiranes. **(B) Confirmational Analysis:** Interconversion of Fischer, Newman andSawhorse projections. Simple acyclic and cyclic (chair and boat cyclohexanes, Decalins, Perhydrophenanthrene) systems. Effects of conformation on reactivity in acyclic compounds, mono and di substituted cyclohexanes and determination of their stability order.	15 Hrs.

Reference Books:	
Unit I:	
1.	Carbenes, Benzynes and Nitrenes by Gilchrist, T. L. and Rees.
2.	Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
3.	Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (Mc Millan India Ltd., 1976).
4.	Organic Chemistry (3/e) by J. B. Hendrickson, Donald J. Crem and George S. Rammond (McGraw-Hill Book Co. & Kogekusha Co. Ltd., 1970).
5.	Organic Chemistry (5/e) by Morrison & Boyd (Prentice Hall).
6.	Advanced Organic Chemistry by Carey &Sundberg (3rd edition).
7.	A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
8.	Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
9.	Organic chemistry 2nd ed. Jonathan clayden, Nick Greeves, Stuart Warren.
10.1.	Reaction Mechanism and Reagents in Organic Chemistry by C. R. Chatwal (Himalaya Publishing House, Bombay, 1987).
UNIT II:	
1.	Advanced Organic Chemistry: Part A: Structure and Mechanisms; By Francis A. Carey, Richard J. Sundberg, fifth edition, Published by Springer.
2.	Advanced Organic Chemistry: Part B: Reaction and Synthesis; By Francis A. Carey, Richard J. Sundberg, fifth edition, Published by Springer.
3.	Stereochemistry of Carbon Compounds; By Ernest L. Eliel, Published by Tata McGraw-Hill Publishing Company Ltd.
4.	Basic organic stereochemistry; By Ernest Ludwig Eliel, Samuel H. Wilen, Michael P. Doyle, Published by Wiley-Interscience.
5.	Introduction to Stereochemistry; By Kurt Martin Mislow, Dover Publication INC.
6.	Stereochemistry of Organic Compounds: Principles and Applications; By D. Nasipuri, New Age International (P) Ltd. Publisher.
7.	Stereochemistry Conformation and Mechanism; By P.S. Kalsi, New Age International (P) Ltd. Publisher.
8.	Basic Stereochemistry of Organic; By Subrata Sen Gupta, First edition, Published by Oxford University Press.

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	External Examination	25

Course Code	**CHP-1002**
Course Tittle	**Organic Chemistry Practical**
Course Outcomes:	**CO1 :** Explain the principles, mechanisms, and reaction conditions involved in important organic transformations such as nitration, bromination, reduction, oxidation, diazotization, Friedel–Crafts reaction, Cannizzaro reaction, aldol condensation, carboxylation, and hydrolysis. **CO2 :** Perform the synthesis of various organic compounds using standard laboratory procedures and appropriate purification techniques. **CO3 :** Apply stoichiometric calculations, reaction monitoring, and characterization methods to evaluate the yield and purity of synthesized organic compounds. **CO4 :** Analyze reaction mechanisms and interpret experimental observations associated with different classes of organic reactions. **CO5 :** Carry out quantitative estimations of organic functional groups and mixtures using volumetric and analytical techniques. **CO6 :** Demonstrate safe laboratory practices, proper handling of chemicals, accurate record keeping, and effective communication of experimental results.

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	√	√			
CO2	√	√		√	√	
CO3	√	√	√	√	√	
CO4	√		√	√		
CO5		√	√	√	√	
CO6		√		√		√

Course Content	**Preparation of organic compounds (Any six):** 1. Nitration: m-Dinitro benzene from benzene 2. Bromination: p-Bromo acetanilide from acetanilide 3. Reduction: m-phenelene diamine from m-dinitrobenzene 4. Oxidation: p-Nitro benzoic acid from p-nitro toluene 5. Diazotization reaction: Preparation of Orange-II 6. Friedl-Craft's reaction: Rescetophenone from resorcinol 7. Cannizzaro reaction: Benzoic acid from benzaldehyde 8. Aldol condensation: Chalcone from benzaldehyde and acetophenone 9. Carboxylation: ß-Resorcylic acid from resorcinol 10. Hydrolysis: Benzoic acid from benzamide **Quantitative Estimations (Any three)** 1. Estimation of acid + ester 2. Estimation of acid + amide 3. Estimation of formaldehyde via oxime 4. Estimation of number of carboxylic acid (succinic acid, oxalic acid)

Reference Books:	
1.	A text book of practical organic chemistry – A. I. Vogel
2.	Practical organic Chemistry – Mann and Saunders
3.	A handbook of quantitative and qualitative analysis – H. T. Clarke
4.	Comprehensive Practical Organic Chemistry : Qualitative Analysis V K Ahluwalia & S. Dhingra.
5.	Comprehensive Practical Organic Chemistry: Preparations and Quantitative Analysis V K Ahluwalia & R. Aggarwal Universities Press.
6.	An Advance Course in practical Chemistry, A K. Nad, B. Mahapatra and A. Ghoshal

Teaching-Learning Methodology	Introduction, interaction with students in calculation of mole ratios, Carrying out experiments at each step according to the respective practical.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	External Examination	25

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS						
Program Name	**M. Sc. (Chemistry)**					
Semester	**I**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-1003**					
Course Level	**400-499**					
Course Tittle	**Physical Chemistry**					
Credit	**Theory:**	**02**	**Practical:**	**02**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Define and recall the fundamental concepts, laws, and terminology of thermodynamics and chemical kinetics including thermodynamic systems, state functions, laws of thermodynamics, rate laws, order of reaction, and activation energy. **CO2 :** Explain the principles of thermodynamic processes, spontaneity, entropy, free energy changes, and reaction rate theories along with factors affecting chemical kinetics and reaction mechanisms. **CO3 :** Apply thermodynamic equations and kinetic rate laws to solve numerical problems related to enthalpy, entropy, Gibbs free energy, equilibrium constants, rate constants, half-life, and reaction rates. **CO4 :** Analyze thermodynamic behavior and kinetic data to distinguish between reversible and irreversible processes, different reaction orders, and various reaction mechanisms using graphical and mathematical methods. **CO5 :** Evaluate the feasibility and efficiency of chemical processes based on thermodynamic criteria and assess reaction pathways, catalytic effects, and kinetic parameters for chemical reactions. **CO 6 :.** Design and propose experimental approaches for studying thermodynamic properties and chemical reaction kinetics, including interpretation of experimental data and development of suitable reaction models.						

Mapping between COs and PSOs

CO/PSO	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO1	√	√	√	√		√
CO2	√	√	√	√	√	√
CO3	√	√	√	√	√	√
CO4	√	√	√	√	√	√
CO5	√	√	√	√	√	√
CO6	√	√	√	√	√	√

Course Content		
Unit	Description	Hours
1.	**CHEMICAL KINETICS** Theories of Unimolecular gas reactions: Lindemann theory, Kinetics of some complex reactions (i)Reversible reactions(only first order opposed by first order) (ii)Consecutive reactions(A→B→C); Equation of Relaxation time for (i) first order opposed by first order (ii) first order opposed by second order, Steady state treatment or approximation, Enzyme catalysed reactions, Kinetics of general Chain reaction, Kinetics of photochemical reactions(H_2-$Cl_2$and H_2-Br_2), Kinetics, Mechanism determination of activation energy and chain length of some organic decomposition (i) decomposition of ethane (ii) decomposition of acetaldehyde, (iii) decomposition of Ozone, Effect of Ionic strength on rates of ionic reactions (Primary and secondary salt effect) Numerical.	15 Hrs.
2.	**THERMODYNAMICS** Introduction to Laws of thermodynamics, state and path functions and their applications, thermodynamic description of various types of processes, Maxwell's relations, Partial molar quantities, Calculation of partial molar quantities, determination of partial molar volume, Ideal and non-ideal liquid mixtures, Thermodynamics functions of mixing of non-ideal solutions (i) free energy of mixing (ii) entropy of mixing (iii) volume of mixing and (iv) enthalpy of mixing, Excess functions (μ^E,G^E, S^E,H^E and V^E) for non-ideal solutions and expression for excess thermodynamic functions. Numerical	15 Hrs.

Reference Books:	
Unit-I	
1.	Chemical Kinetics, Laidler K.J. Tata mcgraw-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
Unit-II	
1.	Thermodynamics for chemist Samuel Glasstone, East-West Press Pvt. Ltd. (2008)
2.	Physical Chemistry,
3.	Principles of Physical Chemistry Puri B.R., Sharma L.R. and Pathania, M.S., Vishal Publishing Co
4.	A Text Book of Physical chemistry K.L. Kapoor Vol-5 MacMillan India Ltd. 2007
5.	An Introduction to Chemical Thermodynamics R P Rastogi and R R Mishra Vikash Publishing House Pvt Ltd. 6th edition
6.	Advanced Physical Chemistry D.N. Bajpai S. Chand & Company Ltd. 2nd edition

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	University Examination	25

Course Code	CHP-1003
Course Tittle	Physical Chemistry Practical
Course Outcomes:	**CO1 :** Apply the principles of electrochemistry, conductometry, potentiometry, pH-metry, spectrophotometry, and surface chemistry to investigate physicochemical systems. **CO2 :** Perform quantitative physicochemical experiments to determine dissociation constants, conductance, critical micelle concentration (CMC), molecular weight of polymers, and reaction parameters. **CO3 :** Analyze experimental data to evaluate reaction kinetics, activation energy, phase behavior, and thermodynamic properties using appropriate mathematical and graphical methods. **CO4 :** Interpret physicochemical phenomena such as ionic conductance, electrolyte behavior, surfactant properties, acid strength, and polymer characteristics based on experimental observations. **CO5 :** Utilize modern analytical instruments and laboratory techniques to obtain accurate and reliable physicochemical measurements. **CO 6 :** Demonstrate scientific reporting, data presentation, problem-solving abilities, and adherence to laboratory safety and ethical practices in physicochemical investigations.

Mapping between COs and PSOs

CO/PSO	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO1	√	√	√			
CO2	√	√		√	√	
CO3	√	√	√	√	√	
CO4	√		√	√		
CO5		√	√	√	√	
CO6		√	√	√		√

Course Code	CHP-1003
Course Tittle	**Physical Chemistry Practical**
Course Content	Perform minimum **any seven** experiments 1. Determine the dissociation constants of a given dibasic acid pH-metrically. 2. Determine the amount of ferrous sulphate / ferrous ammonium sulphate in given flask potentiometrically using cerric salt solution. 3. Verification of Onsager's equation and determination of equivalent conductance at infinite dilution of strong electrolytes. 4. Determine the CMC of a surfactant by conductivity measurements. 5. Calculate the molar absorptivity of each of the given two solutions (A) and (B) and also find out concentration of supplied unknown solution colorimetrically. 6. Investigation the reaction between $K_2S_2O_8$ and KI at two different temperatures and calculate the energy of activation for the reaction. 7. To study the phase diagram of a three components system Water – acetic acid – chloroform. 8. Determination of CMC and area per molecule of a surfactant by surface tension measurement. 9. Determine the molecular weight of a given polymer from viscosity measurement. 10. Deatermine the relative strength of chloroacetic acid and acetic acid by conductance measurement. 11. Determine the strength of acid HCl with NaOH spectrophotometrically.

Reference Books:

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
5.	Advanced Practical Physical Chemistry by Yadav J. B., Krishna Prakashan Media

Teaching-Learning Methodology	Demonstration, inquiry-based laboratory experimentation, instrumental analysis, data interpretation, and problem-solving approaches are employed to develop students' skills in physico-chemical measurements, kinetic studies, electroanalytical techniques, spectrophotometry, conductometry, surface chemistry and phase equilibria characterization.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	External Examination	25

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS

Program Name	**M. Sc. (Chemistry)**					
Semester	**I**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-1004 (Organic)**					
Course Level	**500-599**					
Course Tittle	**Integrated Organic Chemistry**					
Credit	**Theory:**	**04**	**Practical:**	**0**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Define and recall the fundamental concepts, reaction mechanisms, reagents, instrumentation, and terminology related to organic transformations, substitution and elimination reactions, UV-Visible spectrophotometry, and liquid chromatography. **CO2 :** Explain the principles and mechanisms of organic reactions including nucleophilic substitution and elimination pathways, as well as the theoretical basis of UV-Visible spectrophotometry and liquid chromatographic separation techniques. **CO3 :** Apply appropriate organic reagents, spectrophotometric methods, and chromatographic techniques for qualitative and quantitative analysis, reaction prediction, and separation of chemical compounds**.** **CO4 :** Analyze reaction mechanisms, stereochemical outcomes, spectral data, and chromatographic results to identify compounds, determine reaction pathways, and interpret analytical observations. **CO5 :** Evaluate the efficiency, selectivity, and applicability of organic reagents, substitution/elimination reactions, UV-Visible spectroscopic methods, and liquid chromatography techniques in chemical analysis and synthesis. **CO6 :** Design experimental procedures and analytical methodologies involving organic transformations, spectrophotometric analysis, and chromatographic separation for solving chemical and research-related problems.					

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	√	√	√		√
CO2	√	√	√	√	√	√
CO3	√	√	√	√	√	√
CO4	√	√	√	√	√	√
CO5	√	√	√	√	√	√
CO6	√	√	√	√	√	√

Course Content		
Unit	Description	Hours
1.	**ORGANIC TRANSFORMATION AND REAGENTS** 1) Sharplessepoxidation 2) Umpolung reagent (1,3-dithiane) 3) Dess martin periodinane 4) DDQ 5) Baker's yeast 6) Diisobutyl aluminum hybride (DIDAL-H) 7) Lithium disoprpyl amide (LDA) 8) OZONE 9) Phase transfer catalyst: Crown ethers 10) Wilkinson's Catalyst	15 Hrs.
2.	**SUBSTITUTION AND ELIMINATION REACTIONS** **A: Aliphatic Nucleophilic Substitution:** The SN^1 , SN^2 , SN^i mechanisms. Reactions of Allylic halides, neighbouring group participation by -OH, -NH2, -COO- , R-S, - halogen, aromatic ring. **B: Aromatic Nucleophilic Substitution:** The SN^2 , SN^1 and benzyne mechanisms, Reactivity - effect of substrate structure, leaving group and attaching nucleophile, The Von Richter rearrangement. **C: Elimination reaction:** Hoffmann and Zaitsev's rule of elimination, E1, E2 and E1CB Reaction and their regioselectivity	15 Hrs.

3.	**UV-VISIBLE SPECTROPHOTOMETRY** Types of electronic transition, auxochrome, chromophore, Bathochromic effect, Hypsochromic effect, Hyperchromic effect, Hypochromic effect, Factor affecting λ_{max} like resonance, hyper conjugation, hydrogen bonding, steric effect, Woodward's rules for α, β-unsaturated ketones, Diene systems, aromatic system, Effect of solvent on absorption bands, law of absorption with derivation, Elementary idea of double beam automatic recording, Spectrophotometer, Application.	15 Hrs.
4.	**CHROMATOGRAPHY** **(a) Gas Chromatography :** Selection of mobile phase – Selection of stationary phase in GLC and GSC, sample introduction systems, Detectors: modified FID, ECD, and FPD. Comparison between columns and their advantages and disadvantages –Temperature programming– Derivatization in GC – Qualitative (Basic terms: retention Time, Retention Volume, Relative Retention) and Quantitative (Measurement of Area, Area Normalization Method, Internal Standard Method) Analysis. **(b) Liquid Chromatography:** Principle, Comparison with GC, Principle of HPLC, Instrument and significance of each component, Pumps, Guard column, Criteria in selection of mobile phase, Stationary phases (solid, liquid), Bonded phase supports, Detectors: UV absorption, RI detectors– Normal phase and Reversed phase, Gradient Elution, Method of introducing sample.	15 Hrs.

Reference Books:	
1.	Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2.	Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (Mc Millan India Ltd., 1976).
3.	Organic Chemistry (3/e) by J. B. Hendrickson, Donald J. Crem and George S. Rammond (McGraw-Hill Book Co. & Kogekusha Co. Ltd., 1970).
4.	Organic Chemistry (5/e) by Morrison & Boyd (Prentice Hall).
5.	Advanced Organic Chemistry by Carey &Sundberg (3rd edition).
6.	A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
7.	Physical organic chemistry by Jack Hyne
8.	Reaction mechanism by Jagdambasingh.
9.	Organic chemistry-Reaction mechanism, by P.S. Kalsi, New age international publishers.
10.	Organic Chemistry (5/e) by Morrison & Boyd (Prentice Hall).
11.	Advanced Organic Chemistry by Carey &Sundberg (3rd edition).
12.	A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
13.	Name Reactions by A. R. Parikh &H.A.Parikh
14.	Name reaction: A collection of detailed reaction machanisms by Jie Jack Li
15.	Reaction Mechanism and Reagents in Organic Chemistry by C. R. Chatwal (Himalaya Publishing House, Bombay, 1987).
16.	Organic Chemistry-Reactions and Mechanism by P S Kalsi
17.	Advanced Organic Chemistry: Reactions and Mechanisms byM.S. Singh
18.	Fundamental of molecular spectroscopy, C. N. Banwell, Tata Mc-Graw Hill Pub. Camp.
19.	Spectrometric Identification of Organic Compounds (4th edition/5th edition), Silverstein, Bassler & Morril, John Wiley & Sons.
20.	Introduction to Molecular Spectroscopy, G. M. Barrow, McGraw – Hill.
21.	Modern Methods of Chemical Analysis (2nd ed.), Pecsok, Shields, Cairns &McWilliam, John Wiley & Sons.
22.	Instrumental Analysis by R. D. Braun, McGraw-Hill.
23.	Introduction to Instrumental Analysis by R. D. Brawn, McGraw-Hill Book.
24.	Fundamentals of Analytical Chemistry: Skoog D. R. and West D. M. (Holt, Rinehart & Winston, New York).
25.	Instrumental Methods of Analysis by G. W. Ewing.
26.	Quantitative Analysis, 6th Ed., R. A. Day and A. L. Underwood, Prentice – Hall of India,1993.
27.	Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn & Bacon Inc., New York,2nd edition.
28.	Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York),5th edition.
29.	Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (Van Nostrand Reinhold Co., New York), 6th edition.
30.	Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	50
2.	External Examination	50

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS						
Program Name	**M. Sc. (Chemistry)**					
Semester	**I**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-1004 (Inorganic)**					
Course Level	**500-599**					
Course Tittle	**Integrated Inorganic Chemistry**					
Credit	**Theory:**	**04**	**Practical:**	**0**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1:** Explain the fundamental concepts of magnetochemistry, magnetic properties of substances, and theories related to coordination compounds. **CO2:** Describe the principles, instrumentation, and electronic transitions involved in UV-Visible spectrophotometry and chromatographic techniques. **CO3:** Apply crystal field theory, magnetic moment calculations, Beer–Lambert law, and chromatographic principles for chemical analysis.. **CO4:** Analyze coordination complexes based on geometry, magnetic behavior, stability, and spectral characteristics using spectroscopic and chromatographic data. **CO5:** Evaluate the efficiency, selectivity, and applications of Gas Chromatography (GC) and Liquid Chromatography (LC) in qualitative and quantitative analysis. **CO6:** Perform laboratory-based separation and analytical techniques using UV-Visible spectrophotometry, GC, and LC for identification and estimation of chemical substances.					

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	√	√	√		√
CO2	√	√	√	√	√	√
CO3	√	√	√	√	√	√
CO4	√	√	√	√	√	√
CO5	√	√	√	√	√	√
CO6	√	√	√	√	√	√

Course Content		
Unit	Description	Hours
1.	**ELEMENTS OF MAGNETOCHEMISTRY** Definitions of magnetic properties, type of magnetic bodies, the source of paramagnetism, diamagnetism and pascal's constant, Example of pascals constant, Curie and Curie-Weiss law, Magnetic Properties of transition elements, Determination of magnetic susceptibility: (a) Gouy method (b) Faraday method and (c) NMR method, Application of magnetic susceptibility measurements, Temperatureindependent paramagnetism (TIP), Orbital contribution to magnetic moment, Magnetic properties of first transition elements.	15 Hrs.
2.	**COORDINATION COMPOUNDS** Classification, of coordination compounds, Werner's theory of coordination, electronic interpretation of coordination compounds, Factors affecting the formation of complex ions, Detection of complex ion in solution, Chelation, factors influencing the stability of metal chelates, importance of chelates, role of metal chelates in living system and polynuclear complexes, Determination of composition of complex ions.	15 Hrs.

Unit	Description	Hours
3.	**UV-VISIBLE SPECTROPHOTOMETRY** Types of electronic transition, auxochrome, chromophore, Bathochromic effect, Hypsochromic effect, Hyperchromic effect, Hypochromic effect, Factor affecting λ_{max} like resonance, hyper conjugation, hydrogen bonding, steric effect, Woodward's rules for α, β-unsaturated ketones, Diene systems, aromatic system, Effect of solvent on absorption bands, law of absorption with derivation, Elementary idea of double beam automatic recording, Spectrophotometer, Application.	15 Hrs.
4.	**CHROMATOGRAPHY** **(a) Gas Chromatography:** Selection of mobile phase – Selection of stationary phase in GLC and GSC, sample introduction systems, Detectors: modified FID, ECD, and FPD. Comparison between columns and their advantages and disadvantages –Temperature programming – Derivatization in GC – Qualitative (Basic terms: retention Time, Retention Volume, Relative Retention) and Quantitative (Measurement of Area, Area Normalization Method, Internal Standard Method) Analysis. **(b) Liquid Chromatography:** Principle, Comparison with GC, Principle of HPLC, Instrument and significance of each component, Pumps, Guard column, Criteria in selection of mobile phase, Stationary phases (solid, liquid), Bonded phase supports, Detectors: UV absorption, RI detectors – Normal phase and Reversed phase, Gradient Elution, Method of introducing sample.	15 Hrs.

Reference Books:	
1.	Advanced Inorganic Chemistry by F. A. Cotton and R. G. Wilkinson, John Wiley & Sons, New York.
2.	Principles of Inorganic Chemistry by Puri, Sharma, and Kalia (33rd Edition), Vishal Publishing Co., Jalandhar, Delhi, 2017.
3.	Advanced Inorganic Chemistry by S. K. Agarwala and Keemtilal, Pragati Prakashan, Meerut.
4.	Advanced Inorganic Chemistry, Volume II by Gurdeep Raj, Krishna Prakashan Media Ltd., Meerut.
5.	Inorganic Chemistry by Gary L. Miessler and Donald A. Tarr, Pearson Education International.
6.	Magnetochemistry by R. L. Carlin.
7.	Elements of Magnetochemistry by A. S. Syamal and R. L. Dutta, Affiliated East-West Press, New Delhi, 1993.
8.	Spectrometric Identification of Organic Compounds (4^{th} edition/5^{th} edition), Silverstein, Bassler & Morril, John Wiley & Sons.
9.	Modern Methods of Chemical Analysis (2^{nd} ed.), Pecsok, Shields, Cairns & McWilliam, John Wiley & Sons.
10.	Instrumental Analysis by R. D. Braun, McGraw-Hill.
11.	Introduction to Instrumental Analysis by R. D. Brawn, McGraw-Hill Book.
12.	Fundamentals of Analytical Chemistry: Skoog D. R. and West D. M. (Holt, Rinehart & Winston, New York).
13.	Instrumental Methods of Analysis by G. W. Ewing.
14.	Quantitative Analysis, 6^{th} Ed., R. A. Day and A. L. Underwood, Prentice – Hall of India,1993.
15.	Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2^{nd} edition.
16.	Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5^{th} edition.
17.	Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (Van Nostrand Reinhold Co., New York), 6^{th} edition.
18.	Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	50
2.	External Examination	50

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS						
Program Name	**M. Sc. (Chemistry)**					
Semester	**I**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-1004 (Physical)**					
Course Level	**500-599**					
Course Tittle	**Integrated Physical Chemistry**					
Credit	**Theory:**	**04**	**Practical:**	**0**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Explain the fundamental concepts of statistical thermodynamics, distribution laws, partition functions, and thermodynamic probability. **CO2 :** Interpret the principles of biophysical chemistry including bioenergetics, enzyme kinetics, membrane transport, and macromolecular interactions. **CO3 :** Apply the principles of UV-Visible spectrophotometry for qualitative and quantitative chemical analysis using Beer-Lambert law. **CO4 :** Analyze chromatographic separation techniques including Gas Chromatography (GC) and Liquid Chromatography (LC) for identification and estimation of chemical constituents. **CO5 :** Evaluate experimental data obtained from spectrophotometric and chromatographic techniques for accuracy, precision, and interpretation. **CO6 :** Design and perform analytical experiments involving UV-Visible spectrophotometry and chromatographic methods for solving chemical and biochemical problems.					

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	√	√	√		√
CO2	√	√	√	√	√	√
CO3	√	√	√	√	√	√
CO4	√	√	√	√	√	√
CO5	√	√	√	√	√	√
CO6	√	√	√	√	√	√

Course Content		
Unit	Description	Hours
1.	**STATISTICAL THERMODYNAMICS** Basics of Statistical thermodynamics (Assembly,Canonical ensemble, occupation numberstatistical weight factor, probability), Thermodynamic probability, Probability and entropy, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Lagrange's methods of multipliers, Partition function, Thermodynamic properties in term of partition functions(i) Internal energy (ii) Heat Capacity (iii) Helmholtz free energy (iv) Enthalpy (v) Gibb's free energy(vi) Chemical potential Molecular partition functions for an ideal gas , Derivation for Translational, Rotational and Vibrational partition functions Numerical.	15 Hrs.
2.	**BIOPHYSICAL CHEMISTRY** Bioenergetics: Standard free energy change in biochemical reactions (exergonic and endergonic). ATP hydrolysis, synthesis of ATP, Energy rich compounds and energy coupling (Formation and hydrolysis of energy rich bonds in energy rich molecule), Enzyme Kinetics: Michaelis-Menten, Michaelis-Menten for all types of Inhibition, Lineweaver-Burke plots. Apllication of L-B plot, Enzyme inhibition: reversible and irreversible inhibition, Immobilized enzymes, Techniques and methods of immobilization of enzymes, Application of immobilized enzymes. Cell Membrane: Structure and Transport functions of cell membrane. Passive and active transport, Facilitated diffusion, Targeted Diffusion	15 Hrs.

3.	**UV-VISIBLE SPECTROPHOTOMETRY** Types of electronic transition, auxochrome, chromophore, Bathochromic effect, Hypsochromic effect, Hyperchromic effect, Hypochromic effect, Factor affecting λ_{max} like resonance, hyper conjugation, hydrogen bonding, steric effect, Woodward's rules for α, β-unsaturated ketones, Diene systems, aromatic system, Effect of solvent on absorption bands, law of absorption with derivation, Elementary idea of double beam automatic recording, Spectrophotometer, Application.	15 Hrs.
4.	**CHROMATOGRAPHY** **(a) Gas Chromatography:** Selection of mobile phase – Selection of stationary phase in GLC and GSC, sample introduction systems, Detectors: modified FID, ECD, and FPD. Comparison between columns and their advantages and disadvantages –Temperature programming – Derivatization in GC – Qualitative (Basic terms: retention Time, Retention Volume, Relative Retention) and Quantitative (Measurement of Area, Area Normalization Method, Internal Standard Method) Analysis. **(b) Liquid Chromatography:** Principle, Comparison with GC, Principle of HPLC, Instrument and significance of each component, Pumps, Guard column, Criteria in selection of mobile phase, Stationary phases (solid, liquid), Bonded phase supports, Detectors: UV absorption, RI detectors – Normal phase and Reversed phase, Gradient Elution, Method of introducing sample.	15 Hrs.

Reference Books:	
1.	Statistical Thermodynamics BY M. C. Gupta, New Age International, 2007
2.	An Introduction to Statistical Thermodynamics, Terrell L. Hill, Addition Weslay Publishing Company
3.	Principles of Physical Chemistry Puri B.R., Sharma L.R. and Pathania, M.S., Vishal Publishing Co
4.	A Text Book of Physical chemistry K.L. Kapoor Vol-5 Macillan India Ltd. 2007
5.	Physical chemistry by P.W. Atkins & de Paula 7Th Edition
6.	Biochemistry by C.B. Powar and G.R. Chatwal, Himalaya Publishing House
7.	Bioenergetics by David G. Nicholls & Stuart J. Ferguson, Academic Press (Elsevier).
8.	Lehninger Principles of Biochemistry by Nelson & Cox, W. H. Freeman and Company, New York.
9.	Fundamental of molecular spectroscopy, C. N. Banwell, Tata Mc-Graw Hill Pub. Comp.
10.	Spectrometric Identification of Organic Compounds (4^{th} edition/5^{th} edition), Silverstein, Bassler & Morril, John Wiley & Sons.
11.	Introduction to Molecular Spectroscopy, G. M. Barrow, McGraw – Hill.
12.	Modern Methods of Chemical Analysis (2^{nd} ed.), Pecsok, Shields, Cairns & McWilliam, John Wiley & Sons.
13.	Instrumental Analysis by R. D. Braun, McGraw-Hill.
14.	Introduction to Instrumental Analysis by R. D. Brawn, McGraw-Hill Book.
15.	Fundamentals of Analytical Chemistry: Skoog D. R. and West D. M. (Holt, Rinehart & Winston, New York).
16.	Instrumental Methods of Analysis by G. W. Ewing.
17.	Quantitative Analysis, 6^{th} Ed., R. A. Day and A. L. Underwood, Prentice – Hall of India,1993.
18.	Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2^{nd} edition.
19.	Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5^{th} edition.
20.	Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (Van Nostrand Reinhold Co., New York), 6^{th} edition.
21.	Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	50
2.	External Examination	50

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS

Program Name	**M. Sc. (Chemistry)**					
Semester	**I**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-MJ-704 (Analytical)**					
Course Level	**500-599**					
Course Tittle	**Integrated Analytical Chemistry**					
Credit	**Theory:**	**04**	**Practical:**	**0**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Explain the fundamental concepts of chemical mathematics including logarithmic functions, differential equations, matrix operations, and statistical methods used in chemistry. . **CO2 :** Apply mathematical and statistical tools for solving quantitative chemical problems and interpreting analytical data. **CO3 :** Describe the principles, instrumentation, and applications of thermogravimetry and thermometric titration in chemical analysis. **CO4 :** Apply the principles of UV-Visible spectrophotometry, Gas Chromatography (GC), and Liquid Chromatography (LC) for qualitative and quantitative analysis of chemical substances. **CO5 :** Analyze thermal, spectroscopic, and chromatographic data to determine composition, purity, and reaction characteristics of chemical systems. **CO6 :** Evaluate and design analytical procedures using thermogravimetric, thermometric, spectrophotometric, and chromatographic techniques for research and industrial applications.						

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	√	√	√		√
CO2	√	√	√	√	√	√
CO3	√	√	√	√	√	√
CO4	√	√	√	√	√	√
CO5	√	√	√	√	√	√
CO6	√	√	√	√	√	√

Unit	Description	Hours
1.	**CHEMICAL MATHEMATICS** Errors in Chemical analysis, classification of errors, nature and origin of errors, Propagation of error, Accuracy and precision, average deviation and standard deviation and its physical significance, Normal Distribution curve and its properties. Confidence limit and probability, Statistical treatment for error analysis, students' 't' test, rejection criteria and Q test, method of least square.	15 Hrs.
2.	**THERMAL METHODS OF ANALYSIS THERMOGRAVIMETRY** Thermogravimetry, Instruments for TGA- thermobalace and furnace, Calibration of temperature scale (Curie Point & Melting Point), Factors affecting TGA results instrumental and experimental, Applications(Mixture, Proximate analysis, Polymer identification, Carbon black and Structure of Copper Sulfate) **THERMOMETRIC TITRATION** Thermometric Titration (TT), Advantages, Instrument, Applications of TT in Neutralization Titration, Precipitation Titration, Complexometry Titration and Redox Titration.	15 Hrs.

Unit	Description	Hours
3.	**UV-VISIBLE SPECTROPHOTOMETRY** Types of electronic transition, auxochrome, chromophore, Bathochromic effect, Hypsochromic effect, Hyperchromic effect, Hypochromic effect, Factor affecting λ_{max} like resonance, hyper conjugation, hydrogen bonding, steric effect, Woodward's rules for α, β-unsaturated ketones, Diene systems, aromatic system, Effect of solvent on absorption bands, law of absorption with derivation, Elementary idea of double beam automatic recording, Spectrophotometer, Application.	15 Hrs.
4.	**CHROMATOGRAPHY** **(a) Gas Chromatography:** Selection of mobile phase – Selection of stationary phase in GLC and GSC, sample introduction systems, Detectors: modified FID, ECD, and FPD. Comparison between columns and their advantages and disadvantages–Temperature programming–Derivatization in GC–Qualitative (Basic terms: retention Time, Retention Volume, Relative Retention) and Quantitative (Measurement of Area, Area Normalization Method, Internal Standard Method) Analysis. **(b) Liquid Chromatography:** Principle, Comparison with GC, Principle of HPLC, Instrument and significance of each component, Pumps, Guard column, Criteria in selection of mobile phase, Stationary phases (solid, liquid), Bonded phase supports, Detectors: UV absorption, RI detectors – Normal phase and Reversed phase, Gradient Elution, Method of introducing sample.	15 Hrs.

Reference Books:	
1.	Fundamental of molecular spectroscopy, C. N. Banwell, Tata Mc-Graw Hill Pub. Camp.
2.	Spectrometric Identification of Organic Compounds (4th edition/5th edition), Silver stein, Bassler & Morril ,John Wiley &Sons.
3.	Introduction to Molecular Spectroscopy ,G. M. Barrow, McGraw–Hill.
4.	Modern Spectroscopy, J.M .Hollas, John Wiley.
5.	Basic Principles of Spectroscopy, R. Chang, McGraw-Hill.
6.	Modern Methods of Chemical Analysis (2nd ed.), Pecsok, Shields, Cairns & Mc William, John Wiley &Sons.
7.	Instrumental Analysis by R. D. Braun ,McGraw-Hill.
8.	Introduction to Instrumental Analysis by R.D. Brawn, McGraw-Hill Book.
9.	Fundamentals of Analytical Chemistry: Skoog D.R. and West D.M.(Holt, Rinehart &Winston, New York).
10.	Instrumental Methods of Analysis by G. W. Ewing.
11.	Modern Method of Chemical Analysis by Pecsok, Shield, Cairns, Mc William, John WileyandSons.
12.	QuantitativeAnalysis,6thEd.,R. A. Day and A. L. Underwood, Prentice–HallofIndia,1993.
13.	Instrumental Analysis: G. D. Caristian and J.E. O'Reilly(Allyn & Bacon Inc., New York, 2nd edition.
14.	Instrumental Methods of Chemical Analysis: G. W. Ewing(McGraw-Hill, New York), 5th edition.
15.	Instrumental Methods of Analysis:H. R. Willard, L. L. Merrit, J.A. Dean, F. A. Settle(Van Nostr and Reinhold Co., New York), 6thedition.
16.	Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns(John Wiley),2ndedition.
17.	Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company), New Delhi.
18.	Analytical Chemistry: Principles and Techniques: Larry G. Hargis(Prentice-Hall International edition).
19.	Introduction to Modern Liquid Chromatography: L.R. Shyder & J.J. Kirkland (John Wiley & Sons, New York).
20.	Hand book of Analytical Chemistry: L. Meites(McGraw-Hill, New York).

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	50
2.	External Examination	50

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS						
Program Name	**M. Sc. (Chemistry)**					
Semester	**I**					
NCrF Credit Level	**6.0**					
Course Type	**Bharatiya Knowledge System**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-BKS-1005**					
Course Level	**500-599**					
Course Tittle	**Bharatiya Knowledge System in Chemistry: Ancient Dyes, Cosmetics, and Eco-Friendly Technologies**					
Credit	**Theory:**	**04**	**Practical:**	**0**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Describe the origin, composition, preparation methods, and applications of ancient Indian dyes, pigments, textiles, cosmetics, and chemical technologies. **CO2 :** Explain the chemical principles, traditional processing methods, and sustainable practices associated with ancient Indian chemical sciences and environmental management systems. **CO3 :** Apply traditional knowledge of natural dyes, pigments, herbal cosmetics, and eco-friendly chemical practices for preparation, preservation, and sustainable utilization of materials. **CO4 :** Analyze the chemical composition, processing techniques, environmental impact, and scientific relevance of ancient Indian chemical technologies and textile practices. **CO5 :** Evaluate the effectiveness, sustainability, ecological significance, and modern relevance of ancient Indian chemical practices, cosmetics, dyes, and environmental technologies. **CO6 :** Develop innovative and eco-friendly approaches inspired by ancient Indian chemical technologies for applications in textiles, cosmetics, sustainable chemistry, and environmental conservation.						

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√			√		
CO2	√		√	√		
CO3		√	√	√	√	
CO4	√		√	√	√	
CO5			√	√	√	√
CO6		√		√	√	√

Course Content		
Unit	Description	Hours
1.	**Ancient Indian Dyes, Pigments and Textile Chemistry** Ancient Indian concept and modern concept of dyes, ancient Indian concept and modern concept of pigments, natural dyes of ancient India, pigments used in ancient India, ancient Indian dyeing techniques, types of modern dyes, modern dyeing techniques, comparison of ancient Indian dyes and modern dyes, comparison between ancient Indian dyeing techniques and modern Indian dyeing techniques, ancient Indian textile chemistry, modern Indian textile chemistry.	15 Hrs.
2.	**Environmental and Sustainable Chemistry in Ancient India** Eco friendly practices in ancient Indian chemistry, sustainable agriculture, water purification techniques in ancient India, recycling and waste management in ancient India, biodegradable substances, traditional cleaning agents, sustainable metallurgy and corrosion-resistant technologies in ancient India, Organic farming, natural pesticides and ayurvedic formulations, relevance of ancient Indian practices to modern green chemistry.	15 Hrs.

3	**Ancient Indian Cosmetics** Types of cosmetics: kajal, ubtan, herbal pastes Ingredients: turmeric, sandalwood, neem, saffron Functions: cleansing, anti-aging, skin protection Basic chemistry of herbal compounds (alkaloids, essential oils) **Perfumery and Fragrance Science** History of perfumery in India, traditional perfumes (attar) from Kannauj, Natural sources: flowers, woods, spices, Chemistry of aroma compounds (terpenes, esters) **Extraction and Processing Techniques** Distillation methods (Deg & Bhapka system), steam distillation, solvent extraction, preparation of oils, pastes and powders, preservation techniques in ancient times **Chemical Principles in Traditional Formulations** Active constituents: curcumin, santalol, eugenol, role of pH, solubility, and stability, antimicrobial and antioxidant properties, comparison with modern cosmetic chemistry **Modern Relevance and Applications** Revival of herbal cosmetics industry, role in green and sustainable Chemistry, safety, standardization and commercialization, Global demand for natural products.	15 Hrs.
4	**Introduction to Ancient Chemical Technology:** **Science of Appliances:** Concept and development of appliances and instruments in ancient Indian science, Traditional apparatus used in Rasashastra and ancient chemical operations, Ancient heating systems, furnaces, crucibles, distillation and filtration devices, Scientific principles involved in grinding, extraction, calcination, sublimation, and distillation techniques, Indigenous technologies related to pottery, metallurgy, textiles, and food processing appliances, Materials used for preparation of ancient scientific instruments and laboratory equipment, Efficiency, sustainability, and eco-friendly aspects of ancient appliances.	15 Hrs.

Reference Books:	
1.	Natural Dyes for Textiles: Sources, Chemistry and Applications, Author: Padma Shree Vankar
2.	Handbook on Natural Dyes for Industrial Applications (ISBN: 9789381039755) Author: Dr. Padma S. Vankar, Edition: 2nd Revised Edition Publisher: NIIR Project Consultancy Services
3.	Handbook of Natural Dyes and Pigments Authors: HarBhajan Singh & Kumar Avinash Bharati. Publisher: Woodhead Publishing India
4.	The Complete Book on Natural Dyes & Pigments Publisher: NIIR Board of Consultants & Engineers
5.	Natural Dyeing Processes of India Authors: B.C. Mohanty, K.V. Chandramouli & H.D. Naik Published by the Calico Museum of Textiles
6.	Natural Dyes for Sustainable Textiles Authors: Padma Shree Vankar & Dhara Shukla.
7.	Natural Dyeing Processes of India Authors: B. C. Mohanty, K. V. Chandramouli & H. D. Naik , Calico Museum of Textiles
8.	Traditional Indian Handcrafted Textiles: History, Techniques, Processes and Designs (2 Vols) Publisher: Niyogi Books
9.	Charaka Samhita
10.	Sushruta Samhita
11.	The Complete Technology Book on Herbal Perfumes and Cosmetics – H. Panda
12.	Herbal Cosmetics & Ayurvedic Medicines – P. K. Chattopadhyay
13.	Ayurvedic Technical Studies and Herbal Cosmetics of Ancient India – K.H. Krishnamurthy
14.	The Complete Technology Book on Herbal Perfumes and Cosmetics – H. Panda
15.	Herbal Cosmetics & Ayurvedic Medicines – P. K. Chattopadhyay
16.	Ayurvedic Technical Studies and Herbal Cosmetics of Ancient India – K.H. Krishnamurthy
17.	A History of Hindu Chemistry from the Earliest Times to the Middle of the Sixteenth Century A.D. by Prof. P. C. Ray, (1902) published by The Bengal Chemical and Pharmaceutical Works.
18.	History of Science and Technology in Ancient India: Volume II – Metal Technology by Debiprasad Chattopadhyaya (1986) published by Firma KLM, Calcutta.
19.	Introduction to Indian knowledge system concepts and Applications by B. Mahadevan, Vinayak Rajat Bhatt, Nagendra Pavana R. N.
20.	"The Ayurvedic Pharmacopoeia of India" - Govt. of India
21.	"Charaka Samhita"- Maharshi Charaka
22.	Ray, P. (1956) History of Chemistry in Ancient and Medieval India, incorporating the History of Hindu Chemistry by Acharya Prafulla Chandra Ray. Calcutta: Indian Chemical Society.
23.	Rasaratna Samuccaya – Ambikadatta Shastri (Ed.)

24.	Bhagwat, V. S. R., Kurkute, B. R., Shinde, B. T., & Tapare, S. K. (2017). Classification of Rasadravyas In Rasashastra. World Journal of Pharmaceutical Research, 6(4), 792–802. https://doi.org/10.20959/wjpr20174-8226
25.	Danino. Michel, Technology in Ancient India.
26.	Joshi, Damodar. (1997) History of Technology in India, Vol. 1, From Antiquity to c. 1200

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	50
2.	External Examination	50

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS						
Program Name	**M. Sc. (Chemistry)**					
Semester	**I**					
NCrF Credit Level	**6.0**					
Course Type	**Skill Enhancement Course**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-SEC-1006**					
Course Level	**500-599**					
Course Tittle	**Chemicals: Solution and Safety**					
Credit	**Theory:**	**02**	**Practical:**	**0**	**Total:**	**02**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Define the basic concepts, terminology, units, concentration methods, and standard procedures involved in solution preparation, chemical handling, and laboratory safety practices. **CO2 :** Explain the principles of solution preparation, storage techniques, labeling systems, hazard identification, safety symbols, and ethical guidelines for chemical usage and disposal. **CO3 :** Prepare standard solutions, perform dilution and concentration calculations, and apply safe laboratory practices for handling, storage, and transportation of chemicals.. **CO4 :** Analyze chemical hazards, incompatibilities, risk factors, and ethical issues associated with laboratory chemicals and experimental procedures.. **CO5 :** Evaluate laboratory safety measures, waste disposal methods, environmental impacts, and ethical responsibilities related to chemical handling and usage. **CO6 :** Design safe laboratory protocols, standard operating procedures, and sustainable chemical handling strategies in accordance with professional ethics and safety regulations.					

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	√	√		√		
CO2	√	√	√	√		
CO3		√	√	√	√	
CO4			√	√	√	
CO5			√	√	√	√
CO6		√		√	√	√

Course Content		
Unit	Description	Hours
1.	**SOLUTION PREPARATION AND HANDLING** Prepare solution and operate weighing balance for sampling to prepare different types of solution as per the Equivalent weight, Molecular weight, atomic weight, Specific gravity, Normality, Acidity, Basicity, Concentration, Normal Solution and Molar Solutions. Prepare the acid solutions, basic solutions and oxidizing - reducing agent, solutions. Prepare solutions of different concentration and determine the concentration and percentage purity. 4. Prepare the Complexometric solutions, indicators, sampling in solids, liquids and gases. Standardize the solutions, primary standardize, secondary standards, Prepare the Ethylene diamine tetra acetic acid (EDTA) solution & indicator.	15 Hrs.
2.	**CHEMICAL SAFETY AND ETHICAL HANDLING OF CHEMICALS** Safe chemical working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. safe storage and use of a hazardous chemicals, procedure for working with substance that pose hazards, flammable or explosive hazards, procedures for working with gases at pressure above and below atmospheric level, safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identifications, verification and segregation of a laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals, knowledge about the Personnel safety and use of personnel protective equipment's, explain the Behavior Based Safety (BBS), Operate firefighting extinguisher and knowledge of the Fire prevention	15 Hrs.

Reference Books:	
1.	QuantitativeAnalysis,6thEd.,R. A.DayandA.L.Underwood, Prentice–HallofIndia,1993.
2.	Elements of Analytical Chemistry by R. Gopalan; P.S. Subramanian and K.Rengarajan
3.	Vogel's Qualitative Inorganic analysis
4.	Vogel's Qualitative Organic analysis
5.	Chemical Hazards in the workplace, measurement and control, Gangadhar Choudhary,
6.	American Chemical Society.

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	External Examination	25

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

A Proposed Syllabus for

2 years PG Programme After 3 years U.G

SEM - II

M.Sc. Chemistry Programme

Effective from

Academic Year: 2026-27

Structure of M. Sc. Syllabus
Semester-II

Sr. No	Paper Code	Course Category	Course and Marksheet Title	Teaching Hours/ Week		Exam Duration		Credit		Internal Marks		External Marks		Total Marks	
				Th.	Pr.	Th.	Pr.	Th.	Pr.	Th.	Pr.	Th.	Pr.	Th.	Pr.
1	CH-2001	Major Course	Inorganic Chemistry	2	--	1	--	2	--	25	--	25	--	50	--
2	CHP-2001	Major Course	Inorganic Chemistry Practical	--	4	--	4	--	2	--	25		25	--	50
3	CH-2002	Major Course	Organic Chemistry	2	--	1	--	2	--	25	--	25	--	50	--
4	CHP-2002	Major Course	Organic Chemistry Practical	--	4	--	4	--	2	--	25		25	--	50
5	CH-2003	Major Course	Physical Chemistry	2	--	1	--	2	--	25	--	25	--	50	--
6	CHP-2003	Major Course	Physical Chemistry Practical	--	4	--	4	--	2	--	25		25	--	50
7	CH-2004 (Organic) **OR**	Major Course	Integrated Organic Chemistry **OR**	4	--	2	--	4	--	50	--	50	--	100	--
	CH-2004 (Inorganic) **OR**		Integrated Inorganic Chemistry **OR**												
	CH-2004 (Physical) **OR**		Integrated Physical Chemistry **OR**												
	CH-2004 (Analytical)		Integrated Analytical Chemistry												
8	CH-VOC-2005	Vocational Paper	Analytical Techniques	4	--	2	--	4	--	50	--	50	--	100	--
9	CH-SEC-2006	Skill Enhancement Course	Perfumes and Cosmetics	2	--	1	--	2	--	25	--	25	--	50	--

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS

Program Name	**M. Sc. (Chemistry)**					
Semester	**II**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-2001**					
Course Level	**400-499**					
Course Tittle	**Inorganic Chemistry**					
Credit	**Theory:**	**02**	**Practical:**	**02**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Explain the fundamental principles of quantum mechanics, wave functions, operators, and postulates along with thermodynamic and kinetic concepts of metal complexes. **CO2 :** Apply Schrödinger wave equation and quantum mechanical models to simple chemical systems and calculate thermodynamic parameters related to metal complexes. **CO3 :** Analyze the bonding, electronic structure, stability, and reaction mechanisms of coordination compounds using quantum and kinetic theories. **CO4** : Interpret thermodynamic properties such as entropy, enthalpy, free energy, and stability constants in metal complex formation and reactions. **CO5 :** Evaluate substitution reactions, ligand exchange mechanisms, and factors affecting kinetic behaviour and stability of coordination compounds. **CO6:** Develop problem-solving ability for quantum mechanical calculations and predict thermodynamic and kinetic behavior of transition metal complexes in chemical systems.					

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√		√			√
C02	√	√	√		√	√
C03	√		√	√		√
C04	√	√	√	√		
C05		√	√	√	√	
C06	√	√	√	√	√	√

Course Content		
Unit	Description	Hours
1.	**Quantum Mechanics** Recapitulation: Different types of Operators, Postulates of Quantum mechanics, Particles in three dimensional box, Schrodinger's wave equation in polar co-ordinates, its separation in to R, θ and Φ, Discussion of solution of Schrodinger equation to same model system of the one dimensional harmonic oscillator,Two particle rigid rotator, Ordinary angular momentum, generalized angular, momentum, Eigen functions of angular momentum, Eigen values of angular momentum.	15 Hrs.
2.	**Thermodynamic and kinetic Aspects of metal complexes** A brief out line of thermodynamic stability of metal complexes, Factors affecting stability of metal complexes, Lability and inertness – labile and inert complexes, Factors affecting lability of metal complexes, Labile and inert complexes on the basis of reaction rate, VBT and CFT, Determination of stability constant by Job's method, Substitution reaction in square planner complexes e.g. Kinetic substitution reaction in Pt(II) complexes, Trans effect, Theories of Trans effect: (i) Electrostatic polarization theory (ii) π-bond theory	15 Hrs.

Reference Books:	
1.	Quantum Chemistry by Ira N. Levine, Prentice-Hall of India Pvt. Ltd., New Delhi, 1994.
2.	Introductory Quantum Chemistry (Third Edition) by N. W. Hanna, Benjamin, Menlo Park, California, 1988.
3.	Quantum Chemistry and Spectroscopy by M. S. Pathania, Vishal Publications, India, 1981.
4.	Kinetics and Mechanism by A. A. Frost and R. G. Pearson, Wiley, New York, 1953, 1961.
5.	Mechanism of Inorganic Reactions by F. Basolo and R. G. Pearson (Second Edition), Wiley Eastern Limited, New Delhi, 1977.
6.	Advanced Inorganic Chemistry by S. K. Agarwal and Keemtilal, Pragati Prakashan, Meerut.
7.	Principles of Inorganic Chemistry by Puri, Sharma, and Kalia, Vishal Publication Co., Jalandhar, Delhi.
8.	Quantum Chemistry by Ira N. Levine, Prentice-Hall of India Pvt. Ltd., New Delhi, 1994.
9.	Introductory Quantum Chemistry (Third Edition) by N. W. Hanna, Benjamin, Menlo Park, California, 1988.

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	External Examination	25

Course Code	**CHP-2001**
Course Tittle	**Inorganic Chemistry Practical**
Course Outcomes:	**CO1 :** Apply the principles of gravimetric and volumetric analysis for the quantitative determination of metal ions and inorganic compounds in different samples. **CO2 :** Perform gravimetric estimations involving precipitation, filtration, drying, ignition, and weighing techniques for accurate quantitative analysis. **CO3 :** Carry out volumetric titrations including redox, precipitation, complexometric, and back-titration methods for the estimation of various analytes. **CO4** : Calculate the concentration, purity, composition, and percentage of constituents in ores, alloys, minerals, and industrial samples using analytical data. **CO5 :** Analyze experimental results, identify sources of error, and interpret quantitative data with appropriate accuracy and precision. **CO6:** Demonstrate safe laboratory practices, proper handling of analytical reagents, and effective use of laboratory instruments during quantitative chemical analysis.

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√	√	√			
C02	√	√	√	√	√	
C03		√	√	√	√	
C04		√	√	√		√
C05		√	√	√	√	√
C06		√		√	√	√

Course Code	CHP-2001
Course Tittle	**Inorganic Chemistry Practical**
Course Content	**Quantitative Analysis** • **Gravimetric Estimation (Any Three)** 1. Analysis of Solder alloy 2. Determine the amount of Ca as CaC_2O_4. H_2O or as $CaCO_3$ in limestone. 3. Estimation of Cu^{2+} as CuSCN. 4. Estimation of Zn^{2+} as $Zn[(NH_4)PO_4]$. • **Volumetric estimation (Any four)** 1. Estimation of Iron in Iron ore. 2. Estimation of available chlorine in bleaching powder. 3. Estimation of Ca^{2+} and Pb^{2+} present in the given a mixture. 4. Determine the amount of Fe^{3+} and Cr^{3+} present in the given a mixture. 5. Determine the percentage purity of the given sample of Manganese salt. 6. Estimation of Aluminium by back Titration. 7. Determination of Cobalt By EDTA. (Complexometric Titration) 8. Determination of Zinc using Xylenol Orange as Indicator.

Reference Books:	
1.	Text book of Practical Inorganic chemistry – A. I. Vogel.
2.	Practical Chemistry by Dr. O. P. Pandey, D. N. Bajpai, Dr. S. Giri.
3.	Advance inorganic analysis by Agrawal, Keemtilal.
4.	Qualitative Inorganic Analysis – Vogel.
5.	Inorganic Practical by Chatwal and Anand

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	External Examination	25

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS						
Program Name	**M. Sc. (Chemistry)**					
Semester	**II**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-2002**					
Course Level	**400-499**					
1.						
Course Tittle	**Organic Chemistry**					
Credit	**Theory:**	**02**	**Practical:**	**02**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Recall and explain the fundamental concepts, terminology, and mechanisms of pericyclic reactions and photochemical reactions. **CO2 :** Classify electrocyclic reactions, cycloaddition reactions, sigmatropic rearrangements, and photochemical processes on the basis of symmetry and reaction conditions. **CO3 :** Interpret stereochemical outcomes of pericyclic reactions using Woodward–Hoffmann rules and conservation of orbital symmetry principles. **CO4 :** Apply the concepts of excited states, Jablonski diagram, fluorescence, phosphorescence, and energy transfer in explaining photochemical phenomena. **CO5 :** Analyze the mechanisms and synthetic applications of photochemical and pericyclic reactions in organic chemistry. **CO6 :** Evaluate the significance of pericyclic and photochemical reactions in modern organic synthesis and industrial applications.					

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√		√			√
C02	√	√	√			
C03	√		√	√		√
C04	√	√	√		√	
C05	√	√	√	√	√	
C06	√	√	√	√	√	√

Course Content		
Unit	Description	Hours
1.	**PERICYCLIC REACTIONS** **Introduction** - Definition, Characteristics and Classification Molecular orbitals and symmetry properties of ethylene, 1,3- butadiene, 1,3,5- hexatriene and allyl systems. **Electrocyclic Reactions:** Woodward-Hoffman Correlation diagram and derivation of selection rules, Conrotatory and disrotatory motions, FMO and PMO approach for 4n and (4n+2)π electron system and allyl systems. **Cycloaddition Reactions**: Antarafacial and suprafacial additions. FMO and PMO approach for 4n and (4n+2)π electron Systems, Diels-Alder reaction, stereoselectivity. **Sigmatropic rearrangements:** Suprafacial and antarafacial shifts involving H & C moieties, retention and inversion of configurations. 1, 3- dipolar cycloadditions. Examples of electrocyclic, cycloaddition and sigmatropic rearrangements.	15 Hrs.

2.	**PHOTO CHEMISTRY** A. Energy of molecules, photochemical energy, energy transfer, electronic excitation, Jablonski diagram, laws of photochemistry, quantumefficiency. B. Photochemistry of carbonyl compounds- α- cleavage of acyclic, Cyclic and α-β unsaturated cleavage of carbonyl compounds, β-cleavage of, inter and intramolecular hydrogen abstraction, additionto carbon- carbon double bond, photo reduction of carbonyl compounds. C. Photo induce rearrangement of enones, dienones and alkenes. Photochemistry of alkenes and aromatic compounds-isomerization,dimerization and addition reactions	15 Hrs.

Reference Books:	
1.	Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2.	Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976).
3.	Organic Chemistry (3/e) by J. B. Hendrickson, Donald J. Crem and George S. Rammond (McGraw-Hill Book Co. & Kogekusha Co. Ltd., 1970).
4.	Organic Chemistry (5/e) by Morrison & Boyd (Prentice Hall).
5.	Advanced Organic Chemistry by Carey &Sundberg (3rd edition).
6.	A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
7.	Organic Chemistry-Reactions and Mechanism by P S Kalsi
8.	Advanced Organic Chemistry : Reactions and Mechanisms by M.S. Singh
9.	Photochemistry and Pericyclic Reactions by Jagdamba Singh
10.	Pericyclic reactions: A text book by S. Sankararaman
11.	Excited states in Organic Chemistry by J. D. Coyle and J. A. Barltrop
12.	Organic Chemistry by Jonathan Clayden

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	External Examination	25

Course Code	**CHP-2002**
Course Tittle	**Organic Chemistry Practical**
Course Outcomes:	**CO1 :** Explain the principles, mechanisms, and synthetic applications of important organic name reactions such as Sandmeyer, Fischer Indole, Riemer–Tiemann, Skraup, Gabriel Phthalimide, and Knorr Quinoline syntheses. **CO2 :** Perform the synthesis of industrially important organic compounds, drugs, and intermediates using standard laboratory techniques and reaction protocols. **CO3 :** Apply purification techniques such as crystallization, filtration, drying, and recrystallization to obtain pure organic products. **CO4 :** Determine the yield, purity, and physical properties of synthesized compounds and interpret the experimental results. **CO5 :** Analyze reaction pathways, mechanisms, and factors affecting the efficiency and selectivity of organic syntheses. **CO6 :** Demonstrate safe handling of chemicals, proper laboratory practices, and effective documentation and communication of experimental findings.

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√		√			
C02	√	√	√		√	
C03		√	√	√	√	
C04		√	√	√		√
C05	√		√	√	√	
C06		√		√		√

Course Code	CHP-2002
Course Tittle	**Organic Chemistry Practical**
Course Content	**1. Preparation of industrially important compounds by following Name reactions (Any four)** a. Sandmeyer reaction (p-chloro toluene from p-toluidine) b. Fischer indole synthesis (1,2,3,4-tetrahydrocarbazole from cyclohexanone and phenylhydrazine) c. Riemer-Tiemann reaction (Salicyladehyde from phenol) d. Skraup synthesis (Quinoline from aniline) e. Gabriel phthalimide synthesis (Anthranilic acid from phthalic anhydride and phthalimide) f. Knorr Quinoline synthesis (Synthesis of 4-Methyl-2-quinolone from acetoacetanilide). **Preparation of some Drugs and intermediates (Any four)** a. Hippuric acid b. 2,3-Diphenyl quinoxaline c. Benzimidazole d. Benzotriazole e Ethyl cinnamate f Salol g. 2-Phenyl indole

Reference Books:	
1.	A text book of practical organic chemistry – A. I. Vogel
2.	Practical organic Chemistry – Mann and Saunders
3.	A handbook of quantitative and qualitative analysis – H. T. Clarke
4.	Comprehensive Practical Organic Chemistry: Qualitative Analysis V K Ahluwalia & S.Dhingra.
5.	Comprehensive Practical Organic Chemistry: Preparations and Quantitative Analysis V K Ahluwalia & R. Aggarwal Universities Press.
6.	An Advance Course in practical Chemistry, A K. Nad, B. Mahapatra and A. Ghoshal.

Teaching-Learning Methodology	Introduction, interaction with students in calculation of mole ratios, Carrying out experiments at each step according to the respective practical.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	External Examination	25

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS						
Program Name	**M. Sc. (Chemistry)**					
Semester	**II**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-2003**					
Course Level	**400-499**					
Course Tittle	**Physical Chemistry**					
Credit	**Theory:**	**02**	**Practical:**	**02**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Define and explain the basic concepts of electrolytic conductance, overvoltage, adsorption, catalysts, and colloidal systems. **CO2 :** Interpret the theories of electrolytic conductance, ionic mobility, and factors affecting overvoltage in electrochemical processes. **CO3 :** Apply the principles of conductometry and electrochemical behaviour for the study of ionic solutions and electrode processes. **CO4** : Differentiate between physical and chemical adsorption, various adsorption isotherms, and types of colloidal systems. **CO5 :** Analyze the role of surface phenomena and overvoltage in catalysis, corrosion, electroplating, and industrial electrochemical applications. **CO6 :** Evaluate the practical significance of surface chemistry and electrolytic conductance in modern chemical, environmental, and industrial systems.					

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√		√			
C02	√	√	√			
C03	√	√	√		√	
C04	√		√	√		
C05	√	√	√	√	√	√
C06	√		√	√	√	√

Course Content		
Unit	Description	Hours
1.	**UNIT-I: THEORIES OF ELECTROLYTIC CONDUCTANCE AND OVER VOLATEGE** Debye-Huckel theory of strong electrolytes, relaxation effect and electrophoreticeffect, Debye Falkenhagen effect, Wein effect. Ionic strength and its determination, Debye-Huckel limiting law. Activity and activity coefficient, determination of activity coefficient by (i) solubility (solubility product principle) (ii) EMF method (cell without transference), Determination of dissociation constant of monobasic acid by conductance method and approximate EMF method, Relationship between dissociation constant and dissociation function, over voltage, determination of over voltage, theories of over voltage: combination of atom as slow process (Tafel theory), Numerical.	15 Hrs.

2.	**UNIT-II: SURFACE CHEMISTRY** Adsorption Multilayer Adsorption, the BET adsorption isotherms, derivation of BET equation, determination of surface area and area of cross section of molecules by BET equation. Derivation of Langmuir equation from BET equation. Explanation of different adsorption isotherms, Change in enthalpy, entropy and free energy of adsorption, Adsorption at the surface of liquid : Gibbs adsorption isotherms (derivation). Thermodynamic treatment of adsorption, Surface Active substances, orientations of surfactants on the surface of solution, surface inactive substances, surface pressure, Insoluble surface films on liquid, Numerical	15 Hrs.

Reference Books:	
Unit-1	
1.	Atkins, P.W., Physical Chemistry, W.H. Freeman (2021) 12th editon
2.	Samuel Glsstone, Introduction to Electro chemistry, East-West Press Pvt. Ltd. (2008)
3.	Puri, B.R., Sharma, L.R., and Pathania, M.S., Principles of Physical Chemistry, VishalPublishing Co.
4.	Engel, T. & Reid, P. Physical Chemistry, Pearson
5.	Barrow, G.M. Physical Chemistry Tata McGraw Hill (2007)
6.	Maron, S. & Prutton Physical Chemistry, Collier Macmillan Ltd
Unit-2	
1.	Puri, B.R., Sharma, L.R., and Pathania, M.S., Principles of Physical Chemistry, VishalPublishing Co.
2.	Engel, T. & Reid, P. Physical Chemistry, Pearson
3.	Barrow, G.M. Physical Chemistry Tata McGraw Hill (2007)
4.	Maron, S. & Prutton Physical Chemistry, Collier Macmillan Ltd

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	External Examination	25

Course Code	CHP-2003
Course Tittle	Physical Chemistry Practical
Course Outcomes:	**CO1 :** Explain the principles of pH-metry, conductometry, potentiometry, colorimetry, spectrophotometry, and phase equilibrium used in physical and analytical chemistry experiments. **CO2 :** Perform quantitative measurements using instrumental techniques to determine dissociation constants, equilibrium constants, solubility, hydrolysis constants, critical solution temperatures, and reaction kinetics. **CO3 :** Analyze chemical equilibria, complex formation, reaction rates, activation energy, and physicochemical properties using experimental data and scientific reasoning. **CO4** : Apply spectrophotometric and colorimetric methods for the quantitative estimation of chemical species in mixtures and environmental samples. **CO5 :** Evaluate experimental results, perform calculations, interpret graphical data, and assess the accuracy and reliability of measurements. **CO6 :**Demonstrate proficiency in handling analytical instruments, maintaining laboratory safety, and preparing scientific reports based on experimental observations.

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√	√				
C02	√	√	√		√	
C03	√		√	√	√	
C04		√	√	√		
C05		√	√	√	√	√
C06		√		√	√	√

Course Code	CHP-2003
Course Tittle	**Physical Chemistry Practical**
Course Content	Perform minimum any **seven** experiments. 1. Determine the dissociation constant and strength of borax solution pH-metrically. 2. Determine the velocity constant of the hydrolysis of ethyl acetate with sodium hydroxide at room temperature by conductance measurements. 3. Determine the solubility of silver chloride in water potentiometrically. 4. To determine the concentration of given components in a mixture colorimetrically. 5. Determine the equilibrium constant of the reaction $I^- + I_2 = I_3^-$ by distribution method. 6. Investigation the reaction between H_2O_2 and HI at two different temperatures and calculatethe energy of activation for the reaction 7. Determine the formula of a complex between $Cu^{+2}$and NH_3 by distribution method. 8. Determine CST of Phenol -Water system 9. Determine CST of Phenol –NaCl system 10. Trtrate Fe(II) against potassium permanganate spetrophotometrically 11. Determine the degree of hydrolysis and hydrolysis constant of (i) CH_3COONa (ii) NH_4Cl 12. Determination of COD of water sample. 13. Determination of phosphate by colourimetry using ammonium molybdate.

Reference Books:	
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

Teaching-Learning Methodology	Practical based teaching–learning methodology involving hands-on training in physico-chemical experiments using pH metry, conductometry, potentiometry, colorimetry, spectrophotometry, distribution methods, kinetic studies, equilibrium analysis, and quantitative interpretation of experimental data.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	External Examination	25

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS						
Program Name	**M. Sc. (Chemistry)**					
Semester	**II**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-2004 (Organic)**					
Course Level	**500-599**					
Course Tittle	**Integrated Organic Chemistry**					
Credit	**Theory:**	**04**	**Practical:**	**0**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Recall and explain the fundamental concepts, principles, and terminology related to organic name reactions, aromaticity, IR spectroscopy, titrimetric methods, and elemental analysis. **CO2 :** Classify aromatic and antiaromatic compounds, types of titrations, and characteristic IR absorption frequencies of organic functional groups. **CO3 :** Apply mechanisms of important organic name reactions and interpret IR spectra for identification of organic compounds. **CO4** : Perform quantitative calculations and analytical procedures involved in titrimetric methods and elemental analysis. **CO5 :** Analyze reaction pathways, spectral data, and analytical results for the characterization and estimation of chemical substances. **CO6 :** Evaluate the importance and applications of organic reactions, spectroscopic techniques, and analytical methods in chemical research and industrial analysis.					

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√		√			
C02	√	√	√			
C03	√	√	√		√	
C04		√	√	√	√	
C05	√	√	√	√	√	√
C06	√		√	√	√	√

Course Content		
Unit	Description	Hours
1.	**Organic Name Reactions** General nature, method, mechanism and synthetic applications ofthe following reactions: 1) Heck reaction 2) Dakin reaction 3) Darzen'sglycidic ester synthesis 4) Leuckart reaction 5) Suzuki reaction 6) Willgerodt reaction 7) Ene reaction 8) H. V. Z reaction 9) Mitsunobu reaction 10) Sonagashira reaction	15 Hrs.
2.	**AROMATICITY** Aromaticity and Aromatic character; structure and stability of benzene, Frost circle diagram, concept of aromaticity; Resonance and chemical stabilization; Robinson methods, criteria to check aromatic character-IR, NMR, heat of hydrogenation; Huckel's rule; HMO method, Antiaromaticity, homoaromaticity, nonaromaticity; aromaticity in benzanoid compounds: naphthalene, pyrene, acenaphthylene. Aromaticity non-benzenoid compounds: azulene, tropolones,charged rings, annulenes.	15 Hrs.

3.	**IR SPECTROSCOPY** Introduction: Theory, Useful terms: IR region, types of vibrations: fundamental and overtones, linear and non-linear molecule, equation for vibrational frequency, selection rule, coupling interactions, Instrumentation: single beam, double beam spectrophotometers, FTIR: principle, instrument design, and function of beam splitter, radiation sources, sample cells, monochromators, detectors, sample handling, Resolution, wave number measurement, Advantages of FTIR vs. IR. hydrogen bonding information, Fermi resonance. IR spectra: group frequency, group frequency region, fingerprint region, spectra interpretations and structure elucidation.	15 Hrs.
4.	**TITRIMETRIC METHODS AND ELEMENTALANALYSIS** **Solution and Their Concentration**: Molarity, Molality, Normality, ppm, ppb, ppt, %w/v, %w/w, %v/v, Formality, Primary and Secondary standard, Acid Value, Density and Specific Gravity, Numerical. **Non-Aqueous Titration:** Protic and Aprotic Solvent, Solvent system, Dielectric constant, Titrant, Titration Curve, Determination of Equivalence point, Karl Fisher Titration. **Elemental Analysis:** Step on Analysis, C and H Analysis, N Analysis, Halogen Analysis and Sulphur Analysis, Elementary Idea of Modern Elemental analyzer.	15 Hrs.

Reference Books:	
1.	Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2.	Name Reactions by A. R. Parikh &H.A. Parikh
3.	Name reaction: A collection of detailed reaction mechanism by Jie Jack Li
4.	Reaction Mechanism and Reagents in Organic Chemistry by C. R. Chatwal
5.	(Himalaya Publishing House, Bombay, 1987).
6.	Organic Chemistry-Reactions and Mechanism by P S Kalsi
7.	Advanced Organic Chemistry: Reactions and Mechanisms by M.S. Singh
8.	Organic Chemistry by Cram, Hammond, Pine and Hendrickson
9.	March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure by Michael B. Smith.
10.	Advanced Organic Chemistry: Part B: Reaction and Synthesis by Carey & Francis
11.	Organic Chemistry by Jonathan Clayden
12.	Fundamental of molecular spectroscopy, C.N. Banwell, Tata McGraw Hill Pub. Camp.
13.	Spectrometric Identification of Organic Compounds (4^{th} edition/5^{th} edition), Silverstein, Bassler & Morril, John Wiley & Sons.
14.	Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw – Hill.
15.	Modern Spectroscopy, J.M. Hollas, John Wiley.
16.	Basic Principles of Spectroscopy, R. Chang, McGraw-Hill.
17.	Modern Methods of Chemical Analysis (2^{nd} ed.), Pecsok, Shields, Cairns & Mc Williom, John Wiley & Sons.
18.	Instrumental Analysis by R. D. Braun, McGraw-Hill.
19.	Introduction to Instrumental Analysis by R. D. Brawn, McGraw-Hill Book.
20.	Fundamentals of Analytical Chemistry: Skoog D.R. and West D.M. (Holt, Rinehart & Winston, New York).
21.	Chemical Analysis in Industry (in Gujarati) by M. N. Desai.
22.	Instrumental Methods of Analysis by G. W. Ewing.
23.	Quantitative Analysis, 6^{th} Ed., R.A. Day and A.L. Underwood, Prentice– Hall of India, 1993.
24.	Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn& Bacon Inc., New York, 2^{nd} edition.
25.	Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5^{th} edition.
26.	Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	50
2.	External Examination	50

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS

Program Name	**M. Sc. (Chemistry)**					
Semester	**II**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-2004 (Inorganic)**					
Course Level	**500-599**					
Course Tittle	**Integrated Inorganic Chemistry**					
Credit	**Theory:**	**04**	**Practical:**	**0**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Recall the fundamental concepts, structures, classification, and preparation methods of inorganic polymers, metal π-complexes, IR spectroscopy, titrimetric methods, and elemental analysis. **CO2 :** Explain the bonding, properties, reactivity, and applications of inorganic polymers and metal π-complexes, along with the principles and instrumentation of IR spectroscopy, titrimetric techniques, and elemental analysis. **CO3 :** Apply spectroscopic, titrimetric, and elemental analytical methods for qualitative and quantitative analysis of chemical compounds and interpret experimental observations. **CO4** : Analyze IR spectra, reaction mechanisms, coordination behavior, and analytical data to identify functional groups, molecular structures, and composition of compounds. **CO5 :** Evaluate the accuracy, precision, and suitability of different titrimetric and elemental analytical techniques for chemical investigations and research applications.					

	CO6 : Design and perform experiments involving synthesis, characterization and analytical determination using modern instrumental and titrimetric techniques.

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√		√			
C02	√	√	√			
C03	√	√	√		√	
C04	√	√	√	√	√	
C05		√	√	√	√	√
C06	√	√	√	√	√	√

Course Content		
Unit	Description	Hours
1.	**INORGANIC POLYMERS** Definition of polymers and their depiction, Classification of inorganic polymers. Characteristics of inorganic polymer, Characterization of inorganic polymers (physical properties) by molecular weight, number average and weight average, Structural features of polymers: (1) Backbone bonding (2) Branching and cross-linking (3) Chemical and Stereo chemical variability, Glass transition temperature. Phosphorus based polymers, Phosphorus based chain polymers. Sulphur-based polymers, Boron-based polymers, Silicon-based polymers, Properties of silicones, Coordination polymers.	15 Hrs.

2.	**METAL π – COMPLEXES** Metal carbonyls: Introduction, classification of metal carbonyls, structure and bonding, vibrational spectra studies for bonding and structure elucidation. Preparation of metal carbonyls by (1) Direct synthesis and (2) From metal compounds, Preparation, Properties and structure of $Ni(CO)_4$, $Fe_2(CO)_9$, $Fe_3(CO)_{12}$ and CO2(CO)8, 18-electron rule and EAN of metal carbonyls, Metal Nitrosyls: Introduction, coordination compounds of metal nitrosyls, preparation & properties of nitrosyl compounds like nitrosyl halides, nitrosyl cyanides, hydroxides and nitrosyl aquo compounds Complex of NO+, iron, EAN and structures of nitrosyls.	15 Hrs.
3.	**IR SPECTROSCOPY** Introduction: Theory, Useful terms: IR region, types of vibrations: fundamental and overtones, linear and non-linear molecule, equation for vibrational frequency, selection rule, coupling interactions, Instrumentation: single beam, double beam spectrophotometers, FTIR: principle, instrument design, and function of beam splitter, radiation sources, sample cells, monochromators, detectors, sample handling, Resolution, wave number measurement, Advantages of FTIR vs. IR. hydrogen bonding information, Fermi resonance. IR spectra: group frequency, group frequency region, fingerprint region, spectra interpretations and structure elucidation	15 Hrs.
4.	**TITRIMETRIC METHODS AND ELEMENTALANALYSIS** **Solution and Their Concentration**: Molarity, Molality, Normality, ppm, ppb, ppt, %w/v, %w/w, %v/v, Formality, Primary and Secondary standard, Acid Value, Density and Specific Gravity, Numerical. **Non-Aqueous Titration:** Protic and Aprotic Solvent, Solvent system, Dielectric constant, Titrant, Titration Curve, Determination of Equivalence point, Karl Fisher Titration. **Elemental Analysis:** Step on Analysis, C and H Analysis, N Analysis, Halogen Analysis and Sulphur Analysis, Elementary Idea of Modern Elemental analyzer	15 Hrs.

Reference Books:	
1.	Introduction to Metal π-Complex Chemistry by M. Tsutsui, M. Ichikawa, and K. Mori,
2.	Plenum Press, New York.
3.	Introductory Polymer Chemistry by G. S. Mishra, Wiley Eastern Ltd., 1993.
4.	Phosphorous-Nitrogen Compounds by H. R. Allock, Academic Press, New York, 1972.
5.	Advanced Inorganic Chemistry by S. K. Agarwal and Keemtilal, Pragati Prakashan, Meerut.
6.	Coordination Chemistry by Ajaykumar, Aaryush Education Publication, Third Publication.
7.	Principles of Inorganic Chemistry by Puri, Sharma, and Kalia, Vishal Publication Co., Jalandhar, Delhi.
8.	Coordination Chemistry by Gurdeep Chatwal and M. S. Yadav, Himalaya Publishing House.
9.	Inorganic Polymers by Prof. G. R. Chatwal, Himalaya Publishing House.
10.	A Text Book of Inorganic Polymers by Dr. Ajay Bhagi, Himalaya Publishing House.
11.	Fundamental of molecular spectroscopy, C.N. Banwell, Tata McGraw Hill Pub. Camp.
12.	Spectrometric Identification of Organic Compounds (4^{th} edition/5^{th} edition), Silverstein, Bassler & Morril, John Wiley & Sons.
13.	Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw – Hill.
14.	Modern Spectroscopy, J.M.Hollas, John Wiley.
15.	Basic Principles of Spectroscopy, R.Chang, McGraw-Hill.
16.	Modern Methods of Chemical Analysis (2^{nd} ed.), Pecsok, Shields, Cairns & Mc Williom, John Wiley & Sons.
17.	Instrumental Analysis by R. D. Braun, McGraw-Hill.
18.	Introduction to Instrumental Analysis by R. D. Brawn, McGraw-Hill Book.
19.	Fundamentals of Analytical Chemistry: Skoog D.R. and West D.M. (Holt, Rinehart & Winston, New York).
20.	Chemical Analysis in Industry (in Gujarati) by M. N. Desai.
21.	Instrumental Methods of Analysis by G. W. Ewing.
22.	Quantitative Analysis, 6^{th} Ed., R.A. Day and A.L. Underwood, Prentice– Hall of India, 1993.
23.	Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn& Bacon Inc., New York, 2^{nd} edition.
24.	Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5^{th} edition.

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	50
2.	External Examination	50

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS						
Program Name	**M. Sc. (Chemistry)**					
Semester	**II**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-2004 (Physical)**					
Course Level	**500-599**					
Course Tittle	**Integrated Physical Chemistry**					
Credit	**Theory:**	**04**	**Practical:**	**0**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Describe the fundamental concepts, properties and applications of colloids, molecular spectroscopy, IR spectroscopy, titrimetric methods and elemental analysis. **CO2 :** Explain the principles, theories and mechanisms involved in colloidal systems, molecular spectra and analytical techniques. **CO3 :** Apply spectroscopic and titrimetric methods for qualitative and quantitative chemical analysis and interpretation of experimental data. **CO4** : Analyze spectral patterns, colloidal behavior and analytical results obtained from IR spectroscopy and elemental analysis techniques. **CO5 :** Evaluate the efficiency, accuracy and limitations of various spectroscopic and titrimetric analytical methods in chemical investigations.. **CO6 :** Design and perform experiments involving colloidal systems, spectroscopic characterization and elemental estimation using modern analytical techniques.					

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√		√			
C02	√	√	√			
C03	√	√	√		√	
C04	√	√	√	√	√	
C05		√	√	√	√	√
C06	√	√	√	√	√	√

Course Content		
Unit	Description	Hours
1.	**COLLOIDS** Types of colloidal systems, preparation of lyophobic colloidal, Properties of Colloidal systems: (i) electrical properties origin of charges on colloidal, electrical double layer, Zeta potential and its determination by electrophoresis, factor affecting zeta potential, Explanation and derivation DLVO theory of colloid stability (ii) Electrokinetic properties: Electrophoresis, elecroosmosis. Surface active agents, critical micellar concentration (CMC), factors affecting the CMC of surfactants, thermodynamics ofmicellization: mass action and phase separation model, solubilisation, emulsion, types of emulsion, methods for determination of types of emulsion, microemulsion, types of microemulsion, theories of microemulsion.	15 Hrs.

2.	**MOLECULAR SPECTROSCOPY** Molecular spectra, Microwave spectroscopy (Rotationalspectroscopy): The Rotation of molecules, Linear molecule, Symmetric tops ,Spherical tops, Asymmetric tops, Rotational spectra of rigid diatomic molecule ,Intensities of spectral lines , Effect of isotopic substitution, Techniques and instrumentation of rotational spectrum, IR Spectroscopy: Classical frequency of harmonic oscillator,The classical potential energy of harmonic vibration of a diatomic molecule, Quantum expression of potentialenergy, energy level diagram, Relative population of energy levels ,Mechanism of interaction with radiation, selection rule, determination of force constant, Amplitude of vibration, The anharmonic vibration or oscillator, Morse potential , Vibrational energy of diatomic molecule following the Morse potential, energy level diagram, vibrational transitions. Vibrational – Rotational spectra of diatomic molecule(CO molecule) Application of Vibrational rotational spectra Numerical	15 Hrs.
3.	**IR SPECTROSCOPY** Introduction: Theory, Useful terms: IR region, types of vibrations: fundamental and overtones, linear and non-linear molecule, equation for vibrational frequency, selection rule, coupling interactions, Instrumentation: single beam, double beam spectrophotometers, FTIR: principle, instrument design, and function of beam splitter, radiation sources, sample cells, monochromators, detectors, sample handling, Resolution, wave number measurement, Advantages of FTIR vs. IR. hydrogen bonding information, Fermi resonance. IR spectra: group frequency, group frequency region, fingerprint region, spectra interpretations and structure elucidation	15 Hrs.
4.	**TITRIMETRIC METHODS AND ELEMENTALANALYSIS** **Solution and Their Concentration**: Molarity, Molality, Normality, ppm, ppb, ppt, %w/v, %w/w, %v/v, Formality, Primary and Secondary standard, Acid Value, Density and Specific Gravity, Numerical. **Non-Aqueous Titration:** Protic and Aprotic Solvent, Solvent system, Dielectric constant, Titrant, Titration Curve, Determination of Equivalence point, Karl Fisher Titration. **Elemental Analysis:** Step on Analysis, C and H Analysis, N Analysis, Halogen Analysis and Sulphur Analysis, Elementary Idea of Modern Elemental analyzer.	15 Hrs.

Reference Books:	
1.	Puri, B.R., Sharma, L.R., and Pathania, M.S., Principles of Physical Chemistry, VishalPublishing Co.
2.	Engel, T. & Reid, P. Physical Chemistry, Pearson
3.	Maron, S. & Prutton Physical Chemistry, Collier Macmillan Ltd
4.	Colloid Science: Principles, Methods and Applications by T Cosgrove
5.	Physical Chemistry of Surfaces" by A W Adamson and A P Gast
6.	Fundamentals of Molecular Spectroscopy C N Banwell TATA McGRAW-HILL15th edition
7.	Handbook of Molecular Spectroscopy, by D.N. Sathyanarayana
8.	Introduction to Spectroscopy by Donald L. Pavia, George S. Kriz, Gary M. Lampman, James R. Vyvyan
9.	Fundamentals of molecular spectroscopy by Walter S. Struve
10.	Barrow, G.M. Physical Chemistry Tata McGraw Hill (2007)
11.	Fundamental of molecular spectroscopy, C.N. Banwell, Tata McGraw Hill Pub. Camp.
12.	Spectrometric Identification of Organic Compounds (4^{th} edition/5^{th} edition), Silverstein, Bassler & Morril, John Wiley & Sons.
13.	Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw – Hill.
14.	Modern Spectroscopy, J.M.Hollas, John Wiley.
15.	Basic Principles of Spectroscopy, R.Chang, McGraw-Hill.
16.	Modern Methods of Chemical Analysis (2^{nd} ed.), Pecsok, Shields, Cairns & Mc Williom, John Wiley & Sons.
17.	Instrumental Analysis by R. D. Braun, McGraw-Hill.
18.	Introduction to Instrumental Analysis by R. D. Brawn, McGraw-Hill Book.
19.	Fundamentals of Analytical Chemistry: Skoog D.R. and West D.M. (Holt, Rinehart & Winston, New York).
20.	Chemical Analysis in Industry (in Gujarati) by M. N. Desai.
21.	Instrumental Methods of Analysis by G. W. Ewing.
22.	Quantitative Analysis, 6^{th} Ed., R.A. Day and A.L. Underwood, Prentice– Hall of India, 1993.
23.	Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn& Bacon Inc., New York, 2^{nd} edition.
24.	Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5^{th} edition.
25.	Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	50
2.	External Examination	50

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS

Program Name	**M. Sc. (Chemistry)**					
Semester	**II**					
NCrF Credit Level	**6.0**					
Course Type	**Major**					
Course Subtype	**Nil**					
Subject Type	**Discipline Specific**					
Course Code	**CH-2004 (Analytical)**					
Course Level	**500-599**					
Course Tittle	**Integrated Analytical Chemistry**					
Credit	**Theory:**	**04**	**Practical:**	**0**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1 :** Describe the principles, instrumentation and applications of thermogravimetry, thermometric titration, radio-analytical techniques, IR spectroscopy, titrimetric methods and elemental analysis. **CO2 :** Explain thermal behavior, radioactive analytical principles, spectroscopic concepts and titrimetric procedures used in chemical analysis. **CO3 :** Apply thermogravimetric, spectroscopic and titrimetric techniques for qualitative and quantitative determination of chemical substances. **CO4** : Analyze thermal curves, spectral data and analytical results obtained through radio-analytical, IR spectroscopic and elemental analysis methods. **CO5 :**Evaluate the sensitivity, accuracy and limitations of different thermal, spectroscopic and titrimetric analytical techniques. **CO6 :** Design and perform experiments involving thermal analysis, radio-analytical measurements and quantitative estimations using modern analytical methods.					

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√		√			
C02	√	√	√			
C03	√	√	√		√	
C04	√	√	√	√	√	
C05		√	√	√	√	√
C06	√	√	√	√	√	√

Course Content		
Unit	Description	Hours
1.	**THERMAL METHODS OF ANALYSIS** **(A) THERMOGRAVIMETRY** Thermogravimetry, Instruments for TGA- thermobalace and furnace, Calibration of temperature scale, Factors affecting TGA results instrumental and experimental, Applications. **(B) THERMOMETRIC TITRATION:** Thermometric Titration (TT), Advantages, Instrument, Applications of TT in Neutralization Titration, Precipitation Titration, Complexometry Titration and Redox Titration.	15 Hrs
2.	**RADIO-ANALYTICAL TECHNIQUES** **(A)** Interaction of radiation with matter, unit of radioactivity. **(B)** Detection of Radiation **(a)** Gas ionization detector (Ion-Chamber, Proportional chamber, GM Counter) **(b)** Scintillator Detector (Principle, Organic, Inorganic Scintillator) **(c)** Radiochemical principle & Application of tracers **(C)** Radiochemical principle & Application of tracers **(a)** Reaction mechanism (Example of esterification, Base hydrolysis, Friedel-Craft reaction) **(b)** Structural determination **(c)** Radioactive titration **(d)** Isotopic dilution methods **(e)** Neutron activation analysis	15 Hrs

3.	**IR SPECTROSCOPY** Introduction: Theory, Useful terms: IR region, types of vibrations: fundamental and overtones, linear and non-linear molecule, equation for vibrational frequency, selection rule, coupling interactions, Instrumentation: single beam, double beam spectrophotometers, FTIR: principle, instrument design, and function of beam splitter, radiation sources, sample cells, monochromators, detectors, sample handling, Resolution, wave number measurement, Advantages of FTIR vs. IR. hydrogen bonding information, Fermi resonance. IR spectra: group frequency, group frequency region, fingerprint region, spectra interpretations and structure elucidation.	15 Hrs.
4.	**TITRIMETRIC METHODS AND ELEMENTALANALYSIS** **Solution and Their Concentration**: Molarity, Molality, Normality, ppm, ppb, ppt, %w/v, %w/w, %v/v, Formality, Primary and Secondary standard, Acid Value, Density and Specific Gravity, Numerical. **Non-Aqueous Titration:** Protic and Aprotic Solvent, Solvent system, Dielectric constant, Titrant, Titration Curve, Determination of Equivalence point, Karl Fisher Titration. **Elemental Analysis:** Step on Analysis, C and H Analysis, N Analysis, Halogen Analysis and Sulphur Analysis, Elementary Idea of Modern Elemental analyzer.	15 Hrs.

Reference Books:	
1.	Fundamental of molecular spectroscopy, C.N. Banwell, Tata McGraw Hill Pub. Camp.
2.	Spectrometric Identification of Organic Compounds (4^{th} edition/5^{th} edition), Silverstein, Bassler & Morril, John Wiley & Sons.
3.	Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw – Hill.
4.	Modern Spectroscopy, J.M.Hollas, John Wiley.
5.	Basic Principles of Spectroscopy, R.Chang, McGraw-Hill.
6.	Modern Methods of Chemical Analysis (2^{nd} ed.), Pecsok, Shields, Cairns & Mc Williom, John Wiley & Sons.
7.	Instrumental Analysis by R. D. Braun, McGraw-Hill.
8.	Introduction to Instrumental Analysis by R. D. Brawn, McGraw-Hill Book.
9.	Fundamentals of Analytical Chemistry: Skoog D.R. and West D.M. (Holt, Rinehart & Winston, New York).
10.	emical Analysis in Industry (in Gujarati) by M. N. Desai.
11.	Instrumental Methods of Analysis by G. W. Ewing.
12.	Quantitative Analysis, 6^{th} Ed., R.A. Day and A.L. Underwood, Prentice– Hall of India, 1993.
13.	Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn& Bacon Inc., New York, 2^{nd} edition.
14.	Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5^{th} edition.
15.	Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle
16.	Essential of Nuclear Chemistry by H. J. Amikar, New Age International Publishers.
17.	Nuclear and Radiochemistry: Fundamentals and Applications (2^{nd} edition), József Kónya and Noémi M. Nagy, Elsevier.
18.	Nuclear Chemistry by C. V. Shetti, Sultan Chand & Sons.
19.	Introduction to Radiochemistry By A.V.R. Reddy & D.D. Sood: Published By The Indian Association Of Nuclear Chemists And Allied Scientists (Iancas).
20.	Nuclear Chemistry by Maheshwar Sharon and Madhuri Sharon, Springer Nature.

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	50
2.	External Examination	50

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

SYLLABUS

Program Name	**M. Sc. (Chemistry)**					
Semester	**II**					
NCrF Credit Level	**6.0**					
Course Type	**Vocational**					
Course Subtype	**Nil**					
Subject Type	**Vocational Paper**					
Course Code	**CH-VOC-2005**					
Course Level	**500-599**					
Course Tittle	**Analytical Techniques (Vocational paper) (Theory)**					
Credit	**Theory:**	**04**	**Practical:**	**0**	**Total:**	**04**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1**: Describe the principles, terminology, apparatus, reagents, and procedures involved in volumetric analysis, gravimetric analysis, solution preparation, sampling, and quantitative estimation techniques. **CO2**: Explain the theoretical concepts of titrimetric and gravimetric methods, standardization procedures, experimental data presentation, and the operating principles of analytical instruments such as pH meter, weighing balance, RI detector in HPLC, IR moisture balance, KF thermos preparation system, auto titration system, and UPLC. **CO3**: Prepare standard solutions, perform titrations, conduct gravimetric estimations of metal ions, and operate analytical instruments by following standard operating procedures **CO4**: Analyze experimental observations, calculate quantitative results, interpret analytical data obtained from titrimetric, gravimetric, soil, and water analysis experiments, and evaluate accuracy and precision of results.					

Course Outcomes:	**CO5 :** Evaluate analytical methods, instrumental performance, sources of experimental error, and suitability of techniques for quantitative chemical analysis and environmental sample testing.
	CO6: Demonstrate laboratory skills through systematic presentation of experimental data, preparation of analytical reports, safe handling of chemicals and instruments, and effective interpretation of analytical findings.

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√	√				
C02	√	√		√	√	
C03		√	√	√	√	
C04	√	√	√	√	√	
C05	√	√	√	√	√	
C06		√	√		√	√

Course Content		
Unit	Description	Hours
1.	a) **Volumetric Analysis:** Primary standard, acid-base titrations, precipitation titrations (Volhard's and Mohr's), Redox titrations (iodometric and iodimetric), complexometric titrations, characteristics of metallochromic indicators. b) **Gravimetric Analysis:** Supersaturation and nucleation, rate of precipitation, purity of precipitates, co-precipitation, post-precipitation, homogeneous precipitation, organic precipitants, masking agents, acid equilibria.	15 Hrs.

2.	**(a)** Hands-on training on solution preparation, sampling, and presentation of experimental data, titrations, and quantitative estimation of metal ions through gravimetric analysis. **(b)** Various instruments SOP: pH meter, Weighing balance, RI detector in HPLC, IR moisture balance, KF thermos prep., Auto titration system, and UPLC.	15 Hrs.
3.	**Analysis of soil**: Composition of soil, concept of soil pH and its measurements, acidic, basic, and saline soils, Complexometric titrations, Chelation, Chelating agents, use of indicators (i) Determination of pH of soil samples. (ii) Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration. (iii) Essential element detection in soil. (iv) Electrical conductivity of soil. Macro and micronutrients in soil, Role of N, P, K, Ca, Mg, Fe, Zn, Cu, Mn, Deficiency symptoms in plants	15 Hrs.
4.	**Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, and water purification methods. Important water quality parameters: a. Determination of turbidity, colour, taste, pH, acidity, and alkalinity of a water sample. b. Determination of TDS, toxic metals, total hardness, dissolved oxygen (DO), BOD, and COD of a water sample. Standards for drinking water as per BIS specifications.	15 Hrs.

Reference Books:	
1.	Fundamental of molecular spectroscopy, C. N. Banwell, Tata Mc-Graw Hill Pub. Camp.
2.	Spectrometric Identification of Organic Compounds (4^{th} edition/5^{th} edition), Silverstein,Bassler & Morril, John Wiley & Sons.
3.	Introduction to Molecular Spectroscopy, G. M. Barrow, McGraw – Hill.
4.	Modern Methods of Chemical Analysis (2^{nd} ed.), Pecsok, Shields, Cairns & McWilliam, John Wiley & Sons.
5.	Instrumental Analysis by R. D. Braun, McGraw-Hill.
6.	Introduction to Instrumental Analysis by R. D. Brawn, McGraw-Hill Book.
7.	Fundamentals of Analytical Chemistry: Skoog D. R. and West D. M. (Holt, Rinehart & Winston, New York).
8.	Instrumental Methods of Analysis by G. W. Ewing.
9.	Quantitative Analysis, 6^{th} Ed., R. A. Day and A. L. Underwood, Prentice – Hall of India,1993.
10.	Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn & Bacon Inc., New York,2^{nd} edition.
11.	Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5^{th} edition.
12.	Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (VanNostrand Reinhold Co., New York), 6^{th} edition.
13.	Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall Internationaledition).
14.	Gupta, Alka L.; Analytical Chemistry, Pragati Prakashan.
15.	Vogel, A. I. Vogels Qualitative Inorganic Analysis 7th Ed., Prentice Hall.

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	50
2.	External Examination	50

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT SYLLABUS						
Program Name	**M. Sc. (Chemistry)**					
Semester	**II**					
NCrF Credit Level	**6.0**					
Course Type	**Skill Enhancement Course**					
Course Subtype	**Nil**					
Subject Type	**Skill Enhancement Course**					
Course Code	**CH-SEC-2006**					
Course Level	**500-599**					
Course Tittle	**Perfumes and Cosmetics (Theory)**					
Credit	**Theory:**	**02**	**Practical:**	**0**	**Total:**	**02**
Effective From	**Academic Year: 2026-2027**					
Course Outcomes:	**CO1** : Define the basic concepts, terminology, classifications, raw materials, and composition of natural perfumes, synthetic perfumes, Flavors, soaps, detergents, cosmetics, and personal hygiene products. **CO2** : Explain the principles of fragrance extraction, synthesis of aroma compounds, formulation of soaps and detergents, and the functions of cosmetic and hygiene ingredients. **CO3** : Apply formulation techniques, blending methods, quality control procedures, and safety measures in the preparation of perfumes, Flavors, soaps, detergents, and cosmetic products. **CO4** : Analyze the chemical composition, stability, cleansing action, fragrance characteristics, emulsification behavior, and performance of various cosmetic and hygiene products. **CO5 :** Evaluate the effectiveness, safety, environmental impact, quality standards, and consumer suitability of perfumes, detergents, cosmetics, and personal care formulations. **CO6 :** Design and develop innovative formulations of perfumes, Flavors, soaps, detergents, cosmetics, or personal hygiene products using scientific principles and sustainable approaches.						

Mapping between COs and PSOs

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
C01	√				√	
C02	√	√			√	
C03		√	√	√	√	√
C04	√	√	√	√	√	
C05		√	√	√	√	√
C06	√	√	√	√	√	√

Course Content		
Unit	Description	Hours
1.	**UNIT I: NATURAL PERFUMES, SYNTHETIC PERFUMES AND FLAVORS** Perfumes, plant and animal sources, examples, components of perfume, vehicle, characteristics of good vehicle, fixatives and its types, odoriferous compounds, extraction of essential oils by distillation, enfleurage and solvent extraction methods. Rose and Jasmine: composition and preparation of rose and jasmine perfumes, manufacture of fruit Flavors, fruit syrup preparation and composition of apple and pineapple Flavors. Preparation and uses of methyl anthranilate, methyl salicylate, methyl cinnamate, phenyl ethanol, citronellol, vanillin, coumarin and heliotrope.	15 Hrs.
2.	**UNIT II: SOAPS, DETERGENTS, COSMETICS AND PERSONAL HYGIENE PRODUCTS** Cleansing action of soap, ingredients of washing and bathing soap, TFM of bathing soap, types of shampoo and compositions, characteristics of good cosmetics Evaluation of powder and basic composition of talcum powder, face cream, nail polish, hair dye, tooth paste, mouthwash (formulation only)	15 Hrs.

Reference Books:	
1.	Shreve's Chemical Process Industries by George T. Austin, Mc. Graw Hill India; 5th edition.
2.	Perfumery technology: art, Science, industry by Marcel Billot and F.V. Wells, Ellis Horwood Ltd., 2nd edition.
3.	A textbook of cosmetic formulation by Gaurav Kumar Sharma, Jayesh Gandhiya, Meenakshi Dhanawat.
4.	A handbook of cosmetics by B.M. Mithal and R. N. Saha, Delhi Vallabh Prakashan, 5th edition.

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Marks
1.	Internal Examination	25
2.	External Examination	25