VEER NARMAD SOUTH GUJARAT UNIVERSITY

Name of Program	**Master of Science (Chemistry)**
Abbreviation	**M.Sc.**
Duration	**2 Years**
Eligibility Criteria	**M.Sc. Chemistry** **(Organic/Inorganic/Analytical/Physical)** 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 Chemistry)** 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. **M.Sc. (Environmental Chemistry)** 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.- Chemistry/Organic Chemistry (S.F.)/ Environmental Chemistry (S.F.) Course. **M.Sc. Organic Chemistry (Evening)** ELIGIBILITY :(SC/ST- 35%, OPEN/SEBC-40%) A candidate selecting M.Sc. Evening course (2 years) with Organic Chemistry as specialization must have passed the Bachelor's Degree examination with Chemistry and English as compulsory subject. Those who are in service will have to produce minimum one year's experience certificate from the Employer.
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	PO1: To enhance the knowledge in chemistry domains and become master in respective branch of chemistry. To be able to communicate clearly and effectively within and across disciplinary lines. PO2: Built up entrepreneurship ability by taking advantage of industrial hub in periphery of our university. PO3: Establishment of research center with the aid of interdisciplinary subject being run in university. PO4: Persuasion of doctoral degree in the concern subject and further study. PO5: Development of related short-term courses related to demanded subject in anticipation of strengthening knowledge and application. PO6: Training/internship of students for employment in public sector, private sector and national laboratories. PO7: Participation in scientific discussions showing respect and lead interdisciplinary work with experts from other fields. PO8: To understand and adopt the best safety practices in chemical research. PO9: Participation in scientific discussions showing respect and lead interdisciplinary work with experts from other fields. PO10: To understand and adopt the best safety practices in research.

<table>
<tr><td>Program Specific Outcomes</td><td colspan="13">Students need to build up foundation in the fundamentals & application of current chemical and scientific theories in the concerned branches of Inorganic, Organic, Analytical, Physical, Environmental and Pharmaceutical Chemistry.

PSO1: Develop scientific temper, communicate scientific information in a clear, concise and precise manner.
PSO2: Find job opportunities at all level of chemical industries (dyes & pharmaceutical), national laboratories & research centers.
PSO3: Apply the knowledge in sustainable and ecofriendly technologies.
PSO4: Inculcate logical thinking to address the problem and become result oriented.
PSO5: Development of research culture in persuasion of Ph.D. program at national & international institute/university.
PSO6: Participate in specific competitive examination conducted by various public service commission and other public sector.
PSO7: Develop and apply the fundamental knowledge to build small scale industry in context to Atma Nirbhar Bharat.
PSO8: Scale up the synthetic product to a pilot level plant and gradually to bulk.
PSO9: Enhance the scientific temperament among the students in anticipation of developing research culture and implementation of policies at global & local level.
PSO10: Communicate scientific information clear in both writing and orally.
PSO11: Students shall start to become better readers, thinkers and learners in their discipline by processing their ideas through writing.
PSO12: Will build new scientific understanding as it provides students the opportunity to articulate their thinking as they engage in the science practices during an investigation.</td></tr>
<tr><td rowspan="13">Mapping between POs and PSOs</td><td></td><td>PSO 1</td><td>PSO 2</td><td>PSO 3</td><td>PSO 4</td><td>PSO 5</td><td>PSO 6</td><td>PSO 7</td><td>PSO 8</td><td>PSO 9</td><td>PSO 10</td><td>PSO 11</td><td>PSO 12</td></tr>
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<tr><td>PO 9</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>PO 10</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Medium of Instruction</td><td colspan="13">English</td></tr>
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VEER NARMAD SOUTH GUJARAT UNIVERSITY

Structure of M. Sc. Syllabus
Semester-I

Sr. No.	Course Code	Course Title	L	T/C/S	Credit
1	1803080201010001	Inorganic Chemistry	4		4
2	1803080201020001	Organic Chemistry	4		4
3	1803080201030001	Physical Chemistry	4		4
4	1803080201040001	Instrumental and chemical analysis	4		4
5		Practical + T/C/S	12	3	6+3
			28	3	25

Faculty Code: Science Subject code: Level code:
Name of program: M. Sc. Subject: Chemistry
External Examination Time Duration: 03 hrs.

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	I	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Core	04	30	70	100
			Practical +T/C/S	06 + 03	60	140	200
			Total	25	180	420	600

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Structure of M. Sc. Syllabus
Semester-II

Sr. No.	Course Code	Course Title	L	T/C/S	Credit
1	1903080202010001	Inorganic Chemistry	4		4
2	1903080202020001	Organic Chemistry	4		4
3	1903080202030001	Physical Chemistry	4		4
4	1903080202040001	Instrumental and chemical analysis	4		4
5		Practical + T/C/S	12	3	6+3
			28	3	25

Faculty Code: Science Subject code: Level code:
Name of program: M. Sc. Subject: Chemistry
External Examination Time Duration: 03 hrs.

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	II	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Core	04	30	70	100
			Practical + T/C/S	06 + 03	60	140	200
			Total	25	180	420	600

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Inorganic Chemistry
M.Sc. Inorganic Chemistry, Semester-I

Course Code	[1803080201010001]	Title of the Course	**Inorganic Chemistry**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand the concept of symmetry and group theory with its application. • To understand the basics of Quantum mechanics, familiarize with various types of operators and implant the knowledge of orbital configuration. • To learn the inorganic reaction mechanism. Different types of reaction mechanisms and also various types of transition state theory. • Understanding of concepts of metal clusters, classification of metal clusters, Wade's rule, Carboranes, low and high nuclearity carbonyl clusters.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1				■	■	■			■		■	■
CO2	■	■				■			■	■	■	
CO3	■	■				■			■	■	■	■
CO4	■			■		■		■	■	■	■	

Course Content		
Unit	Description	Weightage* (%)
1.	**SYMMETRY AND GROUP THEORY IN CHEMISTRY AND ITS APPLICATIONS** Representation of Group: preparation of matrices and vectors 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, transformation properties of atomic crystals.	25
2.	**QUANTUM MECHANICS** Discussion of solution of Schrodinger equation to same model system	25

	e.g., 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, different types of operators and their uses, addition of angular momentum, spin, Russell-Saunders terms and coupling scheme, term separation energies of the p^n and d^n configuration, magnetic effect: spin orbit coupling and Zeeman effect(splitting).	
3.	**INORGANIC REACTION MECHANISM** Labile and inert complexes, factors responsible for lability and inertness of complexes. Reactivity of metal complexes, ligand replacement reaction: classification of mechanism and energy profile of reaction. Inert and labile complexes, interpretation of liability and inertness of transition metal complex on the basis of reaction rate, VBT and CFT. Transition state or activated complex, substrate, attacking regents electrophilic and nucleophilic nature of central atom. Kinetic application of CFT. Kinetics of octahedral substitution, acid hydrolysis, factor affecting acid hydrolysis, base hydrolysis conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism.	25
4.	**METAL CLUSTERS** Introduction, classification, carbonyl cluster, low nuclearity carbonyl clusters, high nuclearity carbonyl clusters, electron counting scheme for HNCCS, Wade's rule. Halides types clusters: dinuclear clusters, trinuclear clusters, tetranuclear clusters, hexanuclear cluster. Chevrel phases and zintl ions, Carboranes, metalloboranes, metallocarboranes, higher boranes (hexaborane-10, decaborane-14), number and types of bonds present in higher boranes.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the fundamentals of matrices and vectors matrix notations, reducible representation and their relation, applications of group theory
2.	Learn regarding quantum mechanics, angular momentum, understanding the solution of Schrodinger equation, Different types of operators and their uses
3.	Learn different types of inorganic reaction mechanisms, acid hydrolysis, base hydrolysis, conjugate base mechanism their synthetic application
4.	Understand the introduction and classification of metal clusters, electron counting scheme for HNCCS and Wade's rule and their synthetic application

Suggested Reference Books:

1. Chemical applications of group theory by F.A Cotton (Second edition), Wiley Eastern Limited, 1976 New Delhi
2. Group theory and its application by P.K. Bhattacharya, Himalaya publishing hours,Mumbai, 1986
3. Group theory and symmetry by L. R. Hall, McGraw hill, New York, 1989.
4. Quantum Chemistry by Ira N. Levine, Prentice-Hall of India Pvt. Lid, New Delhi, 1994.
5. Introductory Quantum Chemistry (Third edition) by N. W. Hanna, Benjamin, Menlo Park,Cailf, 1988.
6. Quantum Chemistry and Spectroscopy by M. S. Pathania, Vishal Publications, India, 1981.
7. Kinetic and Mechanism' by A. A. Frost and R. G. Pearson, Wiley, New York, 1953, 1961.
8. Mechanism of Inorganic Reactions by F. Basolo and R.G. Pearson, Second Edition, Wiley Eastern Limited, New Delhi, 1977.
9. Advanced Inorganic Chemistry by F. A Cotton and R.G. Wilkinson, John Wiley & Sons, N.Y.
10. Principles of Inorganic Chemistry, by Puri Sharma and Kalia, 33rd Edition, Vishal publishing Co. Jalandhar, Dehli, 2017.
11. Advanced Inorganic Chemistry by S. K. Agarwala and Keemtilal, Pragati Prakashan, Meerut.
12. Advanced Inorganic Chemistry, Volume-Il by Gurdeep Raj, Krishna Prakashan Media Lid.,Meerut.
13. Inorganic Chemistry by Gary L. Miessler and Donald A. Tarr, Pearson Education International

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

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Semester-I

Course Code	[1803080201020001]	Title of the Course	**Organic Chemistry**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand the concept of reactive intermediate and their application in organic synthesis. • To understand the basics of pericyclic reaction, familiarize with various theories of pericyclic reaction to access the feasibility of various pericyclic reactions and implant the knowledge to predict the stereochemical outcome of various pericyclic reactions. • To learn anchimeric assistance, stereochemistry and internal substitution reaction of aliphatic and allylic compounds. Aromatic nucleophilic substitution, cine substitution, elimination reactions, their stereochemistry and mechanisms. • Understanding of concepts of chirality, topicity, prochirality, dynamic resolutions, types of stereoselective and stereospecific reactions, the conformation of substituted and fused aromatic rings along with respective strains theories.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■		■	■	■		■	■	■	■
CO2	■	■		■	■				■	■	■	■
CO3	■	■		■	■		■		■	■	■	■
CO4	■			■	■			■		■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**REACTION MECHANISM & REACTIVE INTERMEDIATES** Detailed study of organic reaction intermediates. Generation, structure, stability and reactions of – **Carbocations (Classical and non-classical):** Phenonium ion, norbornyl system, common carbocation rearrangements- Demjanov, Pinacole-Pinacolone, Rupe. **Carbanions:** Mechanism of condensation involving enolates - Aldol,	25

	Claisen, Mannich, Dieckmann, Michael and Shapiro reactions. **Carbenes:** Mechanism of Arndt-Eistert reaction, Reimer-Tiemann reaction and Bamford Steven's rearrangement reaction. **Free Radicals:** Allylic halogenation (NBS), coupling of alkenes and arylation of aromatic compounds by diazonium salts. Sandmeyer reactions. Free radical rearrangements, Hunsdiecker reaction.	
2.	**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 (No correlation diagram), Diels-Alder reaction, stereoselectivity, Effect of substituents. **Sigmatropic rearrangements**: Suprafacial and antarafacial shifts involving H & C moieties, retention and inversion of configurations. The Cope and Claisen rearrangements, Ene reaction, 1, 3- dipolar cycloadditions. Examples of electrocyclic, cycloaddition and sigmatropic rearrangements.	25
3.	**SUBSTITUTION AND ELIMINATION REACTIONS** **A: Aliphatic Nucleophilic Substitution**: The SN^1, SN^2, SN^i mechanisms. Reactions of Allylic halides, neighboring group participation by -OH, -NH_2, -COO-, -RS, - 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, E_1, E_2 and E_1CB Reaction mechanism and orientation.	25
4.	**A.** Stereo chemical principles; Enantiomeric relationships; Diastereomeric relationship; R-S and E-Z nomenclature; Dynamic stereochemistry; Chiral-Prochiral relationships; Stereo selective and Stereospecific reactions; Racemates and racemic modification, Resolution of racemic modification, Optical activity in the absence of chiral carbons biphenyl, allenes, spiranes. **B.** Confirmational Analysis: Interconversion of Fischer, Newman and Sawhorse projections. Newer method of asymmetric synthesis	25

	(including enzymatic and catalytic nexus), enantio- and diastereo-selective synthesis. Simple acyclic and cyclic (chair and boat cyclohexanes, Decalins, Perhydrophenanthrene) systems. Effects of conformation on reactivity in acyclic compounds and substituted cyclohexanes.	

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand generation of reactive intermediates, their mechanism, rearrangement based on each intermediate, application of reactive intermediate in organic synthesis and industries application.
2.	Recognize pericyclic reactions, understanding of thermal and photochemical reaction, determination of mechanistic pathway, symmetry properties, aromaticity based on Mobius method, application of pericyclic reactions in organic synthesis.
3.	Learn the difference between elimination and addition reaction, the concept of anchimeric assistance in various groups like sulphide, halogen, phenyl, hydroxyl, tosylates & mesilates, amino group etc., aromatic nucleophilic substitution through addition - elimination, elimination-addition, cine substitution and their synthetic application.
4.	Detect chirality in molecular structure, recognize the relationship between enantiomeric and diastereomeric structures, understand & distinguish stereoselectiveand stereospecific reactions, dynamic resolution, the confirmative study of various substituted aromatic and fused aromatic rings and their application in the pharmaceutical industry.

Suggested 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 (McMillanIndia 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. Reaction Mechanism and Reagents in Organic Chemistry by C. R. Chatwal (Himalaya Publishing House, Bombay, 1987).

UNIT II:

1. March's Advanced Organic Chemistry Reactions, Mechanisms, And Structure 7th ed. 2013 Michael B. Smith. Wiley.
2. Mechanism And Theory in Organic Chemistry-2007 by Thomas H. Lowry, Kathleen S. Richardson, Forbes. Harper& Row, Publishers. New York, Hagerstown, San Francisco, London.
3. Advanced Organic Chemistry Part A: Structure and Mechanisms by Carey & Sundberg (5th edition), 2000, Springer.
4. Pericyclic Reactions, S. M. Mukherji, Macmillan, India.
5. Photochemistry And Pericyclic Reactions 3rd ed. by Jagdamba Singh 2010. New Age International Publishers Ltd. New Delhi.
6. Pericyclic Reactions: A mechanistic and problem-solving approach by Sunil Kumar, VinodKumar, S. P. Singh Academic Press 2015

UNIT III:

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. Physical organic chemistry by Jack Hyne
8. Reaction mechanism by Jagdamba Singh.
9. Organic chemistry - Reaction mechanism, by P.S. Kalsi, New age international publishers.

UNIT IV:

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
3. J. Sundberg, fifth edition, Published by Springer.
4. Stereochemistry of Carbon Compounds; By Ernest L. Eliel, Published by Tata McGraw- Hill Publishing Company Ltd.
5. Basic organic stereochemistry; By Ernest Ludwig Eliel, Samuel H. Wilen, Michael P. Doyle, Published by Wiley-Inter-science.
6. Introduction to Stereochemistry; By Kurt Martin Mislow, Dover Publication INC.
7. Stereochemistry of Organic Compounds: Principles and Applications; By D. Nasipuri, NewAge International (P) Ltd. Publisher.
8. Stereochemistry Conformation and Mechanism; By P.S. Kalsi, New Age International (P) Ltd.Publisher.
9. Basic Stereochemistry of Organic; By Subrata Sen Gupta, first edition, Published by Oxford University Press.

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

Master of Science, Physical Chemistry
M.Sc. Physical Chemistry, Semester-I

Course Code	[1803080201030001]	Title of the Course	**Physical Chemistry**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand the concept of thermodynamics in solution. • To understand the type of interactions and orientation of molecules in solution. • To understand basic concept of statistical thermodynamics. • Understanding of concepts of kinetics of different types of chemical reactions. • To learn the basic concept of synthesis of polymer and solution behaviour of polymer

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■		■	■	■	■					■	■
CO2	■		■		■	■					■	■
CO3	■		■	■	■	■					■	■
CO4	■	■			■	■			■	■	■	■
CO5	■		■	■	■	■	■		■		■	■

Course Content

Unit	Description	Weightage* (%)
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); Steady state treatment or approximation, Enzyme catalyzed 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, Effect of Ionic strength on rates of ionic reactions (Primary and secondary salt effect), Numerical.	25

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 and partial molar enthalpy, 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.	25
3.	**STATISTICAL THERMODYNAMICS** Basics of Statistical thermodynamics (Assembly, Canonical ensemble, occupation number statistical 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) Third law of thermodynamics (iv) Helmholtz free energy (v) Enthalpy (vi) Gibb's free energy (vii) Chemical potential (viii) Equilibrium constant. Molecular partition functions for an ideal gas, Derivation for Translational, Rotational and Vibrational partition functions, Numerical.	25
4.	**POLYMER CHEMISTRY** Types of polymers, Stereochemistry of polymers, Kinetics of polymerization (Addition and Condensation), Thermodynamics of polymerization, Phase techniques of polymerization (Bulk, solution, suspension and emulsion), Number & Mass average Molecular mass, Polydispersity Index (P.D.I) Molecular mass determination by Viscometry and Osmometry, Thermal transitions in polymer: glass transition temperature and its significance, Numerical.	25

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per	30%

	CBCS R.6.8.3)	
2.	University Examination	70%

Course Outcome: Having Completed this course, the learner will be able to	
1.	Students learn thermodynamic terminology, fundamental thermodynamic properties, properties of the solution, fundamental knowledge assist student to understand a related topics in the next semester.
2.	Understand the kinetics of different types of reactions. Understand the factors responsible for behaviour of different kind of chemical reaction.
3.	Learn relation between quantum chemistry and statistical thermodynamics. Understand basic terminologies and their application in calculation of thermodynamic function.
4.	Understand the methods for synthesis of polymer and their characterization.

Suggested 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, Volume 1: Thermodynamics and Kinetics (10th Edition) by Professor Peter Atkins, Julio De Paula
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. 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

UNIT III:

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

UNIT IV:

1. Polymer science by V.R. Gowarikar. WILEY EASTERN LTD.
2. Principal of polymer chemistry by A. Ravve, Springer
3. A Textbook of Polymer Chemistry, M S Bhatnagar, S Chand Publications.
4. Principles of Physical Chemistry Puri B.R., Sharma L.R. and Pathania, M.S., Vishal Publishing Co.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Instrumental and Chemical Analysis
M.Sc. Analytical Chemistry, Semester-I

Course Code	[1803080201040001]	Title of the Course	**Instrumental and Chemical Analysis**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To understand concept of electromagnetic radiation, auxochrome, chromophores, various factors affecting the UV-Visible spectra and impart the knowledge to understand the spectra. ● To understand basics of concepts of chromatography, their classification and importance as well as working of various parts of the chromatography instruments. Use of this TLC and GC in various application. ● To learn the different types of errors that occur in qualitative and quantitative and the validation of result obtained in experiments with the help of Q test and Students' t test. ● To learn the thermal methods, their instrumentation, effect of various factors on the experimental results and their application in various field.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■		■		■	■			■	■		■
CO2	■	■		■	■	■			■	■	■	■
CO3		■	■	■		■					■	■
CO4	■	■		■	■	■				■	■	

Course Content		
Unit	Description	Weightage* (%)
1.	**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,	25

	Spectrophotometer, Application.	
2.	**CHROMATOGRAPHY** **Thin-Layer Chromatography**: Selection of stationary and mobile phase, Detection techniques – Elementary idea of HPTLC **Gas Chromatography:** Selection of mobile phase – Selection of stationary phase in GLC and GSC – Detectors: FID (with modifications), TCD and ECD, Their comparison, Packed column, WCOT, SCOT (advantages and disadvantages) –Temperature programming – Derivatization in GC – Quantitative Analysis.	25
3.	**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.	25
4.	**THERMAL METHODS OF ANALYSIS** **THERMOGRAVIMETRY** Thermogravimetry, Instruments for TGA- thermobalance and furnace, Calibration of temperature scale, Factors affecting TGA results instrumental and experimental, Applications. **THERMOMETRIC TITRATION:** Thermometric Titration (TT), Advantages, Instrument, Applications of TT in Neutralization Titration, Precipitation Titration, Complexometry Titration and Redox Titration.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the basic concept of electromagnetic radiation and their interaction

	with the matter and use of UV-Visible spectrophotometer in structure identification and quantitative determination.
2.	Recognize the use of different stationary and mobile phase for the separation of organic molecule and identify the problems and their solution during the analysis and learn the use of the chromatography for those which can't be identified by the techniques.
3.	Learn difference between different types of errors observed during analysis and use of statistical treatment of data. Also learn to accept and reject the data with help of different type of tests.
4.	Use of the thermometric techniques when the other methods are failed. The requirement of this technique is to identify the problems arising during the analysis.

Suggested 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 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 &McWilliam, 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, McWilliam, John Wiley and Sons.
12. Quantitative Analysis, 6^{th} Ed., R. A. Day and A. L. Underwood, Prentice – Hall of India, 1993.
13. Instrumental Analysis: G. D. Caristian 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 (VanNostrand Reinhold Co., New York), 6^{th} edition.
16. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2^{nd} edition.
17. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company), NewDelhi.

18. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall Internationaledition).
19. Introduction to Modern Liquid Chromatography: L. R. Shyder & J. J. Kirkland (John Wiley & Sons, New York).
20. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Inorganic Chemistry
M.Sc. Inorganic Chemistry, Practical

Course Code	[1803080201050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To impart basic knowledge of qualitative analysis of Inorganic mixture. • To identify three anions and three cations including one rare earth element by group separation. • To impart knowledge of different radicals by confirmative test. • Preparation of inorganic metal salts and it's crystallization.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■						■		■	■	■	
CO2	■						■		■	■	■	■
CO3	■			■			■		■	■	■	■
CO4	■		■				■			■	■	■

Course Content

1. Inorganic Qualitative Analysis: (Six elements including ONE rare earth element)
2. Inorganic Preparation.
   a) Hexa-ammine nickel (II) chloride
   b) Mohr's salt (Ferrous Ammonium sulphate)
   c) Sodium trioxalato ferrate trihydrate
   d) Sodium cobaltinitrite
   e) Tetra amine cupric sulphate
   f) Reineck's salt (Ammonium tetrathiocyanate diammine Chromate)

Teaching-Learning Methodology	Introduction, demonstration of handling equipment, reference books, and frequent instruction according to the respective practical.

Evaluation Pattern

Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per	30%

	CBCS R.6.8.3)	
2.	University Examination	70%

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand basics of analysis of Inorganic mixtures.
2.	Identify anions by dry test of the mixture.
3.	Separation of each anion by group test from mixture.
4.	Identify each cation and confirm it by confirmative test.
5.	Understand different methods of Preparations of inorganic salts.
6.	Appreciate good laboratory practices.

Suggested Reference Books:

1. Textbook 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 Agarwal, Keemtilal
4. Qualitative Inorganic analysis - Vogel
5. Inorganic practical by Chatwal and Anand

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Organic Chemistry
M.Sc., Organic Chemistry, Practical

Course Code	[1803080201050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To impart basic knowledge for the separation of organic ternary mixture. • To identify nature of mixture i.e., solid-solid, solid-liquid, liquid-liquid etc. • To impart knowledge of different purification techniques including distillation. • Separation and identification of component with their functional group test and M.P. /B.P. • To confirm the structure and prepare the relevant derivative.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■				■	■		■	■
CO2	■	■		■			■	■	■		■	■
CO3	■	■		■			■	■	■		■	■
CO4	■	■		■			■	■	■		■	■
CO5	■		■	■					■	■	■	■

Course Content
1. Mixture analysis: (Minimum eight mixtures) Ternary mixture to be given. (S+S+S), Semisolids or (L+L+L). Type, determination, Separation by physical and chemical methods. (Both permitted in case of liquids) 2. Paper Chromatography

Teaching-Learning Methodology	Introduction, demonstration of handling equipment, reference books, and frequent instruction according to the respective practical.

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand basics of separation of organic tertiary mixtures.
2.	Identify and chemical nature of mixture.
3.	Separation of each component from mixture.
4.	Identify each component through their functional group test, elemental analysis and M.P/B.P.
5.	Purify the compounds using different techniques including distillation, crystallization etc.
6.	Record physical constants for individual compounds.
7.	Appreciate good laboratory practices.

Suggested 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.

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

Master of Science, Physical Chemistry
M.Sc. Physical Chemistry, Practical

Course Code	[1803080201050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To study the rate constant of chemical reaction. • To understand pH metric and potentiometric titration of between two solutions. • To study the properties of surfactant and polymer in aqueous solution. • To determine the concentration of solution by colorimetry. • To understand the conductivity behaviour of electrolytes solution. • To understand phase behaviour of three component system.

Mapping between CO ands PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■		■	■		■					■	■
CO2	■	■		■		■					■	■
CO3	■	■		■		■	■		■	■	■	
CO4	■		■	■					■	■	■	■
CO5	■	■	■			■			■	■	■	■
CO6	■			■			■		■	■	■	■

Course Content

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 given 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-component 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.

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the chemical kinetics of reaction.
2.	Qualitative analysis of compound.
3.	calculate the concentration of unknown solution by pH, potentiometer and colorimeter.
4.	Understand behaviour of surfactant and polymer.
5.	Separation of solvent using phase diagram.

Suggested 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

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

Master of Science, Inorganic Chemistry
M.Sc. Inorganic Chemistry, Semester-II

Course Code	[1903080202010001]	Title of the Course	**Inorganic Chemistry**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To learn magnetic properties and sources of paramagnetism and diamagnetism • To understand structure, bonding and synthesis of metal carbonyls and nitrosyls • To gain knowledge of characterization, structural features and classification of inorganic polymers • To study the classification, interpretation and composition of coordination compounds.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■			■	■	■			■		■	■
CO2	■			■	■	■			■		■	■
CO3	■		■		■	■			■	■	■	
CO4	■		■		■	■			■	■	■	■

Course Content		
Unit	Description	Weightage* (%)
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 (c) Null deflection method Application of magnetic susceptibility measurements, Temperature independent paramagnetism (TIP), Orbital contribution to magnetic moment.	25
2.	**METAL π – COMPLEXES** Metal carbonyls: Introduction, classification of metal carbonyls, structure and bonding, vibrational spectra studies for bonding and	25

	structure elucidation. Preparation of metal carbonyls by (1) Direct synthesis and (2) From metal compounds. Preparation, Properties and structure of $Ni(CO)_4$ $Fe_2(CO)_9$ and $Co_2(CO)_8$, 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.	
3.	**INORGANIC POLYMERS** Definition of polymers and their depiction. Characteristics of inorganic polymer. Characterization of inorganic polymers (physical properties) bymolecular weight, number average and weight average. Structural features of polymers: (1) Backbone bonding (2) Branching and cross-linking (3) Chemical and Stereo chemical variability. Classification of inorganic polymers, synthesis, properties, structures, uses and application of polyphosphazenes and polysiloxanes.	25
4.	**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.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the definitions of magnetic properties, types of magnetic bodies, determination of magnetic susceptibility and its applications.

2.	Understand classification of metal carbonyls and nitrosyls, structure and bonding. Vibrational spectra studies for bonding and structure elucidation, preparation of metal carbonyls and nitrosyls.
3.	To learn the characteristics of inorganic polymer and characterization of physical properties by molecular weight, number average and weight average. Structural features of polymers by different bonding.
4.	Understand the classification of coordination compounds, Werner's theory, electronic interpretation, factors affecting the formation of complex ions, detection of complex ion in solution, stability of metal chelates and Importance of chelates, role of metal chelates in living system

Suggested Reference Books:

1. Magnetochemistry by R. L Carlin
2. Element of Magnetochemistry by A. Syamal and R. L. Dutta, Affiliated East-West press,new Delhi, 1993.
3. Introduction to metal π-complex chemistry by M. Tsusui, M. lchikwa, K. Mori, Plenum press, New york
4. Introductory polymer chemistry by G. S Mishra, Wiley Eastern Ltd,1993.
5. Phosphorous-Nitrogen Compounds, H. R. Allock, Academic, New York, 1972.
6. Advanced in Inorganic Chemistry by S. K. Agarwal, Keemtilal, Pragati prakashan, Meerut
7. Coordination Chemistry by Ajaykumar, Aaryush Education publication, Thind publication
8. Principles of inorganic chemistry by Puri, Sharma and Kalia, Vishal publication Co. Jalandhar, Delhi
9. Coordination Chemistry by Gurdeep Chatwal, M.S. Yadav, Himalaya Publishing house
10. Inorganic polymers by Prof G. R. Chatwal, Himalaya Publishing House

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

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Semester-II

Course Code	[1903080202020001]	Title of the Course	**Organic Chemistry**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To learn transition metal catalysts based on C-C, C-N coupling reaction, formylation reaction, various acid base catalyzed condensation reactions, reactions which changes configuration etc., and their mechanism. ● To learn aromaticity based on different concept, measurement of aromaticity through various parameters, annulenes, azulene and types of aromaticity. ● To understand the role of chemical reactants in oxidation, reduction, dehydration, cyclisation and transformation of various organic functional groups. ● To understand photochemistry, various types of its reaction, photochemical cleavage of carbonyl compounds, their mechanism and application in synthesis.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■	■		■	■	■	■
CO2	■	■		■	■	■			■	■	■	■
CO3	■	■		■	■	■	■		■	■	■	■
CO4	■			■	■	■			■	■	■	

Course Content		
Unit	Description	Weightage* (%)
1.	**ORGANIC NAME REACTIONS** General nature, method, mechanism and synthetic applications of the following reactions: 1) Heck reaction 2) Dakin reaction 3) Darzen's glycidic ester synthesis 4) Leuckart reaction 5) Suzuki reaction 6) Willgerodt reaction	25

	7) Buchwald-Hartwig reaction 8) H. V. Z reaction 9) Vilsmeyer-Hack reaction 10) Mitsunobu reaction 11) Sonagashira reaction 12) Dickmann reaction.	
2.	**AROMATICITY** Aromaticity and Aromatic character; structure and stability of benzene, Frost circle diagram, concept of aromaticity; Resonance and chemical stabilization; criteria to check aromatic character-IR, NMR, heat of hydrogenation; Huckel's rule; HMO method, Antiaromaticity, homoaromaticity, nonaromaticity, aromaticity in benzanoid compounds: naphthalene, pyrene, acepleialdelene. Aromaticity non-benzenoid compounds: azulene, tropolones, charged rings, annulenes fullerenes, and mesoionic compounds.	25
3.	**ORGANIC TRANSFORMATION AND REAGENTS** 1) Sharpless epoxidation 2) Umpolung reagent (1,3-dithiane) 3) Dess martin periodinane 4) DDQ 5) Tri-n-butyl tinhydride (C4H9)3SnH 6) Di-isobutyl aluminum hydride (DIDAL-H) 7) Lithium diisopropylamide (LDA) 8) OZONE 9) $K_3Fe(CN)_6$ and DMSO 10) Merrifield Peptide Synthesis 11) Crown ethers 12) Wilkinson's Catalyst	25
4.	**PHOTOCHEMISTRY** A. Energy of molecules, photochemical energy, 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, addition to carbon- carbon double bond, photo reduction of carbonyl compounds. C. Photo induced rearrangement of enones, dienones and alkenes. Photochemistry of alkenes and aromatic compounds-isomerization,dimerization and addition reactions,	25

	D. Photochemistry of visiob, singlet-oxygen oxygenations, solar energy conversion and storage	

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the role of transition metal in organic synthesis by studying Heck, Suzuki, Sonagashira and Buchwald-Hartwig reaction, formylation by Villsmayer Heck reaction, substituted amines, amides formation reaction, cyclisation through condensation reaction and inverted configuration through Mitsunobu reaction.
2.	Understand aromaticity, various parameters for the measurement of aromaticity, frost circle method and calculation of energy for the determination of aromaticity. Aromaticity measurement through NMR, types of aromaticity and aromaticity measurement in fused rings, annulenes and azulenes etc.
3.	To learn the chemistry involved in oxidation-reduction reactions by employing numerous reagents & appropriate chemo-selectivity of the reagents, suggest use of miscellaneous reagents in organic synthesis including Wilkinson catalyst, DIBAL- H, PTC-crown ether, 1,3-Dithiane etc.
4.	Get oneself familiarize with usual photochemical reactions, terms of photochemistry, understanding fluorescence, phosphorescence by photoexcitation decay/dissipation of energy. Types of photochemical reactions like Norrish type-I & II, Paterno-Buchi etc., Photo-dimerization and their application in organic synthesis.

Suggested 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. Name Reactions by A. R. Parikh & H.A.Parikh
8. Name reaction: A collection of detailed reaction mechanisms by Jie Jack Li
9. Reaction Mechanism and Reagents in Organic Chemistry by C. R. Chatwal (Himalaya Publishing House, Bombay, 1987).
10. Organic Chemistry-Reactions and Mechanism by P S Kalsi
11. Advanced Organic Chemistry: Reactions and Mechanisms by M.S. Singh
12. Organic chemistry by Cram, Hammond, Pine and Handrickson
13. Photochemistry and Pericyclic Reactions by Jagdamba Singh
14. Pericyclic reactions: A text book by S. Sankararaman
15. Excited states in Organic Chemistry by J. D. Coyle and J. A. Barltrop
16. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure by Michael B.Smith
17. Advanced Organic Chemistry: Part B: Reaction and Synthesis by Carey & Francis
18. Organic Chemistry by Jonathan Clayden

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

Master of Science, Physical Chemistry
M.Sc. Physical Chemistry, Semester-II

Course Code	[1903080202030001]	Title of the Course	**Physical Chemistry**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To learn conductivity behaviour of strong electrolytes in solution, factors affecting electrolysis process. • To learn basics and application of colloids. • To understand the basics of surface chemistry. • To understand basics of molecular spectroscopy.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■			■	■	■			■	■	■	■
CO2	■			■	■	■			■	■	■	■
CO3	■			■	■	■			■	■	■	■
CO4	■	■		■	■	■			■	■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**THEORIES OF ELECTROLYTIC CONDUCTANCE AND OVER VOLATEGE** Debye-Huckel theory of strong electrolytes, relaxation effect and electrophoretic effect, 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, Electrolytic polarization, Dissolution and Decomposition potential, Concentration polarization, Decomposition potential and its determination, over voltage, determination of over voltage, theories of over voltage: combination of atom as slow process (Tafel theory), Numerical.	25
2.	**SURFACE CHEMISTRY** Adsorption, Multilayer Adsorption, the BET adsorption isotherms,	25

	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.	
3.	**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 on DLVO theory of colloid stability (ii) Electrokinetic properties: Electrophoresis, electroosmosis. Surface active agents, critical micellar concentration (CMC), factors affecting the CMC of surfactants, thermodynamics of micellization: mass action and phase separation model, solubilization, emulsion, types of emulsion, methods for determination of types of emulsion, microemulsion, types of microemulsion, theories of microemulsion.	25
4.	**MOLECULAR SPECTROSCOPY** Molecular spectra, Microwave spectroscopy (Rotational spectroscopy): 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 potential energy, 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.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the electrolytes in conductance of solutions. Importance of polarization decomposition potential and over voltage in electrolysis process and in industries.
2.	Understand physical phenomena of surface chemistry. Application of surface-active substance and factor affecting surface chemistry, adsorption of surface-active materials.
3.	Understand the solution behaviour of surfactants. Colloidal chemistry explains the importance of micelle formation for colloidal industry.
4.	Identify the molecular interactions and concentration and identification of compounds.

Suggested Reference Books:

Unit I:

1. Atkins, P.W., Physical Chemistry, W.H. Freeman (2017) 10th edition
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, Vishal Publishing 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 II:

1. Puri, B.R., Sharma, L.R., and Pathania, M.S., Principles of Physical Chemistry, Vishal Publishing 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

UNIT III:

1. Puri, B.R., Sharma, L.R., and Pathania, M.S., Principles of Physical Chemistry, Vishal Publishing 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

UNIT IV:

1. Fundamentals of Molecular Spectroscopy C. N. Banwell TATA McGRAW-HILL15th edition
2. Handbook of Molecular Spectroscopy, by D.N. Sathyanarayana
3. Introduction to Spectroscopy by Donald L. Pavia, George S. Kriz, Gary M. Lampman, James, R. Vyvyan
4. Fundamentals of molecular spectroscopy by Walter S. Struve
5. Barrow, G.M. Physical Chemistry Tata McGraw Hill (2007)

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

Master of Science, Instrumental and ChemicalAnalysis
M.Sc., Analytical Chemistry, Semester-II

Course Code	[1903080202040001]	Title of the Course	**Instrumental and ChemicalAnalysis**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand theory and instrumentation of infrared spectroscopy with working of various parts of instruments. Structure elucidation is also learnt with help of IR spectra. • To learn liquid-liquid chromatography with special focus on the instrumentation of high-pressure liquid chromatography and their application in various field. • To understand the basic concept of green chemistry, twelve principles and green solvents and their application. Also learn the uses of various instrumental and classical method in the analysis of water for removal of toxicants. • To understand units of solution their uses in numerical and solution preparation. To understand the uses of non-aqueous titration when aqueous titration fails and also analysis of C, H, N, O, S with various techniques.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■				■	■			■	■	■	
CO2	■	■		■	■	■			■	■	■	■
CO3	■	■		■	■	■	■	■		■	■	■
CO4	■			■	■	■			■	■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**IR SPECTROSCOPY** Introduction: Theory, 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. Useful terms: IR region, types of vibrations: fundamental and overtones, linear and non-linear molecule, equation for vibrational frequency, selection rule, coupling	25

	interactions, hydrogen bonding information, Fermi resonance. IR spectra: group frequency, group frequency region, fingerprint region, spectra interpretations and structure elucidation.	
2.	**LIQUID CHROMATOGRAPHY** Principle of Liquid – Solid chromatography, Comparison with GC, Column chromatography, Gradient elution, Displacement chromatography, 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, Method of introducing sample.	25
3.	**GREEN CHEMISTRY AND WATER ANALYSIS** **Green Chemistry** Twelve principles, green solvents and their applications: Ionic liquids, types, properties and applications, ILs as solvents, Supercritical fluids, Supercritical CO_2, its properties and applications in dry cleaning and decaffeination of coffee. **Water analysis** Sources of water pollution, Sewage and industrial effluents, Analysis of water pollutants, Sampling, Preservation, Measurement of parameters such as COD, BOD, DO, TDS, suspended solids, TCC, phenols, fluoride.	25
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, Numerical. **Elemental Analysis:** Step on Analysis, C and H Analysis, N Analysis, Halogen Analysis and Sulphur Analysis, Numerical.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the basic concept of Infrared radiation and their interaction with the matter and use of FTIR spectrophotometer in structure identification and quantitative determination.
2.	Recognize the use of different stationary and mobile phase for the separation of organic molecule in liquid chromatography and identify the problems and their solution during the analysis.
3.	Learn different principles of green chemistry and their use in various techniques, also learn the determination of various pollutants in water by different techniques available such as classical and instrumental techniques.
4.	Understand the making of different solution with the help of different concentration and learn the non-aqueous titration when aqueous titration fails. Also learn the determination of various elements in organic compounds.

Suggested 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 byR. D. Braun, McGraw-Hill.
8. Mathematics for Chemistry, Doggett and Sucliffe, Longman.
9. Mathematical preparation for Physical Chemistry, F. Daniels, McGraw-Hill.
10. Introduction to Instrumental Analysis by R. D. Brawn, McGraw-Hill Book.
11. Fundamentals of Analytical Chemistry: Skoog D.R. and West D.M. (Holt, Rinehart & Winston, New York).
12. Chemical Analysis in Industry (in Gujarati) by M. N. Desai.
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. Christian 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), 5th edition.
17. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (Van Nostrand Reinhold Co., New York), 6thedition.
18. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2nd edition.
19. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company), New Delhi.
20. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).
21. Introduction to Modern Liquid Chromatography: L. R. Shyder & J. J. Kirkland (John Wiley & Sons, New York).
22. Treatise on Analytical Chemistry: I. M. Kohthoff & P. J. Elving (John Wiley & Sons, New York).
23. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
24. Environmental Chemistry: B. R. Sharma, H. Kaur (Goel Publishing House, Meerut).
25. Environmental Chemistry by A.K. De
26. Spectrometric Identification of Organic Compounds; By Robert M. Silverstein, Francis
27. X. Webster, David J. Kiemle, David L. Bryce, 8TH edition, Published by Wiley
28. Introduction to Spectroscopy; By Donald L. Pavia, Gary M. Lampman, George S. Kriz, Vyvyan, Fourth edition, Published by Brooks cole.
29. Spectroscopic Methods in Organic Chemistry; By D.H Williams, I. Fleming, Sixth edition, Published by Tata McGraw-Hill Education.
30. Spectroscopy of Organic Compounds; By P S Kalsi, Sixth edition, New Age International Publisher.
31. Organic Spectroscopy: Principles and Applications; By Jag Mohan, second edition, Published by Alpha Science International Ltd.
32. Organic Spectroscopy (NMR, IR, Mass and UV); By Dewan S.K., First edition, CBS Publisher & Distributors Pvt Ltd.
33. Basic Principles of Spectroscopy; By Raymond Chang, Published by McGraw-Hill Inc.
34. Elementary Organic Spectroscopy; By Y R Sharma, S. Chand & Company Pvt. Ltd.
35. Organic Spectroscopy; By William Kemp, Published by Palgrave Macmillan.
36. Green chemistry by V. K. Ahluwalia, Narosa Pub. New Delhi
37. Green Chemistry, Theory and Practice, P. T. Anastas and John C. Warner, Oxford University Press, 2000, New York, USA.
38. Green Chemistry: An Introductory Text, Mike Lancaster, Green Chemistry Network,University of York, RSC, 2002.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Inorganic Chemistry
M.Sc. Inorganic Chemistry, Practical

Course Code	[1903080202050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To impart basic knowledge for carrying out analysis of alloy. ● Understand the types of complexometric titrations ● To understand and calculate the percentage purity of salt. ● Determination of physical constant and confirmation of product. ● Concept of estimation and determination of each radical quantitatively and qualitatively.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■			■	■			■	■	■	
CO2	■	■			■	■			■	■	■	■
CO3	■		■		■	■			■	■	■	■
CO4	■	■			■	■		■	■	■	■	■
CO5	■				■	■			■		■	■

Course Content

Quantitative Analysis:

1. Analysis of Solder and Type metal (Alloy Analysis)
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 Iron in Iron ore.
5. Estimation of available chlorine in bleaching powder.
6. Estimation of Ca^{+2} and Pb^{+2} in Admixture.
7. Determine the amount of Fe^{+3} and Cr^{+3} Present in given Admixture.
8. Determine the percentage purity of the given sample of Manganese salt
9. Estimation of Aluminium by back titration.

Teaching-Learning Methodology	Introduction, demonstration of handling equipment, reference books, and frequent instruction according to the respective practical.

Evaluation Pattern		
Sr.	Details of the Evaluation	Weightage

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the analysis of alloy and ore and calculation of molarity and mole ratio.
2.	Learn to methods to find copper, zinc gravimetrically and volumetrically.
3.	Learn to find available chlorine bleaching powder.
4.	Learn to determine calcium, lead, Iron and chromium in admixture.
5.	Appreciate good laboratory practices.

Suggested Reference Books:

1. Textbook 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 Agarwal, Keemti lal
4. Qualitative Inorganic analysis - Vogel
5. Inorganic practical by Chatwal and Anand

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

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Practical

Course Code	[1903080202050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To impart basic knowledge for carrying out preparation. • Understand nature of reaction and establishment of reaction condition with mechanism. • To understand calculation of mole and mole ratio for each reaction. • Isolation of product from individual step and purification by crystallization. • Determination of physical constant and confirmation of product. • Concept of estimation and determination of each component quantitatively.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■		■	■		■	■	■
CO2	■	■		■	■		■	■		■	■	■
CO3	■	■			■		■	■	■			
CO4	■	■			■		■	■	■			
CO5	■	■			■		■	■	■			
CO6	■	■			■	■	■	■	■			■

Course Content

Preparation of organic compounds:

1. Nitration
2. Bromination
3. Acylation
4. Reduction
5. Oxidation
6. Condensation reaction
7. Diazotization reaction
8. Friedel-Craft's reaction
9. Cannizzaro reaction
10. Aldol condensation

Quantitative Estimations:
1. Estimation of ester + acid 2. Estimation of formaldehyde 3. Estimation of glycine 4. Estimation of amide + acid

Teaching-Learning Methodology	Introduction, demonstration of handling equipment, reference books, and frequent instruction according to the respective practical.

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the basics to carry out reactions, nature of reaction and calculation of mole and mole ratio.
2.	Establish mechanism and monitor a reaction at specified condition.
3.	Work-up after the completion of reaction and purification.
4.	Confirmation of product through the references.
5.	Appreciate good laboratory practices.

Suggested 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.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Physical Chemistry
M.Sc. Physical Chemistry, Practical

Course Code	[1903080202050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To study the physical chemistry parameters for reaction between acid and base. • To study the rate of reaction by conductometry. • To determine the concentration of solution by colorimetry. • To understand the conductivity behaviour of electrolytes solution. • Partitioning behaviour of component in two phases.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■			■	■			■	■	■	
CO2	■	■			■	■			■	■	■	■
CO3	■			■	■	■			■	■	■	■
CO4	■		■		■	■	■		■	■	■	■
CO5	■		■		■	■			■	■	■	■

Course Content

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 the distribution method.
6. Investigation the reaction between H_2O_2 and HI at two different temperatures and calculate theenergy 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.

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand preparation of solutions.
2.	Qualitative chemical kinetics of reactions.
3.	calculate the concentration of unknown solution by pH, potentiometer and colorimeter.
4.	Understand behaviour of surfactant and polymer.
5.	Understand effect of concentration on solubility product.

Suggested 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

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

M.Sc. Semester-III (INORGANIC CHEMISTRY)

Sr. No.	Course Title	L	T/C/S	Credit
1	Selected Topics in Inorganic Chemistry	4		4
2	Metallurgy, Bio-fertilizer & Ion exchange Chromatography	4		4
3	General Topics in Inorganic Chemistry	4		4
4	Co-ordination Chemistry (Special Paper)	4		4
5	Practical	12	4	8
		28	4	24

External Examination Time Duration: 03 hrs.

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	III	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Core	04	30	70	100
			Practical	08	60	140	200
			Total	24	180	420	600

M.Sc. Semester-IV (INORGANIC CHEMISTRY)

Sr. No.	Course Title	L	T/C/S	Credit
1	Selected Topics in Inorganic Chemistry	4		4
2	Chemistry of Complexes	4		4
3	Spectroscopy & Agricultural Pollutants	4		4
4	Co-ordination Chemistry (Special paper)	4		4
5	Practical	12	4	8
		28	4	24

External Examination Time Duration: 03 hrs.

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	IV	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Core	04	30	70	100
			Practical	08	60	140	200
			Total	24	180	420	600

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Inorganic Chemistry
M.Sc. Inorganic Chemistry, Semester-III
Paper-I

Course Code	[1903080203010002]	Title of the Course	**Selected Topics in Inorganic Chemistry**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To learn the properties of non-transition metal elements. • To learn the synthesis, bonding, properties and applications of main group elements. • To understand the Bioinorganic chemistry of Hemoglobin, Myoglobin, Ferritin and Transferrin. • To understand the metal complexes in Medicine and anticancer activity of Platinum complexes.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■			■	■	■			■	■	■	■
CO2	■			■	■	■			■	■	■	■
CO3	■		■	■	■	■			■	■	■	■
CO4	■		■	■	■	■			■	■	■	

Course Content		
Unit	Description	Weightage* (%)
1.	**CHEMISTRY OF NON-TRANSITION ELEMENTS** General discussion on the properties of the non-transition elements, Polymorphism in carbon, phosphorus and sulphur, Synthesis, properties and structure of boranes, carboranes, silicates. carbides, phosphazenes, sulphur-nitrogen compounds, peroxo compounds of boron, carbon, sulphur, structure and bonding in oxyacids of nitrogen, phosphorus, sulphur and halogens, interhalogen, pseudohalides.	25
2.	**ORGANOMETALLIC COMPOUND** 1. Introduction, definition and scope of organometallic Chemistry. 2. Metal-Carbon multiple bonded compounds: Synthesis, bonding. Properties and applications of: (a) Carbenes (b)	25

	carbynes 3. η-C_nR_n carbocyclic polyenes: Synthesis, bonding. Properties and applications of a. allyls η^3 -C_3R_5, b. pentadienyls η^5-C_5R_7, c. cyclobutadienyls η^4-C_4R_4 d. cyclopentadienyls η^5-C_5R_5 e. arenas η^6-C_6R_6 f. cycloheptatrienyls η^7-C_7R_7 4. Synthetic applications of Main group organometallic compounds. a) Organolithium b) Organo-magnesium c) Organozinc d) Organoboron e) Organothallium	
3.	**BIOINORGANIC CHEMISTRY-I** 1. Biological Chemistry of Iron: a) Transport of Iron. b) Hemoglobin and Myoglobin c) Storage and Transport Proteins of Iron viz Ferritin and Transferrin. d) Cytochromes. e) Iron-Sulfur Proteins. 2. Biochemistry of Cobalt a) B_{12} coenzymes and Model compounds b) Actions of Cobalamins and Cobinamides c) Adenosyl-cobalamin as a coenzyme. d) Ribonucleotide reductase e) Methyl-cobalamin as cofactor.	25
4.	**BIOINORGANIC CHEMISTRY-II** 1. Biological Chemistry of Copper a) Type I, Il and III. b) Blue Copper Proteins (plastocyanins, Azurins and Blue Oxidases). c) Models of Blue Copper compounds. d) Non-blue copper proteins (Tyrosinase, Galactose Oxidase, SOD). 2. Biochemistry of Zinc a) Carboxypeptidase and carbonic anhydrase 3. Metal complexes in Medicine.	25

	a) Disease due to Metal deficiency and its treatment: b) Fe, Cu, Zn and Mn c) Metals used in diagnosis: MRI d) Anticancer activity of Platinum complexes.	

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	To learn the properties, synthesis, structure and bonding of the non-transition elements.
2.	To learn the M-C multiple bonded compounds and synthetic applications of main group organometallic compounds.
3.	To learn the biological chemistry of Iron and Cobalt.
4.	To understand the biological chemistry of Copper and Zinc, Metal complexes in medicine and anticancer activity of complexes.

Suggested Reference Books:

1. F. Wells, Structural Inorganic Chemistry - 5th edition (1984).
2. J. D. Lee, Concise inorganic Chemistry, Elbs with Chapman and Hall, London.
3. M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP.
4. F. A. Cotton, R. G. Wilkinson. Advanced Inorganic chemistry.
5. William L. Jooly, Modern Inorganic Chemistry.
6. Advanced Inorganic Chemistry, Bahl and Tuli, S. Chand and Company
7. Inorganic Chemistry 3rd edn. D. F. Shriver and P. W. Atkins, Oxford University Press, 1999, Chapter 16.
8. Organotransition Metal Chemistry, Anthony F. Hill, Royal Society of Chemistry, Tutorial Chemistry Text, 2002. Chapters 1 to 7.
9. Organometallics: A concise Introduction, Ch. Elshebroicn and A. Salzer, VCH, Chapters 12 to 16.
10. Organotransition Metal Chemistry: Applications to Organic Synthesis, S. G. Davies, Pergamon 1982.
11. Bioinorganic Chemistry: A Short Course -Rosette M. Roat-Malone, Wiley Inter science,2002.

12. Biological Inorganic Chemistry -An Introduction, Robert Crichton, Elsevier Science, 2007.
13. The Biological Chemistry of the Elements- The Inorganic Chemistry of Life J. J. R. Frausto da Silva and R. J. P. Williams Clarendon Press, Oxford,1991.
14. Bioinorganic Chemistry, Dr. Asim. K. Das, Books Allied Lid, Kolkata.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Inorganic Chemistry
M.Sc. Inorganic Chemistry, Semester-III
Paper-II

Course Code	[1903080203020002]	Title of the Course	**Metallurgy, Bio-fertilizer & Ionexchange Chromatography**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To understand the classification, methods of production, chemical properties and uses of different fertilizers. ● To learn the different types of magnetic bodies and its magneto chemistry ● To learn types of corrosion principles and corrosion inhibitors. ● To understand the synthesis, characterization and properties of ionexchangers.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■		■	■	■	■			■	■	■	■
CO2	■		■	■	■	■			■	■	■	■
CO3	■		■	■	■	■			■	■	■	■
CO4	■	■		■	■	■				■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**CHEMICAL AND BIOFERTILIZERS** Definition, classification, methods of production, chemical properties and uses of urea, ammonium sulphate, ammonium sulphate nitrate, ammonium chloride, single super phosphate, triplesuper phosphate, biofertilizers, types of biofertilizers, nitrogen fixing biofertilizers, phosphate-solubilizing biofertilizers, preparation of a biofertilizers.	25
2.	**MAGNETO CHEMISTRY** Introduction, definition, types of magnetic bodies, Russel- Saunders and LS coupling. Derivation of Russel-Saunders terms, spin-orbit interaction, thermal energy and magnetic property, magnetic moment for different multiple widths, multiple width large compared to KT, multiple width small compared to KT, multiple width comparable to	25

	KT, stereo chemical application of magnetic properties of the first transition series, lanthanides and actinides. Determination of magnetic susceptibility by different methods.	
3.	**CORROSION INHIBITORS** Introduction, types of corrosion principles of corrosion inhibitors, corrosion as an electrochemical process, practical aspects of corrosion inhibition, anion inhibitor properties in neutral electrolytes, some application of corrosion inhibitors (cooling water circulation-once through and open systems engine radiation and cooling systems, central heating systems, refrigeration plants and high chloride systems, water for steam raising corrosion inhibitors for paint coating.	25
4.	**ION EXCHANGE** Synthesis, characterization and properties of Ion exchangers, mechanism of ion exchange: equilibria-rate theory, Donnan equilibria, liquid ion exchangers and chelate ion-exchange resins, Separation of metal and non-metals using ion exchangers. Inorganic ion exchangers: The clay minerals, zeolites, hetero polyacid salts,hydrous oxides and insoluble salts and their applications.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	To understand the classification, methods of production, chemical properties and uses of urea, Ammonium sulphate, ammonium sulphate nitrate, ammonium chloride, single super phosphate, triple super phosphate, bio fertilizers. Learn the types of biofertilizers like nitrogen fixing and phosphate-solubilizing.
2.	To learn types of magnetic bodies, Russell-Saunders and LS coupling. Derivation of Russell-Saunders terms, spin-orbit interaction, thermal energy and magnetic property, magnetic moment for different multiple widths, multiple width large and small compared to KT, lanthanides and actinides. To understand

	the determination of magnetic susceptibility by different methods.
3.	Learn the types of corrosion principles of corrosion inhibitors, corrosion as an electrochemical process, practical aspects of corrosion inhibition, anion inhibitor properties in neutral electrolytes, some application of corrosion inhibitors.
4.	To understand the synthesis, characterization and properties of Ion exchangers, mechanism of ion exchange, equilibria-rate theory, Separation of metal and non-metals using ion exchangers. To learn the Inorganic ion exchangers and their applications.

Suggested Reference Books:

1. CE Harland 1994 Ion exchange theory and practice, second Edn, Royal society of chemistry Cambridge.
2. J. Korkisch 1989 Handbook of ion exchange resins, their application to inorganic chemistry CRC press, Boca Raton FL.
3. An introduction to metallic corrosion: U. R. Evans, Cambridge, England.
4. UHLIGS Corrosion hand book, R. Winston Revie., John Wiley & Sons JNC.
5. Vogel's text book of quantitative chemical analysis, sixth Edn. J. Mendham R CDenney, J.D. Barnes, M J K Thomas.
6. Advanced in inorganic chemistry vol. 1 & 2, Gurdeep Raj, Krishna Publication Meerut.
7. Collings G. H., Commercial Fertilizers, 5th edition, Mc Graw Hill, New York, 1955.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Inorganic Chemistry
M.Sc. Inorganic Chemistry, Semester-III
Paper-III

Course Code	[1903080203030002]	Title of the Course	**General Topics in Inorganic Chemistry**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To learn different theories to understand shape and geometry of different molecules. ● To learn about nature of nucleus and theory of radio activity. ● To learn about principles, different forms and prevention of corrosion chemistry. ● To understand basic requirement of titration and types of EDTA titration.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■		■	■	■	■			■	■	■	■
CO2	■		■	■	■	■			■	■	■	■
CO3	■	■		■	■	■	■		■	■	■	
CO4	■	■			■	■			■	■	■	

Course Content		
Unit	Description	Weightage* (%)
1.	**STEREOCHEMISTRY AND BONDINGCOMPOUND** Wave mechanical treatment of covalent bond, valence bond theory, molecular orbital theory, VSEPR theory, Walsh diagrams, shapes of molecules having regular and irregular geometry, orbital configuration of some triatomic molecules, hybridization, bent's rule and energetics of hybridization, dπ−pπ bonds, structure of some adducts.	25
2.	**NUCLEAR CHEMISTRY** The nature of the nucleus, nuclear stability, packing fraction, magic number, isotopes, isobars, isotones and isomers, natural radioactivity, theory of radioactivity disintegration, radioactive equilibrium, radioactive series, units of radioactivity, measurement of radioactivity, nuclear transmutation, artificial radioactivity, nuclear reaction, nuclear fission and fusions, traceelements, application of radioactive isotopes.	25

3.	**CORROSION CHEMISTRY** Principle of corrosion and rate expressions, different forms of corrosion, corrosion by sea water and boilers, contact and crevice corrosion, stress corrosion, cracking and related phenomena, hydrogen cracking corrosion prevention-corrosion inhibitors and passivators, cathodic and anodic protection, metallic coating, roleof paints, plastic linings, alloying for corrosion resistance.	25
4.	**VOLUMETRIC TITRIMETRY** Terminology, basic requirements of a titration reaction, standardand primary standard solution, expressing concentration of standard solution, volumetric titration co-relation, p-functions, acid-base titration, theory of acid base indicators, redox titration, complexometric titration, EDTA titration, indicators for EDTA titration, titration curves, EDTA titration methods, cautions in volumetric titrimetry, correction for unavoidable errors.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Learn the wave mechanical treatment of covalent bond, valence bond theory, molecular orbital theory, VSEPR theory, Walsh diagrams, shapes of molecules having regular and irregular geometry, orbital configuration of different molecules.
2.	Learn the nature of the nucleus, natural radioactivity, theory of radioactivity disintegration and its equilibrium, series, units, measurement and application of radioactive isotopes.
3.	Understand the principles of corrosion, different forms of corrosion, prevention-corrosion inhibitors and passivators, cathodic and anodic protection, metallic coating, role of paints, plastic linings, alloying for corrosion resistance.
4.	Gained knowledge of basic requirements of a titration reaction, standard and

	primary standard solution, expressing concentration of standard solution, volumetric titration co-relation, p-functions, acid-base titration, theory of acid base indicators, redox titration, complexometric titration, indicators for EDTA titration, cautions in volumetric titrimetric.

Suggested Reference Books:

1. Principle of Inorganic Chemistry: Puri Sharma, Kalia, Thirty Third Edn. (Vishal Publishing Co.).
2. Advanced in Inorganic Chemistry: S. K. Agrawal, Keemti Lal, Fifteenth Edn. (Pragati Edition).
3. An introduction to metallic corrosion: U. R. Evans, Cambridge, England.
4. UHLIGS Corrosion hand book, R. Winston Revie., John Wiley & Sons JNC.
5. Vogel's text book of quantitative chemical analysis, sixth Edn.
6. Advanced in Inorganic chemistry vol. 1& 2, Gurdeep Raj, Krishna Publication Meerut.
7. Selected topics in inorganic chemistry: Malik, Tuli, Madan.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Inorganic Chemistry
M.Sc. Inorganic Chemistry, Semester-III
Paper-IV

Course Code	[1903080203040002]	Title of the Course	**Co-ordination Chemistry (Special Paper)**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● Understand theoretical principle of valence bond theory, Crystal field theory. ● Learn the Advanced theory Molecular orbital theory for complexation. ● Understand the theoretical aspects of spectra of complexes. ● Learn the Crystal field diagram for d^1 and d^{10} configuration, Orgel diagram for Oh and Td complexes (d^1-d^9 states)

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■				■	■	■
CO2	■		■	■	■	■				■	■	■
CO3	■	■		■	■	■			■	■	■	
CO4	■	■		■	■	■					■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**THEORIES OF METAL LIGAND BONDING-I** **1. Valence bond theory (VBT)** Theoretical principle of VBT, Inner orbital complexes and outer orbital complexes, example of complexes of co-ordination number 2 to 6, advantage and limitation of valence bond theory. **2. Crystal field theory (CFT)** Theoretical principles of CFT, CFT to weak and strong field compounds: splitting patternin octahedral (Oh), tetrahedral (Td), square planar(D4h), trigonal bipyramidal (TBP), and square planar (SP) complexes, limitation of crystal field theory, structural effects of orbital splitting.	25
2.	**THEORIES OF METAL LIGAND BONDING –II**	25

	1. **Advanced theory:** Jahn teller effects and distortions in Oh complexes. Ligand field theory (LFT), experimental evidences in support of metal ligand overlap. Adjusted crystal field theory (ACFT), determination of ligand groupof orbitals, σ bonding and π bonding. **2. Molecular orbital theory for complex ions.** Qualitative molecular orbital energy level diagrams and their interpretation of Oh, Td and square planar complexes with examples.	
3.	**ELECTRONIC SPECTRAL PROPERTIES OF TRANSITION METAL AND METAL COMPLEXES-I** Theoretical aspects of spectra of complexes Spectroscopic terms, coupling of terms, microstates for the p, d and f configurations. Hund's rule for ground state term, derivationof Russel-Saunders terms, the correlation of spectroscopic term in Mulliken symbols, electronic transition selection rules, spin-orbit coupling. Crystal field diagram for d^1 and d^{10} configuration. Orgeldiagram for Oh and Td complexes (d^1-d^9 states).	25
4.	**ELECTRONIC SPECTRAL PROPERTIES OF TRANSITION METAL AND METAL COMPLEXES-II** Tanabe Sugano energy level diagram for Oh and Td complexes (d^1-d^9 states). Charge transfer spectra and interligand spectra, factors affecting charge spectra, calculation of Dq, B' and β, parameters for Co (II) and Ni (II) complexes using electronic spectral data under different geometries. Spectrochemical series and Nephelauxatic series, intensity of spectral peak: oscillator strength and band width.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Learn the theoretical principle of VBT Inner orbital complexes and outer orbital complexes, example of complexes of co-ordination number 2 to 6, advantages and its limitations.
2.	Learn advanced theories like Jahn teller effects and distortions in Oh complexes, Ligand field theory (LFT), Adjusted crystal field theory (ACFT), Qualitative molecular orbital energy level diagrams and their interpretation of Oh, Td and SP.
3.	Understand Spectroscopic terms, coupling of terms, microstates for the p, d and f configurations, Hund's rule for ground state term, electronic transition selection rules, spin-orbit coupling. Crystal field diagram for d^1 and d^{10} configuration. Orgel diagram for Oh and Td complexes (d^1-d^9) states
4.	Understand the Tanabe Sugano energy level diagram for Oh and Td complexes (d^1-d^9 states). Charge transfer spectra and inter ligand spectra, factors affecting charge spectra, calculation of Dq, B' and β, spectrochemical series and nephelauxatic series.

Suggested Reference Books:

1. Inorganic chemistry (principle of structure and coordination compounds) J.E Huheey, Harper and Row International series, New York (1983).
2. Advanced Inorganic chemistry F.A. Cotton and G. Wildinson, Inter science, New York (1988).
3. Theoretical Inorganic Chemistry (new edition) M.C. Day And J. Selbin East-West Press Pvt. Ltd (New Delhi) 1971.
4. A Modern Introduction Chemistry, T. Moeller John Wiley and Sons, New York.
5. Principle of inorganic chemistry, Puri, Kalia and Sharma, Vishal Publishing Co. Jalandhar.
6. Advanced inorganic chemistry, S. K Agrawal and Keemtilal, Pragati Prakashan.
7. Co-Ordination Chemistry Pimplapure, Jain, Pragati Prakashan.
8. General and Inorganic chemistry, R Sarkar, New Central Book Agency.
9. Advanced inorganic chemistry, Tuli Basu and Madan (Volume-II).
10. Inorganic electronic spectroscopy (II edition), A.B.P. Lever, Elsevier, Amsterdam.
11. Introduction to ligand field, B.N. Feggis, Inter science, New York (1966).
12. Physical Methods in Inorganic chemistry (both edition), R.S. Drago, W.B. Saunders, Philadelphia (1977).
13. Introduction to ligand field theory, C.G. Ballhenson, Mc Graw-Hill, New York (1962).
14. Electron absorption spectroscopy and related techniques, D.N. Sathyanarayana Compound, Indrajeet Kumar, Pragati Prakashan.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

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

Course Code	[1903080203050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	12 hrs.

Course Objectives:	● To impart basic knowledge of constituents of Ores, alloys, samples. ● Understand the opening of alloy and ores. ● To learn the analysis of constituents in alloys and ores. ● To learn practical methods for estimation of different metals in ores, alloys gravimetrically and volumetrically ● To learn mole-ratio method and Job's method to know the composition of the complexes.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■		■	■			■	■		
CO2	■		■		■	■			■	■	■	
CO3	■		■	■	■	■					■	■
CO4	■	■	■		■	■	■		■	■	■	
CO5	■		■		■	■		■		■	■	■

Course Content	
Estimation of Ore-Alloy	4-Credit
Analysis of Sample	
Job's Method	4-Credit
Viva-Voce	

1. Analysis of Brass alloy.
2. Analysis of Ultramarine sample.
3. Analysis of Hydrogen peroxide (H2O2).
4. Analysis of Dolomite Ore.
5. Analysis of fertilizer sample.
6. Analysis of Stainless Steel.
7. Analysis of German Silver.
8. Analysis of Portland Cement.
9. Analysis of Available lime.
10. Analysis of PO_4^{-3} for K_2HPO_4 spectrophotometrically.
11. Determine the λ_{max} for Cu-en complex [(1:1), (1:2), (1:3)] complex.

12. Determine the composition of Cu-en complex by Job's method. 13. Determine the λ_{max} for Ni-en complex [(1:1), (1:2), (1:3)] complex. 14. Determine the composition of Ni-en complex by Job's method.

Teaching-Learning Methodology	Introduction, interaction with student for analysis of Ore/Alloy,Sample and estimation of metal-ligand by Mole-ratio method andperforming the experiment according to the respective method.

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the basics of opening of ores and alloys.
2.	Learn the percentage of constituents in different samples, alloys and ore by different methods.
3.	Learnt to perform experiments using different references.
4.	Learn to perform practical by qualitative methods.
5.	Learn Mole-ratio of metals and ligands.
6.	Understand the calculation using different references.
7.	Appreciate good laboratory practices.

Suggested References:

1. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Ren Aggarwal
2. Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST.
3. Quantitative analysis by Arther I. Vogel.
4. Quantitative analysis by V.K. Ahluwalia.
5. Quantitative analysis by Mann and sanders

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Inorganic Chemistry
M.Sc. Inorganic Chemistry, Semester-IV
Paper-I

Course Code	[2003080204010002]	Title of the Course	**Selected Topics in InorganicChemistry**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● Photochemistry laws and photo physical processes. ● Types, sources and control of various types of pollution and their effect on the environment and ecosystem and methods for the control of such pollutions. ● Types of homogeneous catalysis and their action in the reaction mechanism. ● Transition metal hydrides, dihydrogen complexes and various steps for the procedure of the homogeneous catalysis.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■		■	■	■	■			■	■	■	■
CO2	■	■		■	■	■	■			■	■	■
CO3	■	■		■	■	■	■	■			■	■
CO4	■	■		■	■	■	■	■			■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**PHOTOCHEMISTRY OF INORGANIC COMPOUNDS AND CO-ORDINATION COMPOUNDS** **Introduction**: Photochemistry laws and photochemical kinetics, Absorption of light, quantum yield and reactivity, life time, kinetic aspects of photochemical process, temperature dependence of photochemical process and photochemical equipment. **Photo physical process:** Introduction, theory and relative process stimulated absorption, spontaneous emission, selection rules, oscillator strength and radiative life time, Frank Condon principle, theory of non-radiative processes, radiation-less transitions and biomolecular.	25
2.	**ENVIRONMENTAL CHEMISTRY** Various types of pollution: Introduction, definition andclassification	25

	Air Pollution: Sources and sinks of gases pollutants on living and non-living things, Green House Effect, Acid rain, Ozone layer Depletion and their consequences on environment. Effect of air pollution, photochemical smog and major air pollution. **Method of control of air pollution**: Different methods of control air pollution, precipitation wet and dry scrubber, filters, gravity and cyclonic separation, adsorption, absorption and condensation of gaseous effluent. **Water pollution:** types, sources and classification of water pollution, constituent and oxygen control of water and aquatic life, oxygen electrode and its use. Effect of water pollutants on life and environment. **Method of control of water pollution:** principle of coagulation, flocculation, softening, disinfection, demineralization, and fluoridation. Objective analysis: color, turbidity, total solids, conductivity, acidity, alkalinity, hardness, chlorine, sulphate, fluoride, silica, phosphate and different form. DO, BOD, COD and significance.	
3.	**HOMOGENEOUS CATALYSIS** Introduction, types of catalysts, Catalytic steps, Hydrogenation of alkene, Ziegler-Natta polymerization of olefins, Hydro-carbonylation of olefins, The Wacker process, Monsanto Acetic Acid Synthesis, Water-gas Shift Reaction, Hydrosilation, Activation of C-H bond.	25
4.	**TRANSITION METAL COMPOUNDS WITH BOND TO HYDROGEN AND REACTIONS OF HOMOGENEOUS CATALYSIS** Transition metal compounds with Bond to Hydrogen: Introduction, characterization of transition metal hydride complexes, methods of preparation, properties, Mononuclear poly-hydrides, Homoleptic poly-hydrido anions, Metal carbonyl hydrides, Dihydrogen complexes. **Reaction of homogeneous catalysis:** Oxidative-Addition Reaction: Energetics and Mechanism, Reductive-Elimination Reaction, Insertion Reaction.	25

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per	30%

	CBCS R.6.8.3)	
2.	University Examination	70%

Course Outcome: Having Completed this course, the learner will be able to	
1.	Learn about Photochemistry laws and photochemical kinetics, photochemical process and photochemical equipment, Photo physical process theory and relative process stimulated absorption, spontaneous emission, selection rules, theory of non-radiative processes, radiation-less transitions and bimolecular
2.	Learnt and understand about various types of water pollution, sources, sinks and methods of control.
3.	Understand the types of catalysts, different methods of homogeneous catalysis, Hydrogenation of alkene, Ziegler-Natta polymerization of olefins, Hydro-carbonylation of olefins, The Wacker process, Monsanto Acetic Acid Synthesis, Water-gas Shift Reaction, Hydrosilation, Activation of C-H bond.
4.	Learn the characterization of transition metal hydride complexes, methods of preparation, properties, Mononuclear poly-hydrides, Homoleptic poly-hydrido anions, Metal carbonyl hydrides, Dihydrogen complexes.

Suggested Reference Books:

1. Fundamentals of photochemistry, K. K. Rohatgi, Mukherjee. Wiley Eastern Limited, New Delhi, (1978).
2. Photochemistry, J. G. Calvents and J. N. Pitts. John-Wiley & Sons.
3. Introduction to photochemistry. Wells.
4. Photochemistry of solutions. C. A. Parker, Elsevier.
5. Photochemistry of coordination compounds, V. Balzani and V. Carassitti, Academic Press, London (1970).
6. Concept of Inorganic photochemistry, A. W. Adamson and Paur D. Fleischauer, A Wiley Interscience Publication, New Delhi, 1975.
7. Water pollution. J. E. Jajic, Marcel-Dekker,
8. Air pollution. H. W. Parker, Prentice-Hall
9. Environmental chemistry. A. K. De, Wiley Eastern Ltd, New Delhi.
10. Environmental pollution control in process industries. S. P. Mahajan.
11. Introduction to air pollution. P. K. Trivedi.
12. Environmental pollution Analysis, S. M. Khopkar.
13. A text book of Environmental pollution. D.D. Tyagi and M. Mehre.
14. Environmental pollution Engineering and control. C. S. Rao.
15. Environmental Chemistry, B. K. Sharma, Goel Publishing house.
16. Environmental Chemistry, S.C Bhatia, CBS Publisher and Distributer.
17. Elements of Magnetochemistry, R.L. Datta& A. Syamal, Affiliated East- West Press Pvt. Ltd., New Delhi (1993).

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Inorganic Chemistry
M.Sc. Inorganic Chemistry, Semester-IV
Paper-II

Course Code	[2003080204020002]	Title of the Course	**Chemistry of Complexes**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To understand and familiarize the development of supra molecular chemistry, Host-guest compounds and its concepts and design. ● To understand isomerism among Inorganic compounds. ● To understand the various solids, closed packing, its lattice energy and its calculation. ● Learn different cells, oxidation-reduction reaction and its related diagram.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■			■	■	■	■
CO2	■	■		■	■	■			■	■	■	■
CO3	■	■	■	■	■	■					■	■
CO4	■	■		■	■	■			■	■		■

Course Content		
Unit	Description	Weightage* (%)
1.	**ISOMERISM AMONG INORGANIC COMPLEXES** Structural isomerism, stereoisomerism or space isomerism,geometrical isomerism in 4 - and 6 - coordinates compound, distinguish between cis and trans-isomers, optical or mirror image isomerism. Condition for a molecule to show optical isomerism. Optical isomerism in 4 - and 6 - coordinates compounds. Resolution of racemic mixtures.	25
2.	**BASICS OF SUPRAMOLECULAR CHEMISTRY** Definition and development of Supramolecular chemistry, classification of Supramolecular Host-Guest compounds, Receptors, coordination and lock and key analogy, binding constant, cooperativity and the chelate effect, preorganization and complementarity, Thermodynamic and kinetic selectivity and discrimination, nature of	25

	supramolecular interactions, solvation and hydrophobic effects, supramolecular concepts and design.	
3.	**CHEMISTRY OF SOLID STATE** Crystalline and amorphous solids, size and shape of crystals, symmetry in crystals, space lattice and unit cell, Bravais lattices, Miller indices, types of crystals, close packing of identical solid spheres, interstitial sites in close packing of spheres, limiting radius ratio, radius ratio rule and the shape of an ionic crystal, structure of metallic crystals and ionic crystals, lattice energy of an ionic crystal and calculation, Born equation and its application, experimental determination of lattice energy, defect structures of crystals, semiconductors, fabrication of transistors.	25
4.	**OXIDATION AND REDUCTION** Oxidation number, Galvanic cell, single electrode potential, sign of electrode potential, standard electrode potentials, electrochemical series, Nernst equation, application of electrochemical series, source of electrical energy in a galvanic cell, hydrogen over voltage, oxygen over voltage, redox stability in water, oxidation by atmospheric Oxygen, Latimer diagram, Frost diagram, pourbaix diagram.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Learn about development of Supramolecular chemistry, classification of Supramolecular Host-Guest compounds, Receptors, coordination and lock and key analogy, nature of supramolecular interactions, solvation and hydrophobic effects, supramolecular concepts and design.
2.	Understand regarding the structural isomerism, stereoisomerism geometrical isomerism in 4 - and 6 - coordinates compound, cis and trans- isomers, mirror imageisomerism, Optical isomerism in 4 - and 6 - coordinates compounds. Resolution of racemic mixtures.

3.	Learn about the crystalline and amorphous solids, types of crystals, close packing of identical solid spheres, interstitial sites in close packing of spheres, limiting radius ratio, radius ratio rule and the shape of an ionic crystal, structure of metallic crystals and ionic crystals, lattice energy of an ionic crystal and calculation, Born equation, experimental determination of lattice energy, defect structures of crystals.
4.	Knowledge of Oxidation number, Galvanic cell, single electrode potential, sign of electrode potential, standard electrode potentials, electrochemical series, Nernst equation, application of electrochemical series, galvanic cell, hydrogen over voltage, oxygen over voltage, redox stability in water, oxidation by atmospheric Oxygen, Latimer diagram, Frost diagram, pourbaix diagram.

Suggested Reference Books:

1. Supramolecular chemistry by Jonathan W. steed, Jerry L. Atwood, John Wiley &sons Ltd.
2. F. Wells, Structural Inorganic chemistry, 3rd Edn, oxford Fair Lawn, N. J. 1962.
3. Principles of inorganic chemistry: Puri, Sharma, Kalia, Thirty third Edn. (Vishal publishing co.).
4. Advanced in inorganic chemistry: S. K. Agrawal, Keemti Lal, Fifteenth Edn. (Pragati Edition).
5. Vogel's text book of quantitative inorganic analysis, ELBS III Edn. 1987.
6. Advanced in inorganic chemistry vol. 1 & 2, Gurdeep Raj, Krishna PublicationMeerut.
7. Selected topics in inorganic chemistry: Malik, Tuli, Madan.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Inorganic Chemistry
M.Sc. Inorganic Chemistry, Semester-IV
Paper-III

Course Code	[2003080204030002]	Title of the Course	**Spectroscopy & Agricultural Pollutants**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● General aspects and classification, structural features of somecommon insecticides. ● Learn the Principle and presentation of the ESR spectrum, Hyperfine splitting, Anisotropy and interpretation of g values. ● Principle, working and application of FT-NMR, its applications.chemistry of lanthanides and actinides. ● Basic principle, Spectral parameters and spectrum Display. Interpretation of Isomer shift. Application of Mossbauer spectroscopy.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■	■		■	■	■	
CO2	■		■	■	■	■			■		■	■
CO3	■	■		■	■	■			■		■	■
CO4	■	■	■	■	■	■			■	■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**POLLUTION FROM AGRICULTURE PESTICIDES AND FERTILIZERS** Pesticides: general aspects and classification, structural features of some common insecticides, mode of action-general aspects, fate of insecticides in environment and environment hazards, characteristics features of some commonly used insecticides, some important fungicides herbicides and their characteristics features, major disasters with the pesticides and herbicides, alternative to chemical pesticides, fertilizers and environmental hazards from the fertilizers, eutrophication.	25
2.	**ELECTRON SPIN RESONANCE**	25

	Principle and presentation of the spectrum. Hyperfine splitting. Anisotropy and interpretation of g values. Hyperfine coupling andzero field splitting. Survey of EPR spectra of first row transition metal ion complexes. Double Resonance and Fourier transform EPR techniques.	
3.	**A. NMR SPECTROSCOPY** Principle and application of FT-NMR, Chemical shift, contactshift and pseudo contact shift lanthanide complexes as shift reagents. Double resonance technique, Proton, Boron, Carbon, Nitrogen, Phosphorous NMR of inorganic compounds. **B. CHEMISTRY OF LANTHANIDES AND ACTINIDES** Separations, spectral and magnetic properties, organometallic chemistry of lanthanides and actinides, trans-uranium elements.	25
4.	**MOSSBAUER SPECTROSCOPY** Basic principle, Spectral parameters and spectrum Display. Interpretation of Isomer shift. Application of technique to the studies of bonding and structure of Fe^{+2} and Fe^{+3} compounds, Sn^{+2} and Sn^{+4} compounds and detection of oxidation states. FABand electron spray, mass spectrometry of metal complexes.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Learn about general aspects and classification of pesticides, structural features of some common insecticides, mode of action-general aspects, fate of insecticides in environment and environment hazards, characteristics, fungicides herbicides, major disasters with the pesticides and herbicides, alternative to chemical pesticides, fertilizers and environmental hazards from the fertilizers, eutrophication.
2.	Understand the principle and presentation of the spectrum of ESR, Hyperfine splitting, Anisotropy and interpretation of g values, hyperfine coupling and zero field splitting,Double Resonance and Fourier transform EPR techniques.

3.	Learn the principle and application of FT-NMR, Chemical shift, contact shift and pseudo contact shift lanthanide complexes as shift reagents. Double resonance technique, Proton, Boron, Carbon, Nitrogen, Phosphorous NMR of inorganic compounds.
4.	To learn the basic principle, Spectral parameters and spectrum Display. Interpretation of Isomer shift. Application of technique to the studies of bonding and structure of Fe^{+2} and Fe^{+3} compounds, Sn^{+2} and Sn^{+4} compounds and detection of oxidation states. FAB and electron spray, mass spectrometry of metal complexes.

Suggested References Books:

1. Structural methods in inorganic chemistry. E. A. V. Ebsworth, D. W. H. Rankin and S. Cardock.
2. Spectroscopic identification of organic compounds -R. M. Silverstein, G. C. Bassler and Morril.
3. Physical methods in Inorganic chemistry- R. S. Drago.
4. Application of absorption spectroscopy of organic compounds- J. Dyers.
5. Electron Spin Resonance-Elementary theory and Practical Applications- Wertz and Olton.
6. Principles of inorganic chemistry: Puri, Sharma, Kalia, Thirty third Edn. (Vishal publishing co.)
7. Advanced in inorganic chemistry: S. K. Agrawal, Keemti Lal, Fifteenth Edn. (PragatiEdition).
8. Advanced in inorganic chemistry vol. 1 & 2, Gurdeep Raj, Krishna Publication Meerut.
9. Environmental chemistry with green chemistry: Asim K. Das, Books and allied (p) ltd.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Inorganic Chemistry
M.Sc. Inorganic Chemistry, Semester-IV
Paper-IV

Course Code	[2003080204040002]	Title of the Course	**Co-ordination Chemistry (Special Paper)**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• Reactivity of metal complexes, ligand replacement reaction, classification of various mechanisms. • Spectrophotometric methods, Potentiometric method and polarographic methods for the determination of complexes. • Anomalous magnetic behavior of complexes in the presence of different magnetisms. • Importance of Biocatalyst and photocatalyst as a Green Chemistry. Stereochemistry of unusual co-ordination complexes.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■		■	■	■		■
CO2	■	■		■	■	■			■	■	■	
CO3	■	■		■	■	■				■	■	■
CO4	■	■	■	■	■	■	■		■	■		

Course Content		
Unit	Description	Weightage* (%)
1.	**KINETICS AND REACTION MECHANISM OFTRANSITION METAL COMPLEXES** Reactivity of metal complexes, ligand replacement reaction, classification of mechanism. **KINETICS OF OCTAHEDRAL SUBSTITUTIONREACTION:** Complementary reaction, Noncomplementary reaction, Anation reaction, reactions without metal-ligand bond cleavage. **STEREOCHEMICAL CHANGES IN OCTAHEDRAL COMPLEXES:** Molecular rearrangement in complexes, reaction of geometrical and optical isomers. Isomerization and racemization of octahedral	25

	complexes, Ligand stereo specificity. **REDOX REACTION:** Electron transfer reactions, mechanism of one electron transfer reactions, outer sphere electron transfer reactions, tunneling effect, cross reaction, Marker-Hush theory, inner sphere electron transfer reactions, bridged activated mechanism, experimental Techniques.	
2.	**METAL-LIGAND COMPLEX EQUILIBRIA INSOLUTION** Stability of complex ions in solution, Basic principles, mathematical function and interrelationship. **DETERMINATION OF STABILITY CONSTANTS OF BINARY COMPLEX BY EXPERIMENTAL METHODS:** Spectrophotometric methods, Potentiometric method (pH-metric titration technique. i.e., Irving-Rossotti methods), Polarographic method. Factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand. Statistical, electronic, chelate effect and its thermodynamics (ΔG, ΔH and ΔS).	25
3.	**MAGNETIC PROPERTIES OF TRANSITION METAL COMPLEXES** **Anomalous magnetic behavior:** Solute-Solvent interaction, Solute-Solute interaction, configurational equilibrium, Equilibrium between two spin states,magnetically non-equivalent sites in the unit -cell, Quenching of Orbital moments, Spin cross-over, Magnetic exchange coupling,stereochemical applications of magnetic properties.	25
4.	**SELECTED TOPIC IN INORGANIC CHEMISTRY** Stereochemistry of unusual co-ordination number 2 to 9. Metal sequestration and its industrial applications. Catalysis and Green Chemistry: Biocatalysts - Enzyme, Synthesis, Advantages and Disadvantages, Uses. **Photocatalysts:** Synthesis, Photochemical Reactions,Advantages and Challenges.	25

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per	30%

	CBCS R.6.8.3)	
2.	University Examination	70%

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand kinetics of octahedral substitution reaction, stereochemical changes inoctahedral complexes, redox reaction.
2.	Learn the metal-ligand complex equilibria in solution**,** Stability of complex ions in solution, Basic principles, mathematical function and interrelationship, determination of stability constants of binary complex by experimental methods, Spectrophotometric methods, Potentiometric methods.
3.	Understand the Solute-Solvent interaction, Solute-Solute interaction, configurational equilibrium, Magnetic exchange coupling, stereochemical applications of magnetic properties.
4.	Understand the Stereochemistry of unusual co-ordination number 2 to 9, Metal sequestration and its industrial applications, Catalysis and Green Chemistry.

Suggested Reference Books:

1. Inorganic reaction mechanism, Basello and Pearson, Wiley EasternLtd. New Delhi-1977.
2. Kinetic and Mechanism of Inorganic reactions: A study of metal complexes in solution, A. A. Frost and R. G. Pearson, Wiley, NewYork-(1953, 1961).
3. Inorganic reaction mechanism, S.k. Skyes.
4. Electron Transfer reaction of metal complex ions in solution, H.Taube, Academic press, London-1970.
5. Modern Inorganic Chemistry, J. Lewis and R. G. Wilkinson,Inter science, New York.
6. Inorganic Reaction Mechanism, M. L. Obe, Nelson, London-1972.
7. Mechanism of Inorganic Reactions in solutions: An Introduction, D. Benson, Mc Grow Hill, Chapter-15, P-455, 1968.
8. "Comprehensive coordination Chemistry" G. Wilkinson, R. D. Gillard and J. A. Mccleverty Pergamon, London, Vol-1. P-281-322, 331- 374,385-411, 415- 458 (Chapter-7-4) and P-463-471-1987.
9. Coordination Chemistry, Rajbir Singh, Mittal Publication, New Delhi.
10. Instability constants of complex compounds, K.B. Yatsimirskil and V.P.A. Vasilis (Translated from Russian), D. Van Mostrand Co. Inc.Princeton, New Jersey.
11. Chemistry of complex Equilibria, M.T. Beck (Hungary), translated by R.A., van Nostrand Co., London, 1970.
12. Irving H. and Rossotti H. S. J. Chem. Soc, 3397, 1953.
13. Elements of Magnetochemistry, R.L. Datta & A. Syamal, AffiliatedEast- West press Ltd., New Delhi (1993).
14. Magnetochemistry, R. L. Karlin, Springer-Verlag, New York (1993).
15. Introduction to Magnetochemistry, A. Earnashaw, Academic Press,New York (1968).
16. Magnetism and Transition metal Complexes, F. E. Mabbs & D. J.Machin, Chapman and Hall, London (1973).
17. Stereo chemistry and bonding in Inorganic chemistry, J. E.Fergusion. Prentice Hall, Inc. Eryleword Cliffs, N. J. 1974.

18. Inorganic chemistry (Principles of structure and coordination compounds).
19. J. E. Huhee Harper and Row Intermediated series, N.Y. 1963.
20. Organic sequestering agents, Chaberck S. and Martell, John Wileyand Sons, Inc, New York (1959).
21. Green Chemistry, K. R. Desai, Tarulata Chhowala, Bhavanaben Mistry, Himalaya Publication, Mumbai.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Inorganic Chemistry
M.Sc. Inorganic Chemistry, Practical
Semester-IV

Course Code	[2003080204050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	12 hrs.

Course Objectives:	● To impart basic knowledge of complexes. ● Understand and synthesize different inorganic complexes and estimate the percentage of the metal present in them. ● Learn and perform practical for analysis of water. ● To understand and perform the Irving-Rossotti method for the determination of the stability constant of the complex.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1												
CO2												
CO3												
CO4												

Course Content	
Water Analysis	4-Credit
Preparation of Inorganiccomplexes	
Irving-Rossotti Method	4-Credit
Viva-Voce	

1. Preparation and Estimation of chloro-pentaammine Cobalt-II chloride[$CoCl(NH_3)_5$] Cl_2.
2. Preparation and Estimation of Reineck's salt [Ammonium tetrathiocyanato diammine chromate] [$NH_4(NH_3)_2Cr(CNS)_4$].
3. Preparation and Estimation of Bis[Ethylene diammine]coppersulphate.
4. Preparation and Estimation of potassium trioxalato ferrate[$K_3(Fe(C_2O_4)_3.3H_2O$].
5. Preparation and Estimation of Potassium trioxalato aluminate$K_3[Al(C_2O_4).3H_2O$.
6. Preparation and Estimation of Cu[Resacetophenone]$_2$ [$Cu(C_8H_7O_3)_2$].
7. Preparation and Estimation of Cu[Salicylaldehyde]$_2$ [$Cu(C_7H_5O_2)_2$].
8. Preparation and Estimation of Cu[Salicylaldehyde]$_2$ Schiff base[$Cu(C_7H_6ON)_2$].
9. Preparation and Estimation of Ni[Salicylaldehyde]$_2$ [$Ni(C_7H_5O_2)_2$].
10. Preparation and Estimation of Ni[Salicylaldehyde]$_2$ Schiff base[$Ni(C_7H_6ON)_2$].
11. Preparation and Estimation of Potash alum [$K_2SO_4.Al_2(SO_4)_3.24H_2O$].
12. Preparation and Estimation of Co[Salicylaldehyde]$_2$ [$Co(C_7H_5O2)_2$].
13. Preparation and Estimation of Co[Salicylaldehyde]$_2$ Schiff base[$Co(C_7H_6ON)_2$]
14. Analysis of water sample.

15. Determine the stability constant of Ni-glycine complex by usingIrving - Rossoti method. 16. Determine the stability constant of Co-glycine complex by usingIrving- Rossoti method. 17. Determine the stability constant of Cu-glycine complex by usingIrving- Rossoti method.

Teaching-Learning Methodology	Introduction, interaction with students in calculation of mole ratios, carry out experiments at each step according to the respective practical, interpretation of spectra and deduce the structure.

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the basics to carry out reactions, nature of reaction and calculation ofmole ratio.
2.	Establish mechanism and monitoring reaction at specified reaction condition.
3.	Learn to work-up after the complexation of metal and ligands.
4.	Learn Irving-Rossotti methods through the references.
5.	Perform practicals at different pH and draw their respective graphs.
6.	Understand the calculation with reference to respective factors.
7.	Appreciate good laboratory practices.

Suggested Reference Books:

1. Vogel's Textbook of practical organic chemistry, 5th edition, B. S. Furniss, A. J., P. W. G.Smith, A. R. Tatchell (Pearson Education).
2. Comprehensive practical organic chemistry: Preparation and Quantitative analysis, V. K.Ahluwalia, Renu Agarwal (Universities Press).
3. Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST.
4. L. D. Field, S. Sternhell, J. R. Kalman - Organic Structures from Spectra-Wiley (2013)
5. Inorganic Vogel by Mendhan.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

M.Sc. Semester-III (ORGANIC CHEMISTRY)

Sr. No.	Course Title	L	T/C/S	Credit
1	Natural Products and Bio-molecules	4		4
2	Selected Topics in Organic Chemistry-I	4		4
3	Organic Chemistry in Industry	4		4
4	Medicinal Chemistry-I OR Dye and Intermediates-I	4		4
5	Practical	12	4	8
		28	4	24

External Examination Time Duration: 03 hrs.

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	III	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Core	04	30	70	100
			Practical	08	60	140	200
			Total	24	180	420	600

M.Sc. Semester-IV (ORGANIC CHEMISTRY)

Sr. No.	Course Title	L	T/C/S	Credit
1	Advance Organic Chemistry	4		4
2	Selected Topics in Organic Chemistry-II	4		4
3	Advance Organic Synthesis	4		4
4	Medicinal Chemistry-II OR Dye and Intermediates-II	4		4
5	Practical	12	4	8
		28	4	24

External Examination Time Duration: 03 hrs.

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	IV	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Core	04	30	70	100
			Practical	08	60	140	200
			Total	24	180	420	600

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Semester-III
Paper-I

Course Code	[1903080203010003]	Title of the Course	**Natural Products and Biomolecules**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand the concept of biomolecules and natural products, structural elucidation of natural pigment and alkaloids of different class, their interrelation to each other, synthesis of intermediates and their confirmation through synthetic pathways. • To learn steroids and their respected sex hormones, structural elucidation of steroid molecules, biosynthetic pathways, synthesis of intermediates, steroid based sex hormones and their interrelationto each other, physiological importance and their synthesis. • To understand biochemical function of vitamins, classification and structural elucidation of vitamins & terpenoids through analytical and synthetic evidences. • To learn about nucleic acid and enzymes. Structural elucidation of DNA, RNA and their role in biochemical function, classificationof enzymes & their catalytic activities
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■		■	■	■		■	■	■	■
CO2	■	■	■	■	■	■	■		■	■	■	■
CO3	■		■	■	■	■			■	■		■
CO4	■	■			■	■				■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**NATURAL PIGMENTS and ALKALOIDS** **(A) Natural Pigments and Porphyrins** **Derivatives** Porphyrins: General structures, Synthesis and Spectral properties. Synthesis of cryptopyrrole, Phytopyrrole,	25

	Opsopyrrole and Haemopyrrole and their carboxylic acid derivatives. Structural elucidation of Haemoglobin and Chlorophyll (Analytical evidences only) **(B) Alkaloids** Classification of alkaloids; Structural elucidation of Morphine, Reserpine and Colchicine (Analytical evidencesonly)	
2.	**STEROIDS and SEX HORMONES** **(A) Steroids** Introduction to Sterols: Structure determination ofcholesterol and ergosterol (no synthesis), Bile acids: Introduction, Structural elucidation and Synthesis of Cholanic acids (α and β both). **(B) Sex Hormones** Classification of hormones: Structure and synthesis of Androgens, Oestrogens and Gestrogens. Name and structures of Adrenocortical hormones, Partial synthesis ofcortisone.	25
3.	**VITAMINS and TERPENOIDS** **(A) Vitamins** Structure determination, Synthesis and biochemical functions of Vitamin A, Vitamins B_1 and B_2, Vitamin H **(B) Terpenoids** Classification, nomenclature and isolation Structure determination and synthesis of Farnesol, Zingiberene, Cadinene, Gibrelic acid and Abietic acid.	25
4.	**NUCLEIC ACIDS & ENZYMES** **(A) Nucleic Acids** Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding, Chemical and enzymatic hydrolysis of nucleic acids, Structure of nucleosides and nucleotides, DNA, RNA (Basics structures only), DNA replication, Transcription, Translation, Protein Biosynthesis. **(B) Enzymes** Classification, nomenclature and inhibition, factors affecting catalytic activity and specificity in action, regulation of enzyme activity	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the nature of natural pigments & alkaloids, spectral properties of porphyrins, generation of various pyrrole and their carboxylic acid derivatives and their synthesis, structural elucidation of pigments and alkaloids, their analytical evidences for the confirmation of structure including intermediates.
2.	To learn basic skeleton of steroids, structural elucidation of cholesterol, ergosterol,bile acids, male, female sex hormones, their interrelation of each other, corticoids and their physiological activities.
3.	To learn biochemical function of vitamins, classification & structural elucidation, through analytical and synthetic evidences of vitamins and terpenoids, confirmation of intermediates through respective synthetic pathway, their respective oxidation, reduction, hydrolysis etc. and rearrangement reactions.
4.	To understand nucleic acids, respective purine and pyridine bases, their interrelation to each other, structural elucidation of DNA & RNA, their classification & nomenclature of enzymes, their next generation, protein synthesis, catalytic activities through various parameters.

Suggested Reference Books:

1. Organic Chemistry, Vol. I & II (Sixth edition), I. L. Finar.
2. S.W. Pelletier, Chemistry of the Alkaloids, Van Nostrand Reinhold Co., New York (1970).
3. K.W. Bentley, The Alkaloids, Vol. I., Interscience Publishers, New York (1957).
4. Chemistry of Organic Natural Products, Vol. I & II, O. P. Agrawal.
5. Organic Chemistry of Natural Products, Vol. I & II, Chatwal.
6. Organic Chemistry (5/e) by Morrison & Boyd.
7. Chemistry of Vitamins – S. F. Dyke.
8. Natural Products Chemistry, Vol. I & II, K. Nakanishi.
9. The Molecules of Nature, J. B. Hendrickson.
10. Selected Organic Synthesis: Ian Fleming.
11. Chemistry of Natural Products, N. R. Krishnaswamy.
12. The Chemistry of Natural Products, K. W. Bentley. Vol. I – V.
13. J.W. Apsimon, Total Synthesis of Natural Products, Vol. 1-6, Wiley-Interscience Publications, New York (Vol. 1, 1973).
14. Principles of biochemistry –Donald J.Voet, Judish G.Voet, charlotte w. pratt (John

willey and sons).
15. Lehninger principles of biochemistry- David L.Nelson and Michael M.wx (Palgrave Macmillan / W.H. freeman company new York).
16. Biochemistry – U. Satyanarayana Baro and allied P. Ltd., Kolkata.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Semester-III
Paper-II

Course Code	[1903080203020003]	Title of the Course	**Selected Topics in Organic Chemistry-I**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To understand the familiarize with the basic properties, theory & interpretation of ^{1}H NMR, ^{13}C NMR and 2D NMR spectrometry, to impart knowledge in the theory & principles of spectroscopic techniques for characterization & differentiation of various molecules. ● To learn about various pollution-water & air and effluent treatment. Contamination of water through heavy minerals, halogens, pathogens, air pollution, detection of various components and hydrocarbons, effluent treatment of sugar, peeper & pulp and distilleries. ● To learn monocyclic, fused and bridged heterocyclic compounds, their nomenclature, synthesis, aromatic character, reactivity and application in the preparation of building blocks, fine chemicals and dye industry. ● To understand the role of chemical reagents in oxidation, reduction, cyclisation and transformation of various organic functional groups, their synthesis and industrial application.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■				■	■	■
CO2	■	■	■		■	■	■		■	■	■	
CO3	■	■			■	■			■	■	■	■
CO4	■	■	■	■	■	■		■		■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**NMR SPECTROSCOPY** Theory and principles of NMR spectroscopy, Theory of Fourier Transform **(i) ^{1}H NMR Spectroscopy**	25

	Proton resonance condition, Aspects of PMR spectra – number of signals, chemical shift, factors influencing chemical shift, deshielding, chemical shift values and correlation for protons bonded to carbons (aliphatic, olefinic, aldehydic, aromatic) and other nuclei (alcohols, phenols, enols, acids, amides and mercaptans), effect of deuteration, spin- spin coupling, (n+1) rule, factors effecting coupling constant "J" **(ii) ^{13}C NMR spectroscopy** Types of 13C NMR Spectra: proton coupled and decoupled 13C spectra, chemical shift, calculations of chemical shifts of aliphatic, olefinic, alkyne, aromatic, hetero aromatic and carbonyl carbons, factors affecting chemical shifts **(iii)2D NMR Techniques** Preliminary idea of 2D NMR,	
2.	**ENVIRONMENTAL CHEMISTRY** **(i) Water Pollution:** Basic Concepts of Eutrophication, Water Quality, Water contaminants, Heavy minerals, Organic contaminants, PCBs and other Halogen's materials, PAH, Pesticides, Waterborne Pathogens, Aquatic toxicology, Water Purification Methods, Sewage treatment. **(ii) Air Pollution:** Air pollution sources and emissions- Particulates, Aerosols, Photochemical smog, Determination of SO_x, NO_x, CO_x and hydrocarbons, Air pollution control technologies of particulate and gaseous pollutants **(iii)Effluent treatment:** Industrial pollution of sugar, distillery,drug, pulp & paper and their analysis. Effluent treatment plants ofabove industries.	25
3.	**HETEROCYCLIC CHEMISTRY-I** **(i) Nomenclature of Heterocycles:** Hantzsch-Widman nomenclature systems for monocyclic and fused heterocycles and bridged heterocycles **(ii) Five and six membered heterocycles with two hetero atoms:** Synthesis, reactivity, aromatic character and importance of following heterocyclic rings: Oxazole, Thiazole, Pyrazole, Imidazole, Pyridazine, Pyrimidine, Pyrazine **(iii)Condensed five membered heterocycles:** Synthesis, reactivity, aromatic character and importance of following heterocyclic Rings: Benzoxazole, Benzthiazole, Benzopyrazole, Benzimidazole.	25

4.	**REAGENTS FOR ORGANIC SYNTHESIS** Introduction, Preparation and Industrial Applications of thefollowing, 1. N-Bromosuccinimide (NBS) 2 Grubbs 1st and 2nd generation catalyst 3. N,N-dicyclohexylcarbodiimide (DCC) 4. Lead tetra-acetate (LTA) 5. Baker's yeast 6. n- butyl lithium 7. $K_3Fe(CN)_6$ and DMSO 8. Grignard Reagent 9. Diazomethane 10. Polyphosphoric acid	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand fundamental & basic terms involved in ^{1}H NMR, ^{13}C NMR & 2D NMR spectroscopy, know effects of various factors on the spectra, interpretation from spectral data, identify structure of organic compounds by using combined spectral data, distinguish isomers and other closely related compounds by using spectral techniques.
2.	Learn water & air pollution, basic concepts of Eutrophication, water contamination with heavy materials, halogens, hydrocarbons and water purifying techniques and purification of water, sewage treatment, determination of air pollutants SO_X, NO_X, CO_X and hydrocarbons. Development of technologies to compart gaseous pollutants, effluent treatment of various paper pulp & distillation.
3.	To understand the basic concept of name reaction for the heterocyclic chemistry, aware about all heterocyclic ring systems such as mono, bi, tri and fused ring systems with all backgrounds in terms of naming of new compounds, application of heterocycles in medicinal chemistry.
4.	Understand the chemistry involved in oxidation, reduction, transformation, cyclisation etc. by employing numerous reactants to appreciate the chemo-

	selectivityof the reagents, synthesis of reagents with respective mechanism and their application in industry. Suggest the use of miscellaneous reagents in organic synthesis.

Suggested Reference Books:

1. R.M. Silverstein and F.X. Webster, Spectroscopic Identification of Organic Compounds,6th Edition (2003) John Wiley, New York.
2. D.H. Williams and I.F. Fleming, Spectroscopic Methods in Organic Chemistry, 4th Edition (1988), Tata-McGraw Hill, New Delhi.
3. P.Y Bruice, Organic Chemistry, 2nd Edition (1998) Prentice – Hall, New Delhi.
4. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer- Verlag (1986).
5. One- and two- dimensional NMR Spectroscopy – Atta-Ur-Rehman, Elsevier (1989).
6. Organic structure Analysis- Phillip Crews, Rodriguez, Jaspars, Oxford University Press (1998).
7. G.W. Vanloon, S.J. Duffer, Environmental Chemistry - A Global Perspective, Oxford University Press (2000).
8. F.W. Fifield and W.P.J. Hairens, Environmental Analytical Chemistry, 2nd Edition (2000), Black Well Science Ltd.
9. Colin Baird, Environmental Chemistry, W.H. Freeman and Company, New York (1995).
10. A.K. De, Environmental Chemistry, 4th Edition (2000), New Age International Private Ltd., New Delhi.
11. Peter O. Warner, Analysis of Air Pollutants, 1st Edition (1996), John Wiley, New York.
12. S.M. Khopkar, Environmental Pollution Analysis, 1st Edition (1993), Wiley Eastern Ltd.,New Delhi.
13. S.K. Banerji, Environmental Chemistry, 1st Edition (1993), Prentice-Hall of India, New Delhi.
14. An introduction to the chemistry of heterocyclic compounds-R M Acheso.
15. Heterocyclic Chemistry- J A Joule and Smith.
16. Heterocyclic Chemistry-II- R.R. Gupta, M Kumar, V Gupta, Springer (India) Pvt.
17. Heterocyclic Chemistry, 4th Edition by J. A. Joule & K. Mills, Published by Chapman &Hall (1995).
18. Principles of modern heterocyclic chemistry, edited by Leo A. Paquette, Published by Pearson Benjamin Cummings (1968).
19. Heterocyclic Chemistry, 3rd Edition by Thomas L. Gilchrist, Published by Prentice Hall (1997)..
20. The Structure & Reactions of Heterocyclic Compounds, edited by Michael Henry Palmer, Published by Edward Arnold (1967)
21. Heterocyclic chemistry by V. K. Ahluwalia, Narosa publishing house.
22. Organic synthesis using transition metals-Roderick Bates (Wiley).
23. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press).
24. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition

(2007).
25. Guidebook to organic synthesis-R K Meckie, D M Smith and R A. Atken.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Semester-III
Paper-III

Course Code	[1903080203030003]	Title of the Course	**Organic Chemistry in Industry**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To understand process chemistry and research, basic knowledge ofdrug discovery, preclinical trail of medicines. Classes of agrochemicals and their properties. ● To learn about color industry-dyes and pigments, nomenclature and color index, types of dyes, theories of dyes, properties, various types of fiber and miscellaneous applications. ● To learn about drug & medicines, nomenclature, generic and trivial name. Various theories of drug action, administration of dyes and determination of physiochemical properties. ● To understand unit processes and implementation in industry, determination of various agents in unit process and their synthetic route.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■	■	■			■	■
CO2	■	■	■	■	■	■	■				■	■
CO3	■	■		■	■	■			■	■		■
CO4	■	■	■	■	■	■		■			■	

Course Content		
Unit	Description	Weightage* (%)
1.	**ORGANIC CHEMISTRY IN INDUSTRY** Introduction, Process Chemistry versus Research Chemistry **Pharmaceutical Industry:** Drug Discovery, Drug development, Preclinical and clinical testing, Medicine, Future Problems and Opportunities **Agrochemical Industry:** Classification, Biodegradable and Persistent Pesticides, Toxicity, Chemical Classification ofPesticides-Herbicides and Insecticides	25

2.	**BASIC CONCEPTS OF DYE AND DYEINTERMEDIATES** Introduction of Dyes and Pigments, Absorption of visible lights,colour of wavelength absorbed, complementary colour. Relation between color and chemical Constitution, Witt's theory, Armstrong's theory, Nietzki's theory, Valence bond theory, Molecular orbital theory, Fastness Properties, Exhaustion and fixation properties. Natural Dyes, Nomenclature of Dye Intermediates, Colour Index Classification of Dyes: Based on structure, based on mode of application to fibers, non– Textile uses of dyes: Dyes in medicine, leather, paper, colour photography and electro photography, food, cosmetics, displays and laser dyes.	25
3.	**BASIC CONCEPT OF DRUGS** Introduction, Classifications: On the basis of their chemical structure and therapeutic action, Nomenclature: Proprietary andNon-proprietary name, Nomenclature of new drugs by WHO, Names of drugs: Generic and brand names Theories of drug action: Occupancy theory, Rate theory andinduced fit theory biological defense, chemical defenses, Furguson principle Absorption of drugs: Routes of administration, factors that effect on absorption Physio chemical properties: Solubility, Partition coefficients, Ionization constant, electronic effect, Steric effect, Stereochemical consideration	25
4.	**UNIT PROCESSES** **Nitration**: Nitrating agents. Mechanism of aromatic nitration. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using Nitration. **Sulphonation and Sulfation**: Sulphonating and Sulfating agents. Mechanism of aromatic Sulphonation. Industrial chemicals derived from Benzene, Naphthalene, Anthracene using Sulphonation. **Amination:** Aminating agents, Amination by reduction, Amination by Ammonolysis. Industrial chemicals derived from Benzene using Amination. **Alkylation:** Alkylating agents. Industrial important alkylcompounds derived by various rroutes **Halogenation:** Halogenating agents, industrial important halogenated compounds derived by various routes.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand process chemistry versus research chemistry, concept of clinical trials on various phases, FDA, ADMET, classes of agrochemical-pesticides, herbicides, insecticides and toxicity studies.
2.	Learn colour and chemical constitution, various theories, fastness properties of dyes through various parameters. Application of dyes on various fibers, miscellaneous application of dyes like- non textiles, leather, medicines, photography, cosmetics etc.
3.	Understand of drugs, nomenclature & classification, generic and trivial/brand names of drugs, various theories of drug action, biological defense, administrationof drug and study their various physio chemical parameters.
4.	Understand unit process & operation. Various unit processes, determination of agents employed in unit process on the basic motif & analogous, establishment of mechanism and their application in industry with different routes.

Suggested Reference Books:

1. Organic Chemistry: A Mechanism Approach; Penny Chaloner, CRC Press, Tailor and Francis; Florida.
2. Pharmaceutical Process development: Current Chemical and Engineering Challenges, J.Blacker and M. T. Williams, RSC Cambridge, UK.
3. Fine Chemicals: The Industry and Its Business, P. Pollak, 2nd Edition, Wiley.
4. The chemistry of synthetic Dyes, Vol. I to VII by Venkataraman, Academic Press, New York.
5. Chemistry of Synthetic Dyes & Pigments by Lubs.
6. Dyes and their intermediates by E. N. Abrahart.
7. Handbook of synthetic dyes and pigments, Vol. I & II by K. M. Shah.
8. Industrial Dyes by Klans Hunger, Germany by Wiley-VCH.
9. Development in the Chemistry and technology of Organic Dyes by J. Griffiths, BlackwellSci. Pub., Oxford, London.
10. Principles of colour Technology by Fred W. Billmeyer and Max Saltzman, John Wiley &Sons.
11. Medicinal Chemistry by G. R. Chatwal.
12. A textbook of Pharmaceutical Chemistry by Jayshree Ghosh.
13. Chemical Process Industries by R. N. Shreve.

14. Riegel's Hand-Book of Industrial Chemistry, Ed. by James A. Kent.
15. Industrial Chemicals by Faith, Keyes, Clark.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Semester-III
Paper-IV

Course Code	[1903080203040031]	Title of the Course	**Medicinal Chemistry-I**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To understand drug design. Different parameters for drug design, concept of drug design & optimization, SAR, receptor, administration, role of enzymes in biotransformation and relevant parameters. ● To understand types of psychoactive drugs, their division, classification, general structure, effect of substituent, their SAR, MOA and synthesis. ● To learn about diuretics, hypoglycemic and cardiovascular agents/drugs. Classification, general structure, effect of substituent,their SAR, MOA and synthesis. ● To understand Analgesic, antipyretic, NSAIDs Agents, classification, general structure, effect of substituent, their SAR, MOA and synthesis.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■	■				■	■
CO2	■	■	■	■	■	■					■	■
CO3	■		■	■	■	■			■	■	■	■
CO4	■	■		■	■	■			■	■	■	

Course Content		
Unit	Description	Weightage* (%)
1.	**DRUG DESIGN, PHARMACOKINETICS AND PHARMACODYNAMICS** Drugs and Drug Design Introduction, drug targets, procedure fordrug design, pro- drug, concepts of lead compounds, lead modification, structure activity relationship (SAR), LD50, ED50, therapeutic index, Concepts of drug receptors, Elementary treatment of drug receptor interactions. Introduction to Phramcokinetic and Pharmacodynamic, Drug	25

	administration, Drug absorption, drug distribution, drug metabolism (general pathway of drug metabolism: Phase-I and Phase-II), elementary treatment of enzyme stimulation, biotransformation, Drug excretion.	
2.	**PSYCHOACTIVE DRUGS** (i) General anesthetics: General classification and Structural variations. (ii) Local Anesthetics: General classification and SAR. (iii)Sedatives and Hypnotics: General classification, Structural variations and mode of action Synthesis and therapeutic uses of only the following: Thiopental (Pentothal), Amobarbital (Amytal), Diazepam, Chlorazepam, alprazolam, glutethimide, Nikethamide, Benzocaine, Procaine, Lidocaine (xylocaine), Dibucaine (Nupercaine).	25
3.	**ANTIPYRETIC ANALGESICS AND NSAIDS AGENTS** General classification of Antipyretic Analgesics, NarcoticAnalgesics and Non-Steroidal Anti- Inflammatory Drugs. Structural variations in Morphine, Morphan and 4- Phenylpiperidine Analogues. Opioid Receptors (Name only),Limitations of Opoids, Synthesis and therapeutic uses of only the following: Meperidine (Pethidine), Ibuprofen, Meclofenamate sodium, Oxyphenbutazone, Diclofenac Sodium, Mefanamic acid.	25
4.	**DIURETICS, ANTI-DIABETIC AGENTS AND CARDIOVASCULAR DRUGS** (i) Diuretics: General classification. Structural variation and SAR of ThiazideDiuretics Synthesis and therapeutic uses of only the following: Chlorothiazide, Furosemide, Ethacrynic acid, Triamterene. (ii) Insulin and Oral Hypoglycemic Agents (Anti-diabetic agentsor drugs affecting sugar metabolism): General classification, Synthesis and therapeutic uses of only the following: Glipizide, Glybomuride Troglitazone, Chlorporpamide, Glibenclamide. (iii)Cardiovascular Drugs: General introduction of Antiarrythmic agents and Antihypertensive drugs Structure variation in ß-adrenergic blockers and Dihydropyridines, Structure – activity Relationship of ACE Inhibitors.	25

	Synthesis and therapeutic uses of only the following: Verapamil,Methyldopa, Atenolol, Lisinopril, Losartan.	

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand drug design, procedure of drug design, preparation of library of compounds-leads to identification and optimization. Various concept like pro drug, soft drug, SAR, MOA, ADMET and receptor, drug administration, pharmacokinetics and pharmacodynamics, role of enzyme in biotransformation etc.
2.	Learn general classification of psychoactive agents, difference between sedative and hypnotics, general structure of each class of drugs with substituent, their SAR and trivial/generic name, synthesis and uses of selective drug.
3.	Understand general classification of analgesic, antipyretic, NSAIDs Agents, general structure of each class of drugs with substituent, their SAR and trivial/generic name, synthesis and uses of selective drug.
4.	General classification of diuretics, general structure of each class of drugs with substituent, their SAR and trivial/generic name, synthesis and uses of selective drug method.

Suggested Reference Books:

1. Burger's Medicinal Chemistry and Drug Discovery (5/e), 1997, Vol. 1, 2, 3, 4,5, Edited by ManFred E. Wolff (John Wiley & Sons, inc., New York).
2. Principles of Medicinal Chemistry, Vol. I & II (5/e), by S. S. Kadam, K. R. Mahadik, K. G. Bothra (Nirali Prakashan).
3. Principles of Medicinal Chemistry by William O. Foye (ed.), Lea and Febiyer, Philadelphia.
4. Wilson and Gisvold's Text-book of Organic Medicinal and Pharmaceutical Chemistry (5/e, 1982) by Robert F. Doerge (J. B. Lippincott Company, Philadelphia/Toppan Co. Ltd., Tokyo).
5. Essential of Medicinal Chemistry (2/e) by Andrejus Korolkovas (A Wiley Interscience Publication, 1988, John Wiley & Sons, Canada).

6. Medicinal Chemistry by Ashutoshkar (Wiley Eastern Ltd., 1993).
7. The Pharmaceutical Basis of Therapeutics by Goodman and Gilman (The Macmillan Co.).
8. The Organic Chemistry of Drug Synthesis, Vol. I, II & III (1980), Ed. By D. Lednicer and L.A.Mitscher (John Wiley and Sons, New York).
9. Topics in Medicinal Chemistry, Vol. I & II by Rabinowitz and Myerson (Editor) (Interscience, 1968).
10. Adhunik Sanshleshit Aushodhonu Rasayanvighyan, Dr. Anamik Shah, University GranthNirman Board, Ahmedabad.
11. Medicinal Chemistry, D. Sriram and P. Yogeeswari, 1st edi., Pearson Education, 2007.
12. Handbook of pharmaceutical chemicals by Dr. A. R. Shenoy and Dr. V. R. Shenoy Multitech Publishing Co., 15-Yogesh, Hingwala Lane, Ghatkopar (East) Mumbai.
13. Fundamentals of Medicinal Chemistry by G Thomas.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Semester-III
Paper-IV

Course Code	[1903081003040032]	Title of the Course	**Dyes and Intermediates-I**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To understand azo dyes, diazotization and coupling, methods of diazotization, types of azo dyes and synthesis. ● To learn about fluorescent dye. ● To understand classification of dyes according to application and chemical constituents, application of various non-textile dyes, medicinal, indicator, laser dyes etc. ● To understand pigment, types of pigment & their application, heterocyclic dyes and their synthesis.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	`											
CO2												
CO3												
CO4												

Course Content		
Unit	Description	Weightage* (%)
1.	**AZO DYES** General Introduction: Diazotization, mechanism and differentmethods of diazotization and laws of coupling, General introduction, classification and synthesis of Monoazo dyes, Bisazo dyes and Azoic dyes. Synthesis of the following: Disperse Red 13, Acid Blue 92, Mordant Black 3, Acid Black 1, Acid Blue 113, Direct Blue 15, Direct Violet 1, Direct Red 28, Naphthol AS-BR, Fast Orange GGD.	25
2.	**FLUORESCENT WHITENING AGENTS** Introduction, Theory of fluorescence, Classification of FWA and synthesis of important member of each class and their uses.	25

	Types of Fibres and Basic Operations in Dyeing Process Types of fibres, Natural, semisynthetic and synthetic, Dyeing and Interactions: Ionic Interactions, Hydrogen bond, Van der Waal's Interactions and Covalent Interactions. Basic Operations in Dyeing Process: Preparation of the fibres, Preparation of the dyebath, application of the dyebath and finishings, Various methods of dyeing: Direct dyeing, Vat dyeing, Mordant dyeing, disperse dyeing and Formation of dye on the fibre, Dyeing of wool with the acid dyes, Dyeing with the reactive dyes, Fastnessproperties: Colour fastness, Light fastness, Sublimation fastnessand Burnt gas fumes fastness.	
3.	**(A) Classification of Dyes according to application andchemical constitution.** **(B) Evaluation of dyes** **(C) Dyes for Non-Textile Application** Leather dyes, Paper dyes, Hair dyes, Food dyes, Ink dyes, Photographic dyes, Indicator dyes, Laser dyes, Liquid crystal dyes, Solar cell, biological uses of dyes. Synthesis of the following: Eriochrome Black T, Sunset Yellow FCF, Acridine Yellow G, Safranine B, Prontosil, Methylene Blue, Nile Blue 2B, Tartrazine	25
4.	**(A) Pigments** Different classes of organic and inorganic pigments and their applications with examples. **(B) Heterocyclic Dyes** Pyrazolone dyes, cyanine dyes, dyes containing azine, oxazine and thiazine ring systems, Thiazole Dyes Synthesis of only the following: Basic Yellow 11, Basic Orange 21, Safranine B, Rosinduline GG, Sirius Supra Blue FFRL, Brilliant Alizarin Blue 3R, Sirius Supra Yellow RT, Acid Yellow 19, Copper Phthalocyanine, Sirius SupraLight Green FFGL	25

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per	30%

	CBCS R.6.8.3)	
2.	University Examination	70%

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand azo and azoic dyes, methods of diazotization & their mechanism, concepts, position of coupling, classification of dyes-mono, bio azo dyes & synthesis.
2.	Understand various FBA, classification of FBA, types of fibres and mechanism of dyeing on different parameters, various methods of dyeing and their fastness properties.
3.	Understand classification of dyes according to their chemical constitution, application, application of non-textile application-like stanning, laser, liquid crystal, etc. and synthesis.
4.	Understand pigments, Inorganic and Organic heterocyclic dyes, classification andsynthesis.

Suggested Reference Books:

1. The chemistry of synthetic Dyes, Vol. I to VII by Venkataraman, Academic Press, New York.
2. Chemistry of Synthetic Dyes & Pigments by Lubs.
3. Dyes and their intermediates by E. N. Abrahart.
4. Handbook of synthetic dyes and pigments, Vol. I & II by K. M. Shah.
5. Industrial Dyes by Klans Hunger, Germany by Wiley-VCH.
6. Development in the Chemistry and technology of Organic Dyes by J.Griffiths, BlackwellSci. Pub., Oxford, London.
7. Principles of colour Technology by Fred W. Billmeyer and Max Saltzman, John Wiley &Sons.
8. Advance in colour chemistry, series vol.-3, Modern colourants: Synthesis and structure, edited by A.T.Peters and H.S. Freeman, Blackie Academic & Professional(1995).
9. Colour chemistry: Synthesis, properties and applications of organic dyes and pigments, Heinrich Zollinger VCH, Germajy(1987).
10. Organic Chemnistry in Colour V., P.F.Gordan, P. Gregory, Spinger-Verlag(1983).
11. Textile Auxiliaries, J.W. Batty.
12. The production and applications fluorescent brightening agents, Milos Zahradnik, John Wiley & Sons (1982).
13. Chemistry of Dyes and Principles of dyeing-V.A. Shenai.
14. Synthetic dyes- G.R. Chatwal.
15. Critical reports on Applied chemistry, Vol-7, Developments in chemistry and Technologyof organic dyes, Edited by: J. Griffths, Blackwell.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

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

Course Code	[1903080203050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	12 hrs.

Course Objectives:	● To impart basic knowledge for carrying out multistep synthesisbased on some name reactions. ● Understand nature of reaction and establishment of reaction condition with mechanism. ● To learn about the calculation of mole ratio for each reaction. ● Isolation of product from individual step, purification and confirmation of the product. ● Preparation of reagent to carry out estimation. ● To understand the purpose of estimation and establishment of respective condition.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■		■		■	■			■	■
CO2	■	■	■		■		■	■			■	■
CO3	■	■	■		■		■	■		■	■	■
CO4	■	■	■		■		■	■	■		■	
CO5	■	■	■	■	■		■	■	■		■	■
CO6	■	■	■	■	■		■		■			■

Course Content	
Green Synthesis	4-Credit
Preparation	
(From Given Name reactions)	4-Credit
Estimation	

Green Synthesis (Any four)

1. Preparation of acetanilide from aniline and acetic acid using Zn dust.
2. Base catalyzed aldol condensation using LiOH.H2O as a Catalyst.
3. Bromination of *trans*-stilbene using sodium bromide and sodium bromated.
4. [4+2] cycloaddition reaction in aqueous medium at room temperature.
5. Benzil Benzilic acid rearrangement under solvent free condition.

Preparation of industrially important compounds by following Name reactions (Any four)

1. Sandmayer reaction (P-chloro toluene from p-toluidine).
2. Fischer indole synthesis (1, 2, 3, 4-tetrahydrocarbazole from cyclohexanone and phenylhydrazine).
3. Riemer-Tiemann reaction (Salicyladehyde from phenol).
4. Skraup synthesis (Quinoline from aniline).
5. Gebriel phthalimide synthesis (Anthranilic acid from phthalic anhydride and phthalimide).
6. 2-hydroxy 1-naphthaldehyde from β naphthol.

Organic Estimations (Any Six)

1. Determination of Sulphonamides with Silver Nitrate solution by Volumetrically.
2. Determination of aromatic primary amines by either diazotization or indirect diazotization.
3. Estimation of Benzyl Penicillin.
4. Determination of coupling value (C.V.) of Dye intermediates.
5. Non-aqueous titration of Sodium Benzoate.
6. Estimation of Isonazid.
7. Enzyme inhibition.
8. $-NO_2$ and-OH group.

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	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the basics to carry out reactions, nature of reaction and calculation ofmole ratio.
2.	Establish mechanism of reaction and monitoring specified reaction condition.
3.	Learn to work-up after the completion of reaction, purification.
4.	Confirm the product through the references.
5.	Learn to set up reaction condition for individual estimation of compound.
6.	Understand the calculation with reference to respective factors.
7.	Appreciate good laboratory practices.

Suggested Reference Books:

1. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Ren Aggarwal.
2. Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST.
3. Quantitative analysis by Arther I.Vogel.
4. Quantitative analysis by V.K.Ahluwalia.
5. Quantitative analysis by Mann and sanders.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Semester-IV
Paper-I

Course Code	[2003080204010003]	Title of the Course	**Advance Organic Chemistry**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To learn multicomponent reaction, alkene formation, asymmetric synthesis, amide formation, role of intermediate in synthesis, transformation and study their mechanism. ● Role of various oxidizing agents in organic synthesis,chemo selectivity, factors affecting oxidation reaction, study their working mechanism and various applications. ● Role of various reducing agents in organic synthesis, chemo selectivity, factors affecting reduction reaction, study their working mechanism and various application. ● Study of cationotropic, aniontropic migration, involvement of reactive intermediate in various rearrangement, migrating aptitude of various groups.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■	■				■	■
CO2	■	■	■	■	■	■	■				■	■
CO3	■	■	■	■	■	■	■		■	■	■	■
CO4	■	■		■	■	■			■		■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**NAME REACTIONS** General nature, method, mechanism and synthetic applications ofthe following reactions; 1. Ugi reaction 2. Noyori reaction 3. Wittig reaction 4. Peterson olefination reaction 5. Mannich reaction 6. Stille reaction	25

	7. Ene recation 8. Staudinger reaction 9 Corey-Fuchs reaction 10. Ritter reaction 11. Mcmurry reaction 12. Michael addition	
2.	**OXIDATION** Introduction, Oxidation with Cr(VI), Mn(VII), Mn(IV), OsO4, Periodic acid. Peroxy acid. Oxidation of hydrocarbons-alkenes, aromatic rings, saturated C-H group (activated and unactivated), aldehyde and ketones	25
3.	**REDUCTION** Introduction, different reductive processes, hydrocarbons- alkenes, alkynes and aromatic rings, Carbonyl compounds- aldehydes, ketones, ($LiAlH_4$, $NaBH_4$ only for aldehyde and ketone) acids and their derivatives, epoxides, nitro, nitroso, azo and oxime groups, Birch reduction, Shapiro reduction.	25
4.	**MOLECULAR REARRANGEMENTS** Rearrangement involving migration to electron deficient carbon: 1. Expansion and contraction of rings/Demajnov rearrangement 2. Benzil-benzilic acid rearrangement Rearrangement involving migration to electron rich carbon: 1. Favorskii rearrangement 2. Sommelet-Hauser rearrangement 3. Neber rearrangement Rearrangement involving migration to electron deficientnitrogen: 1. Schmidt rearrangement 2. Curtius rearrangement Aromatic rearrangements: 1. Migration around the aromatic nucleus: Jacobsen rearrangement 2. Migration of group from the side chain to the nucleus: Orton rearrangement, Hoffmann-Martius rearrangement, Rearrangement of N-nitrosoanilines (Fischer- Hepp rearrangement). Rearrangement involving migration from oxygen to ring: 1. Fries rearrangement 2. Claisen rearrangement	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	To learn type of transformation, intermediate step. Types of multicomponent reaction, in-situ reaction, role of reactive intermediate in transformation, types of asymmetric synthesis, alkene formation reaction, base catalyzed reaction, mechanism of reaction and their synthetic applications.
2.	To learn the role of various oxidizing agents, study chemo selectivity, mechanism of reaction, transformation of group, name reactions based on various oxidizing agents and their synthetic applications.
3.	To learn about role of various reducing agents, chemo selectivity, mechanism of reaction, transformation of group, name reactions based on various reducing agents and their synthetic applications.
4.	To learn about type of rearrangement, migrating aptitude, ring expansion, contraction, strain theory, isotopic effect, effect of other groups with reference to functional group and their application.

Suggested Reference Books:

1. Organic synthesis using transition metals-Roderick Bates (Wiley)
2. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)
3. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
4. Organic synthesis – Michael B. Smith
5. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007)
6. Guidebook to organic synthesis-R K Meckie, D M Smith and R A. Atken
7. Organic synthesis- Robert E Ireland
8. Strategic Applications of named reactions in organic synthesis-Laszlo Kurti and BarbaraCzako
9. Organic Synthesis, Jagdamba Singh & L.D.S. Yadav, 6th edition, Pragati Prakashan (2010).
10. Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976)
11. Advance Organic Chemistry, Reaction Mechanism and Structure by Jerry March, 4th

ed. John Wiley & Sons, 1992

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Semester-IV
Paper-II

Course Code	[2003080204020003]	Title of the Course	**Selected Topics in Organic Chemistry-II**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand and familiarize the basic principles, theory and instrumentation of mass spectroscopy, low and high resolutions mass spectra, to impart knowledge in theory and principles of spectroscopy, spectroscopic technique for characterization and differentiation of various nucleus. • To understand kinetically and thermodynamically controlled reactions, effect of substituent on structure on reactivity, terms involved in linear free energy relationship. • To provide basic theoretical understanding of heterocyclic chemistry, improving general methodology for different kind of ring synthesis which implies the new heterocyclic systems by changing the functionality with respective positions in skeleton. • To understand natural and synthetic polymers, structural variations, classification properties and applications.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■			■	■	■	
CO2	■	■			■	■			■	■	■	■
CO3	■	■		■	■	■			■	■	■	
CO4	■	■		■	■	■	■	■			■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**MASS SPECTROMETRY** Theory and principles of mass spectroscopy; Instrumentation; low and high resolution mass spectra; Ionization techniques – Electron Impact (EI) ionization, Chemical Ionization (CI), Field Desorption (FD), Fast Atom Bombardment (FAB), Electron spray Ionization (ESI); Determination of molecular weight and molecular formula, nitrogen	25

	rule, detection of molecular ion peak, metastable ion peak; Fragmentations – rules governing the fragmentations, Mc Lafferty rearrangement; Interpretation of mass spectra of different class of compounds – saturated and unsaturated hydrocarbons, aromatic hydrocarbons, alcohols, ethers, ketones, aldehydes, carboxylic acids, amines, amides, compounds containing halogens; To write possible fragmentationfor given compound; To identify structure from mass spectral data; To identify structure from combined spectral data. *Structure elucidation by suing UV, IR, NMR and Mass Spectroscopic techniques*	
2.	**STRUCTURE-REACTIVITY PRINCIPLES** Types of mechanisms, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtian-Hammet principle, potential energy diagrams, transition state and intermediates, methods of determining mechanisms- isotope effect. Effect of structure on reactivity- resonance and field effect, steric effect, quantitative treatment. The Hammet equation andlinear free energy relationships, substituent and reaction constants,positive and negative deviation from Hammet equation, Taft equation, Solvent effect	25
3.	**HETEROCYCLIC CHEMISTRY-II** 1. Five and six membered heterocycles with more than twohetero atoms: Synthesis, reactivity, aromatic character and importance of following heterocycles:1,2,3- triazole, 1,2,4- triazole, 1,2,4-oxadiazole, 1,3,4-oxadiazole, 1,2,5-oxadiazole 2. Condensed six membered heterocycles: Synthesis, reactivity, aromatic character and importance of following heterocyclic Rings: Quinoline, Isoquinoline, Cinnoline, Quinoxaline, Phthalazine, Naphthyridine, Phenoxazine	25
4.	**SYNTHETIC AND BIO-POLYMERS** **Bio-polymers:** General introduction, types, properties and uses of polysaccharides – starch and cellulose **Synthetic polymers:** General introduction, method of preparation, properties and uses of Polyester, poly- tetrafluoroethylene, polyamino acids, polycyanoacrylates, polyurethanes, silicone rubbers, polyphosphazenes, divinylether - maleic anhydride cyclopolymer (DIVEMA) polymeric antioxidants	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the theory, instrumentation and important terms of mass spectrometry, fragmentation pattern, to set valuable insight into the types of molecular interaction and interpreting from obtained data.
2.	To learn about basic concept, synthesis and application of heterocyclic chemistry, aware about heterocyclic systems, types of heterocyclic rings, application of heterocycles in medicinal chemistry.
3.	To learn about type of reactions in context to kinetically and thermodynamically control concept, derivatization of various equation and their significance, different terminology and their application in designing various bioactive scaffolds.
4.	To learn about natural and synthetic polymers, their classification, properties andsynthetic applications.

Suggested Reference Books:

1. Spectroscopic Identification of Organic Compounds, R. M. Silverstein and F. X. Webster, 6th edition (John Wiley & Sons)
2. Introduction to Spectroscopy, D. L. Pavia, G. M. Lampman and G. S. Kriz,3rdedition (Thomson Brooks/Cole)
3. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming,4thedition (Mcgraw – Hill Book Company)
4. Organic Spectroscopy, William Kemp, 3rd edition (Palgrave)
5. Organic Spectroscopy – Principles and Applications, Jag Mohan, 2nd edition (Narosa Publishing House)
6. Spectroscopy of Organic Compounds, P. S. Kalsi, 5th edition (New Age International Publishers)
7. Elementary Organic Spectroscopy: Principles and Chemical applications (revised edition), Y. R. Sharma (S. Chand Publishing)
8. Organic Chemistry by Francis A. Carey (McGraw-Hill Book Co., 1987).
9. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell Uni.Press.
10. Principles of Organic Synthesis, R.O.C. Norman and J. M. Coxon, Blackie Academic

and Professional.
11. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
12. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers
13. An introduction to the chemistry of heterocyclic compounds-R M AchesoHeterocyclic Chemistry- J A Joule and Smith
14. Heterocyclic Chemistry-II- R R Gupta, M Kumar, V Gupta, Springer (India) pvt
15. Heterocyclic Chemistry, 4th Edition by J. A. Joule & K. Mills, Published by Chapman & Hall (1995)
16. Principles of modern heterocyclic chemistry, edited by Leo A. Paquette, Published by Pearson Benjamin Cummings (1968)
17. Heterocyclic Chemistry, 3rd Edition by Thomas L. Gilchrist, Published by Prentice Hall (1997)
18. The Structure & Reactions of Heterocyclic Compounds, Edited by Michael Henry
19. Palmer, Published by Edward Arnold (1967)
20. Heterocyclic chemistry by V. K. Ahluwalia, Narosa publishing house. 21.Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary
21. Polymer Chemistry, 3rd edition, Pearson Prentice Hall, 2005.
22. Organic Polymer Chemistry by K. J. Saunders

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Semester-IV
Paper-III

Course Code	[2003080204030003]	Title of the Course	**Advance Organic Synthesis**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand the reaction mechanism of a chemical reaction, the path and the feasibility of a reaction, reactivity of a group and needto understand preferential group, suitable reagent and appropriate condition. • To understand the synthetic pathway, breaking and assembling molecules, suitable reagent, to suggest synthetic route for complex organic compounds with stereochemistry. • To learn ring synthesis based on retrosynthetic pathway, application of various name reactions, generation of intermediates and their involvement in the construction of ring and generation of aromatic compounds from heterocycles. • To learn about organometallic chemistry, synthesis of hydrocarbon, olefin, transformation of various functional group, name reactions based on organometallic compound, their mechanism and synthetic applications.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■	■			■	■	■
CO2	■	■	■	■	■	■	■			■	■	■
CO3	■	■	■	■	■	■	■				■	■
CO4	■	■	■	■	■	■	■				■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**PROTECTING GROUPS** Need of protecting groups – Protection of alcohols, Carbonyl, Carboxylic acid and amino groups, Synthetic equivalent groupsand examples on transformations	25
2.	**DISCONNECTION APPROACH**	25

	Introduction to disconnection, Concept of synthon, Synthetic equivalent, Functional group interconversion (i) One group disconnection: Disconnection and synthesis of alcohols, olefins, simple ketones, acids and its derivatives (ii) Two groups disconnection: Disconnections in 1,3-dioxygenated skeletons, preparation of β-hydroxy carbonyl compounds, α, β-unsaturated carbonyl compounds, 1,3-dicarbonyls, 1,5- dicarbonyls and use of Mannich reaction (iii) Pericyclic reactions: Disconnections based on Diels-Alder reaction and electrocyclic reaction: Its use in organic synthesis	
3.	**RING SYNTHESIS** Introduction to ring synthesis (i) Synthesis of saturated heterocycles: Synthesis of 3 and 4 membered rings (ii) heterocycles in organic synthesis: Synthesis of alkanes and cycloalkanes from thiophene, Synthesisof alkenes and cycloalkenes from pyridines, Synthesis of Aromatic compounds from pyrilium salts,pyridazine, thiophenes and furan	25
4.	**ORGANOMETALLIC COMPOUNDS AND THEIR APPLICATIONS** (i) Carbon-metal bonds in organometallic compounds, Synthesisand applications of Organolithium, Organozinc and Lithium diorganocuprate. (ii) Basic concept of organoboranes, Preparation of organoboranes, Stereochemistry of hydroboration, Mechanism of hydroboration – oxidation, Synthetic applications.	25

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

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

2.	University Examination	70%

Course Outcome: Having Completed this course, the learner will be able to	
1.	Focus on the protecting and deprotecting groups with various organic scaffolds, choose of reagents, solvents and synthetic pathway, the reactions of group and their synthetic applications.
2.	Understand deep aspects of retrosynthesis and oxidation-reduction reaction, assumption of synthetic equipment and design the novel route for the synthesis target.
3.	Understand synthesis of various rings based on retrosynthetic pathway, application of reactive intermediate in the synthesis of ring, can be able to design new molecules of interest and generation of aromatic hydrocarbons from various heterocycles.
4.	Learn the Role of organometallic compounds in organic synthesis, reduction, oxidation, transformation of a group, application in pharmaceutical industries for thesynthesis of pharmaceutically active agents.

Suggested Reference Books:

1. Organic synthesis using transition metals-Roderick Bates (Wiley).
2. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press).
3. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
4. Organic synthesis – Michael B. Smith.
5. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition(2007).
6. Guidebook to organic synthesis-R K Meckie, D M Smith and R A Atken.
7. Organic synthesis- Robert E Ireland.
8. Strategic Applications of named reactions in organic synthesis-Laszlo Kurti andBarbara Czako.
9. Organic Synthesis, Jagdamba Singh & L.D.S. Yadav, 6th edition, Pragati Prakashan (2010).
10. Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976).
11. Advance Organic Chemistry, Reaction Mechanism and Structure by Jerry March, 4th ed. John Wiley & Sons, 1992.
12. Designing Organic Synthesis – A Programmed Introduction to the Synthon Approach, Stuart Warren, John Wiley & Sons (1994).
13. Organic Synthesis: The disconnection approach, Stuart Warren, John Wiley & Sons (1994).
14. Selected Organic Synthesis, Ian Fleming, John Wiley & Sons (1977).
15. Principles of Organic Chemistry by R.O.C. Norman (Chapman and Hall, 1986).
16. Organometallic Chemistry by P. L. Pauson (Edward Arnold, 1968).
17. Principles of Organometallic Chemistry by Coats, Green, Powell & Wade (Chapman

and Hall, 1977).

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Semester-IV
Paper-IV

Course Code	[2003080204040031]	Title of the Course	**Medicinal Chemistry-II**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand antibiotics, classification and drug belong to that class, structural variation, synthesis and uses of antibiotics. • To learn about types of anti-allergic and anti-infective drugs, their classification, general structures, effect of substituent, SAR, synthesis and uses. • To understand anti-malarial drug, life cycle of plasmodium, general classification, their structural variation, synthesis and uses. • To understand life cycle of virus. Various classes of enzymes, general structure of anti-viral and anti-HIV agents, structural variation, synthesis and uses.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■			■	■	■	
CO2	■	■		■	■	■			■	■	■	
CO3	■	■	■	■	■	■			■	■	■	
CO4	■	■		■	■	■	■		■	■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**ANTIBIOTICS** General introduction and classification of antibiotics Broad spectrum antibiotics, Macrolide antibiotics, Amino glycoside antibiotics and non-classifiable antibiotics 1. β-lactam antibiotics: Penicillins (Structural variations and SAR), Cephalosporins(Structural variations) 2. Non-lactam antibiotics: Tetracyclin (Structural variations and SAR) Structures and medicinal importance/ clinical uses/pharmacological	25

	applications of the following: Bacitracin, Vancomycin, Erythromycin, Lincomycin, Chloramphenicol, Nalidixic acid, Norfloxacin, Ciprofloxacin Synthesis and therapeutic uses of only the following: Methicillin, Ampicillin, Cephalexin, Chloramphenicol, Ciprofloxacin	
2.	**ANTIALLERGIC AND LOCAL ANTI-INFECTIVEDRUGS** **1. Antihistamines and related Antiallergic Drugs:** General introduction and mode of action, Structure variation in Aminoalkylethers, Ethylenediamines and Piperazine derivatives. Synthesis and therapeutic uses of only the following: Diphenhydramine (Benadryl), Antazoline, Chlorpheniramine, Primethazine. **2. Anti – mycobacterial agents:** General Introduction of Tuberculosis & Leprosy-disease, Treatment, Mode of action, adverse effect of Anti TB agents & Anti–leprotic agents. Synthesis and therapeutic uses of only the following: Ethionamide, Ethambutol, DDS (Dapsone), Pyrazinamide. **3. Sulfonamides:** General classification, mode of action and SAR Synthesis and therapeutic uses of only the following: Sulfamethoxine (Sufadoxine), Sulfamethoxy-Pyrazine (Sulfalene), Succinyl sulfathiazole (Sulfasuxidine).	25
3.	**ANTIMALARIALS AND ANTINEOPLASTIC AGENTS** 1. **Antimalarials**: Introduction, Types, Life cycle of plasmodium, drug resistance, General classification, SAR of 4- and 8-aminoquinolines and Structure variation in Sesquiterpene Lactones, mode of action Synthesis and therapeutic uses of only the following: Mefloquine, Chloroquine, Primaquine, Pyrimethamine (Daraprim), Quinacrine. **2. Antineoplastic Agents (Cancer Chemotherapy):** Introduction to cancer, types, Causes & Treatment of cancer, Metastasis, Drug Resistance, Targets of anticancer agents, adverse effects of cancer therapy (in brief) General classification of antineoplastic agents, Cell Cycle-Specific (CCS) and Non-CellCycle-Specific (CCS) Agents, Mode of action. Synthesis and therapeutic uses of only the following:	25

	Mechlorethamine, Cyclophosphamide, Melphalan, 6-Mercaptopyrine, Trimetrexate, Cytarabine.	
4.	**ANTI-VIRAL AND ANTI-HIV AGENTS** **1. Antiviral agents:** Introduction, Types & classes of viruses, Classification of antiviral agents, mechanism of action, Antiviral Compounds forDNA Viruses & Selected RNA Virus Infections other than HIV(Influenza A and B Viruses, Hepatitis C Virus). **2. Anti-HIV Drugs:** Introduction, HIV Infection and its Pathological Effects, HIV Structure and life cycle, Targets for Drug Design of Anti-HIV Agents, HIV drugs in clinical use, Development of Drug Resistance, the need for new Anti-HIV Drugs, Introduction of AIDS. Synthesis and therapeutic uses of only the following: Amantadine, Acyclovir, Zidovudine, Indinavir, Ritonavir.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand antibiotics, their classification, general structure, lactum and non-lactum antibiotics, next generation antibiotics, SAR, synthesis and uses of selected drug molecules.
2.	Learn general classification of anti-histamines, anti-mycobacterial and sulphonamides, their structural variations, mode of action and synthesis of selected drug molecules.
3.	Learn life cycle of malaria, types of plasmodia, general structure of anti-malarial agents, structural variation among them, mode of action, synthesis and uses of selected drug molecules.
4.	Understand life cycle of virus. Identification of enzymes responsible for replication of virus, mechanism of drug action. Synthesis and uses of selected drug molecules.

Suggested Reference Books:

1. Burger's Medicinal Chemistry and Drug Discovery (5/e), 1997, Vol. 1, 2, 3, 4,5, Editedby ManFred E. Wolff (John Wiley & Sons, inc., New York).
2. Principles of Medicinal Chemistry, Vol. I & II (5/e), by S. S. Kadam, K. R. Mahadik, K. G. Bothra (Nirali Prakashan).
3. Principles of Medicinal Chemistry by William O. Foye (ed.), Lea and Febiyer,Philadelphia.
4. Wilson and Gisvold's Text-book of Organic Medicinal and Pharmaceutical Chemistry(5/e, 1982) by Robert F. Doerge (J. B. Lippincott Company, Philadelphia/Toppan Co. Ltd., Tokyo).
5. Essential of Medicinal Chemistry (2/e) by Andrejus Korolkovas (A Wiley Interscience Publication, 1988, John Wiley & Sons, Canada).
6. Medicinal Chemistry by Ashutoshkar (Wiley Eastern Ltd., 1993).
7. The Pharmaceutical Basis of Therapeutics by Goodman and Gilman (The MacmillanCo.).
8. The Organic Chemistry of Drug Synthesis, Vol. I, II & III (1980), Ed. By D. Lednicerand L.A. Mitscher (John Wiley and Sons, New York).
9. Topics in Medicinal Chemistry, Vol. I & II by Rabinowitz and Myerson (Editor) (Interscience, 1968).
10. Adhunik Sanshleshit Aushodhonu Rasayanvighyan, Dr. Anamik Shah, University Granth Nirman Board, Ahmedabad.
11. Medicinal Chemistry, D. Sriram and P. Yogeeswari, 1st edi, Pearson Education, 2007.
12. Handbook of pharmaceutical chemicals by Dr. A. R. Shenoy and Dr. V. R. Shenoy Multitech Publishing Co., 15-Yogesh, Hingwala Lane, Ghatkopar (East) Mumbai.
13. Fundamentals of Medicinal Chemistry by G Thomas.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Semester-IV
Paper-IV

Course Code	[2003081004040032]	Title of the Course	**Dyes and Intermediates-II**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand vat dyes, their classification, various methods, various processes, synthesis and uses. • To learn about reactive, acid and TPM dyes, classification, methodof application, synthesis and uses. • To learn about various, disperse, indigo and cationic dyes, classification, methods of application, synthesis and uses. • To understand nature of fibres, application of various dyes on various fibres, application of dyes as medicine, LCD, laser, photo- sensitizer etc.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■		■		■	■	■
CO2	■	■		■	■	■		■		■	■	■
CO3	■	■		■	■	■	■	■			■	■
CO4	■	■	■		■	■	■	■	■	■	■	

Course Content		
Unit	Description	Weightage* (%)
1.	**ANTHRAQUINONE DYES** Vat Dyes and Solubilized Vat dyes, Acid dyes, Mordant dyes and dyes for cellulose acetate. Synthesis of only the following: Indanthrene Orange 7RK, Indanthrene Yellow FFRK. Indanthrene Khakhi 2G, Indanthrene Orange FFRK, Indanthrene Yellow 4GK, Indanthrene Scarlet B, Caledon Jade Green XBN, Anthracene Blue SWX, Indanthrene Brilliant Orange GR, Celliton fast aBlue FFG.	25
2.	General nature, classification, structural variation, synthesis and application of fibres of the following classes of dyes:	25

	(i) Reactive dyes (ii)Triphenylmethane dyes (TPM)(iii)Acid dyes Synthesis of only the following: Procion Brilliant Blue MR, Procion Brilliant Red H-3B, Remazol Brilliant Blue R, Malachite Green, Crystal Violet, AcidYellow 73, Acid Red 1, Acid Black 24.	
3.	General nature, classification, structural variation, synthesis and application of fibres of the following classes of dyes: Disperse dyes Indigoid and Thio-indigoid dyes. Cationic dyes Synthesis of the following: Disperse Yellow 16, Disperse Blue 14, Celliton Fast Yellow 7G,Ciba Blue 2B, Indanthrene Brilliant Pink R, Bismarck Brown, Chrysoidine Y, Methylene Blue, Acridine Yellow G, Disperse Orange 29.	25
4.	General nature, classification, structural variation, synthesis and application of fibres of the following classes of dyes: (A) Sulphur dyes (B) Ecology and toxicity of dyes with reference to textile dyes,food colours, benzidine etc. (C) Medicinal dyes and biological staining agents. (D) High tech application of dyes: Liquid crystal display (LCD), Laser dyes, Photochromic dyes, Thermochromic dyes, dye sensitizer solar cells.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand vating process, mechanism, classes of dyes, synthesis and uses of selected dyes.
2.	Learn application of dyes on various fibres for reactive, TPM and acid dyes andsynthesis of selected dyes.
3.	Understand disperse, indigo and cationic dyes, their application on various fibres, mechanism of application, structure and uses of selected dyes.
4.	To learn about medicinal, ecology and toxicity of dyes, LCD, photochemical

	dyes,laser dyes, their application and synthesis of selected dyes.

Suggested Reference Books:

1. The chemistry of synthetic Dyes, Vol. I to VII by Venkataraman, Academic Press, New York.
2. Chemistry of Synthetic Dyes & Pigments by Lubs.
3. Dyes and their intermediates by E. N. Abrahart.
4. Handbook of synthetic dyes and pigments, Vol. I & II by K. M. Shah.
5. Industrial Dyes by Klans Hunger, Germany by Wiley-VCH.
6. Development in the Chemistry and technology of Organic Dyes by J.Griffiths, Blackwell Sci. Pub., Oxford, London.
7. Principles of colour Technology by Fred W. Billmeyer and Max Saltzman, John Wiley & Sons.
8. Advance in colour chemistry, series vol.-3, Modern colourants: Synthesis and structure, edited by A.T.Peters and H.S. Freeman, Blackie Academic and Professional (1995).
9. Colour chemistry: Synthesis, properties and applications of organic dyes and pigments, Heinrich Zollinger VCH, Germany (1987).
10. Organic Chemnistry in Colour V., P.F.Gordan, P. Gregory, Spinger-Verlag (1983).
11. Textile Auxiliaries, J.W. Batty
12. The production and applications fluorescent brightening agents, Milos Zahradnik, John Wiley & Sons (1982).
13. Chemistry of Dyes and Principles of dyeing-V.A. Shenai
14. Synthetic dyes- G.R. Chatwal
15. Critical reports on Applied chemistry, Vol-7, Developments in chemistry and Technology of organic dyes, Edited by : J. Griffths, Blackwell

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Organic Chemistry
M.Sc. Organic Chemistry, Practical
Semester-IV

Course Code	[2003080204050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	12 hrs.

Course Objectives:	• Able to interpret structure of organic compounds from spectra likeUV, IR, NMR and Mass. • To impart basic knowledge for carrying out multistep synthesisbased on some name reactions. • Understand nature of reaction and establishment of reaction condition with mechanism • To learn about the calculation of mole ratio for each reaction. • Isolation of product from individual step, purification and confirmation of the product. • To understand the purpose of green synthesis.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■	■	■			■	■
CO2	■	■		■	■	■	■	■			■	■
CO3	■	■		■	■	■		■		■	■	■
CO4	■	■	■	■	■	■	■	■			■	■
CO5	■	■		■	■	■	■	■			■	■
CO6	■	■		■	■	■	■	■			■	■

Course Content	
Spectral Exercise	4-Credit
Preparation or organiccompounds	
Green Synthesis	4-Credit
Viva-Voce	

1. Spectral Exercise (Minimum 10 from syllabus)

1. Structure interpretation of organic compounds from spectra (UV, IR, NMR and Mass)

2. Preparation of industrially important compounds (Minimum 8)

1. Sulfanilamide from via p-acetamido benzene sulphonyl chloride and acetamido benzene-sulfonamide.
2. Acridone from anthranilic acid via o-chloro benzoic acid and N-phenylanthranilic acid

3. Benzocaine from p-nitro toluene via p-nitro benzoic acid and p-amino benzoic acid.
4. Eosin from phthalic acid via phthalic anhydride and fluorescein.
5. Benzanilide from benzene via Benzophenone and Benzophenonoxime.
6. p-Nitro chloro benzene from acetanilide via p-nitro acetanilide and p-nitroaniline.
7. p-Chloro bromo benzene from acetanilide via p-bromo acetanilide and p-bromoaniline.
8. Anthrone from phthalic anhydride via o-benzoyl benzoic acid and anthraquinone.
9. 4-Methyl-7-hydroxy-8-acetyl coumarin from resorcinol via 4-methyl-7-hydroxycoumarin and 4-methyl-7-acetyl coumarin.
10. Preparation of Congo red dye from naphthionic acid via hydrozobenzene.
11. Preparation of o & p-hydroxyacetophenone from Aniline via phenol and phenylacetate.

3. Green Synthesis (Any Four)

1. Green approach for preparation of benzopinacolone from bezopinacol using iodine catalyst
2. Preparation of 1, 1-bis-2-naphthol under grinding at room temperature
3. Three component coupling reaction by green approach. (Synthesis of dihydropyrimidinone)
4. Green approach to Transesterification reaction (Synthesis of biodiesel)
5. Ecofriendly nitration of phenols and its derivatives using Calcium nitrate

Teaching-Learning Methodology	Introduction, interaction with students in calculation of mole ratios, carry out experiments at each step according to the respective practical, interpretation of spectra and deduce the structure.

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the basics to carry out reactions, nature of reaction and calculation of mole ratio.
2.	Establish mechanism and monitoring reaction at specified reaction condition.
3.	Learn to work-up after the completion of reaction, purification.
4.	Confirmation of product through the references.
5.	Learn to interpret structure of organic compounds from given spectra.
6.	Understand the calculation with reference to respective factors.
7.	Appreciate good laboratory practices.

Suggested Reference Books:

1. Vogel's Textbook of practical organic chemistry, 5th edition, B. S. Furniss, A. J., P. W. G.Smith, A. R. Tatchell (Pearson Education).
2. Comprehensive practical organic chemistry: Preparation and Quantitative analysis, V. K.Ahluwalia, Renu Agarwal (Universities Press).
3. Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task ForceCommittee, DST
4. L. D. Field, S. Sternhell, J. R. Kalman – Organic Structures from Spectra-Wiley (2013)

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

M.Sc. Semester-III (PHYSICAL CHEMISTRY)

Sr. No.	Course Title	L	T/C/S	Credit
1	Advanced Thermodynamics	4		4
2	Molecular Spectroscopy	4		4
3	Electro AnalyticalTechniques	4		4
4	Physical Chemistry of Materials	4		4
5	Practical	12	4	8
		28	4	24

External Examination Time Duration: 03 hrs.

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	III	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Core	04	30	70	100
			Practical	08	60	140	200
			Total	24	180	420	600

M.Sc. Semester-IV (PHYSICAL CHEMISTRY)

Sr. No.	Course Title	L	T/C/S	Credit
1	Advanced Chemical Kinetics	4		4
2	Atomic Spectroscopy	4		4
3	Separation Techniques	4		4
4	Polymer Chemistry	4		4
5	Practical	12	4	8
		28	4	24

External Examination Time Duration: 03 hrs.

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	IV	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Core	04	30	70	100
			Practical	08	60	140	200
			Total	24	180	420	600

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Physical Chemistry
M.Sc. Physical Chemistry, Semester-III
Paper-I

Course Code	[1903080203010004]	Title of the Course	**Advanced Thermodynamics**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● Application of statistical thermodynamics to gas, liquid and solid ● To learn the calculation of partition function for different ensembles and gaseous systems. ● Theoretical explanation on thermodynamic function of liquidmixtures. ● The behaviour of gaseous stems in terms of empirical equations

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■			■	■	■	
CO2	■	■		■	■	■			■	■	■	
CO3	■	■	■		■	■				■	■	■
CO4	■	■		■	■	■			■	■	■	

Course Content		
Unit	Description	Weightage* (%)
1.	**STATISTICAL THERMODYNAMICS OF ENSEMBLES** Phase Space, The Liouville theorem, Ergodic Hypothesis, Ensemble and probability, ensemble averages and postulates. Details of types of ensemble: Canonical and Microcanonical and Grand canonical ensemble. Probability distribution, partition function and thermodynamic function of canonical ensemble, Equilibrium constant and canonical ensemble, Partition function for Grand canonical ensemble, Fluctuations, Meandistribution and mean square deviation, Fluctuation in energy in a canonical ensemble	25
2.	**STATISTICAL THERMODYNAMICS OF IDEAL GASES AND SOLID** Ideal mono atomic gas, Thermodynamic function for mono atomic gas	25

	(statistical derivation of Helmholtz free Energy function, pressure, Internal energy, Entropy) Gibbs Paradox, Partition function and Thermodynamic function for diatomic and polyatomic gas (Helmholtz free energy, Internal energy, heat capacity, entropy). Derivation of Sackur-Tetrode equation. Treatment of diatomic and polyatomic molecules – entropy, vibrational entropy and rotational entropy, Internal rotation in polyatomic molecules, Statistical thermodynamic of solid, characteristic of crystalline solid, Einstein model.	
3.	**THERMODYNAMICS OF LIQUID MIXTURES** Types of molecular interactions in solution of electrolytes and non-electrolyte, Fugacity and activity coefficient in solution, ideal and non-ideal behaviour of phase equilibria (isothermal and isobaric), semi empirical equations explaining multi component thermodynamics properties for binary data, Theories of solutions non-electrolyte liquids: van Laar theory, van der Waals theory, Scatchard- Hildebrand theory, Lattice theory. Theory of electrolytes: limitations/modifications of Debye Huckle limiting law, Bromley's Method, Pitzer's Method	25
4.	**THERMODYNAMICS OF GAS STATE** Ideal Gas law, empirical equation for ideal gas, deviation of real gas from ideal behaviour, Adiabatic expression of ideal gas, thermodynamic epresentation of real gas: Fugacity, Reference state for real gas, Determination of activity coefficient for real gas: Approximate method, graphical method, viral expression representation of real gas, The van der Waals equation : correction due to excluded volume, force of attraction, nternal pressure, Second Viral Coefficient, van der Waals equation as unction of pressure and temperature, intermolecular forces, critical phenomena, phase transition and van der Waals, Reduced van der Waals equation, other equation of state	25

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

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

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

Suggested Reference Books:

1. Statistical Thermodynamics by M. G. Gupta, New Age Publication
2. Statistical Thermodynamics : Fundamental and Applications by Normanad Laurendeau, Cambridge Press
3. Molecular Thermodynamics of Fluid Phase Equilibria by J.M.Prausnitz, R.N. Lichtenthaler, E.G.Azevedo
4. Thermodynamic Properties of Nonelectrolyte Solutions By William Acree, Acadamic Press
5. Physical Chemistry : Concepts and Theory: Kenneth Schmitz, Elsevier

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Physical Chemistry
M.Sc. Physical Chemistry, Semester-III
Paper-II

Course Code	[1903080203020004]	Title of the Course	**Molecular Spectroscopy**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To understand the familiarize with the basic properties, theory & interpretation of IR, ^{1}H NMR, Mass and Luminescence Spectroscopy. ● To impart knowledge in the theory & principals of spectroscopic techniques for characterization & differentiation of various molecules. ● To impart knowledge on identification of compounds using spectroscopy

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■					■	■
CO2	■	■	■	■	■	■	■		■	■	■	
CO3	■	■	■	■	■	■			■	■	■	

Course Content		
Unit	Description	Weightage* (%)
1.	**IR AND RAMAN SPECTROSCOPY** Theory of IR and Raman, selection rules, IR absorption, Raman scattering, Mutual exclusion rule, complimentary techniques, Instrumentation - FTIR and Raman, Cells and sampling techniques, Resonance Raman spectroscopy, Interpretation of IR spectra using correlation charts, Advantages of FTIR spectroscopy, Mid-IR Reflection – DRS, ATR, Data processing in Near IR, Applications in structure, elucidation of inorganic and organic molecules.	25
2.	**NMR SPECTROSCOPY** Theory of NMR, Relaxation, population of energy levels, Larmor precession, chemical shift and factors affecting it, references and solvents, Spin-spin splitting, Coupling constant, Magnetic Anisotropy, Instrumentation, Shift Reagents, Interpretation of simple NMR	25

	spectra,Signal averaging, FT-NMR, Pulse FT-NMR spectroscopy, ^{13}C NMR spectra, Calculation of chemical shift in ^{13}C NMR, NMR in medical diagnostics, Double resonance technique, Multi-dimensional NMR, Problems to elucidate structure from NMR spectra	
3.	**MOLECULAR MASS SPECTROSCOPY** Instrumentation, Methods of ion production (EI, CI, FI, FD, Electro Spray, MALDI), Ion separators, Ion collection and recording, Double focusing, Time of flight analyser, Quadruple-mass spectrometer, Sample handling techniques, Resolution, Parent peak, Base peak, Metastable ions isotope effect, Molecular formula from mass spectra, Nitrogen rule, Ring rule, Fragmentation rules, Behavior of classes of compounds, Interpretation of mass spectra, Additional applications, Problems to elucidate structure from mass spectral data.	25
4.	**MOLECULAR LUMINESCENCESPECTROSCOPY** Introduction to molecular luminescence (fluorescence, phosphorescence and chemiluminescence); theory of luminescence, energy level diagram, Deactivation process,; instruments for measuring fluorescence(fluorometer and spectrofluorometer);, factor affecting, Emission and excitation spectra, wavelength selector, detector, application and problems	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand fundamental & basic terms involved in IR, ^{1}H NMR, Mass and Luminescence Spectroscopy, know effects of various factors on the spectra, interpretation from spectral data, identify structure of organic compounds by using combined spectral data, distinguish isomers and other closely related compounds by using spectral techniques.
2.	Identify drug testing contamination in food, isotope ratio determination and protein identification with the help of spectroscopy

3.	Identify the name of compounds using spectroscopy
4.	Understand the instrumental set up for all instruments.

Suggested Reference Books:

1. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5thedition.
2. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A.Settle (VanNostrand Reinhold Co., New York), 6th edition.
3. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2nd edition.
4. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company),New Delhi.
5. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).
6. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
7. Photometric and Fluorometric Methods of Analysis: F. D. Snell (John Wiley & Sons Inc.,New York).
8. Instrumental Methods of Chemical Analysis: B. R. Sharma (Goel Publishing House, Meerut).

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Physical Chemistry
M.Sc. Physical Chemistry, Semester-III
Paper-III

Course Code	[1903080203030004]	Title of the Course	**Electroanalytical Techniques**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To understand process chemistry and research, basic knowledge of Polarography. ● To learn about calculation of concentration of compound using Polarography. ● To learn about types of electrodes and their selectivity for the ions in solution. ● Concept of Chronopotentiometry.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■			■	■	■	
CO2	■	■		■	■	■			■	■	■	
CO3	■	■	■	■	■	■			■	■		
CO4	■	■	■	■	■	■					■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**POTENTIOMETRIC TITRATION AND CHRONOPOTENTIOMETRY** Fundamentals of potentiometry, Instrumentation, electrode system, accuracy of direct potentiometric measurements and its limitations, potentiometric titrations, neutralization titrations, end- point detection, oxidation- reduction, precipitation titrations, complexometry titrations with example, applications and advantages. **Chronopotentiometry** Principle, Instrumentation and procedure, applications	25
2.	**DC-POLAROGRAPHY** Theory and Applications of Polarography, Types of currents: Residual Current, Migration Current and Diffusion Current, Natureof the Limiting Current: 1) Kinetic currents, 2) Catalytic currents and 3)	25

	Adsorption currents, Electro capillary maxima, Maxima of first kind and second kind, Maxima suppressors, DME as electrode, Wave equation, Ilkovic equation (derivation), Reversible electrode reactions at DME half wave potential, Interference and removal of oxygen, Reversible Electrode Reactions of Metal Complexes at D.M.E (Ligane method) Determination of stability constants of complexes. **Amperometric titrations:** Principle, DME & RPE, curves, Biamperometric titration.	
3.	**MODERN POLAROGRAPHIC METHODS** **A.C. Polarography:** Principle of Sinusoidal alternating applied potential, AC peak polarogram, Peak current equation, Characteristic of AC polarographic peak, Importance of signal to noise ratio for the sensitivity, Comparison with DC polarography. **Square-wave Polarography:** Principle of alternating rectangular wave voltage applied, Frequency of square wave applied, Problemsof large condenser currents in A.C., Peak polarogram, Peak current equation, Limitations of techniques. **Pulse Polarography:** Effect of capillary response with frequencyof applied square wave potential, Principles and difference between Normal Pulse Polarography and Differential Pulse Polarography, Importance of charging and Faradaic currents.	25
4.	**ION SELECTIVE ELECTRODES** Classification of ion selective electrodes, Solid state electrodes – Glass electrode effect of glass structure on selectivity function of the glass electrode. Acid error, Alkali error, Silver halide, Sulphide, Lanthanum fluoride ion selective electrodes. Liquid ion exchange electrode – Calcium selective ion electrodes. Gas electrodes, ammonia, sulphur dioxide, oxygen and CO_2 sensing electrode, Micro ion selective electrode, enzyme electrodes.Application and Numericals	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand concept of POLAROGRAPHY and its importance in analysis of elctroactive compounds
2.	Learn types of various electrodes their characteristics and their uses
3.	Understand the application of different Polarography in identification of compounds
4.	Understand the Potentiometric Titration and Chronopotentiometry

Suggested Reference Books:

1. "Polarography": Kolthoff I. M. and Lingane J. J. (Vol. I & II) (Interscience Publishers, NewYork).
2. "Polarographic Techniques": L. Meites (Interscience Publishers, New York).
3. Principles of Instrumental Analysis (5^{th} ed.) by Skoog, Holler and Nieman (Saunders College Publishings).
4. Modern Polarographic Methods in Analytical Chemistry by A M Bond CRC Press Inc
5. Undergraduate Instrumental Analysis (5^{th} ed.), J. W. Robinson (Marcel Dekker Inc.).

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Physical Chemistry
M.Sc. Physical Chemistry, Semester-III
Paper-IV

Course Code	[1903080203040004]	Title of the Course	**Physical Chemistry of Materials**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	● To understand kinetics of enzyme catalyst reaction. Enzymes inhibition immobilization, thermodynamics of biological reactions ● To understand phase diagrams for the mixtures. ● To learn about arrangements of molecules in solids. ● To understand concept of Electronic Behavior of Materials.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■			■	■		
CO2	■	■	■	■	■	■			■	■		
CO3	■	■		■	■	■					■	■
CO4	■	■		■	■	■				■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**BIOPHYSICAL CHEMISTRY** Bioenergetics: Standard free energy change in biochemical reactions (exergonic and endergonic). Coupled reaction, Energyrich compounds and energy coupling (Formation and hydrolysis of energy rich bonds in energy rich molecule), Enzyme Kinetics: MichaelisMenten, Michaelis-Menten for Inhibition and Activation, Lineweaver-Burke plots. Enzyme inhibition reversible and irreversible inhibition, Immobilized enzymes, Techniques andmethods of immobilization of enzymes, Application of immobilized enzymes. Cell Membrane: Structure and Transport functions of cell membrane.	25
2.	**PHASE EQUILIBRIA OF MULTI COMPONENT SYSTEMS** Reduced Phase rule, Application of reduced phase rule to Two component systems: System with congruent and incongruent M.P., Phase rule for three component systems, Representation, methods of	25

	computing composition of ternary systems : methods of paralleland perpendicular lines, lever arm rule, Systems of three liquid component exhibiting partial miscibility (Formation of (a) one pair, (b) two pair and (c) three pairs of partially miscible liquids System composed of two solids and liquid components (a) crystallization of pure components (b) double salt formation (c) hydrate formation (d) formation of solid solution (Phase transitions in the ternary system	
3.	**SOLID STATE CHEMISTRY** Ionic Crystals & Their structures, detailed explanation of types of packing and coordination number, Radius ratio rule and prediction of packing of crystals, Polarization, Crystalline solids: Geometry of AB_2 type: Fluorite (CdI_2), antifluorites (CdC_{l2}), Rutile structures (TiO_2). AB_2 type: ReO_3, BiI_3, A_2B_3 type: Fe_2O_3, Corundum Al_2O_3, Ternary Compounds ABO_3 type: Perovskite, AB_2O_4 type : Spinelstructure Perfect & Imperfect crystals, Schottky defect, Frenkel defect, thermodynamics of Schottky& Frankel defects, Line defects: Dissociation, Extended defects: Lineage boundary, grain boundary, stacking fault	25
4.	**ELECTRONIC BEHAVIOR OF MATERIALS** Metals, Insulators and Semiconductors, Electronic structure of solid, bond theory, band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping of semiconductors and conduction mechanism, the band gap. Temperature dependence of conductivity, carrier density and carrier mobility in semiconductors, synthesis and purification of semiconducting materials, single crystal growth, zone refining, fractional crystallization. Superconductivity: Introduction, theory of super conductivity, Meissner effect, Type I&II superconductors, crystal structure of high temperature semiconductors.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand biophysical chemistry of enzyme catalysed reaction. Immobilization ofenzymes and role of cell membrane.
2.	Identify the separation of solid or liquid using phase diagram.
3.	Designing of new compounds using concept of solid state.
4.	Different theories help to understand the behaviour of Electronic materials in depth.

Suggested Reference Books:

1. Phase equilibria by Mats Hillert
2. Biochemistry by C.B. Powar and G.R. Chatwal
3. Physical chemistry by P.W. Atkins & de Paula 7Th Edition
4. Advanced physical chemistry by Gurtu & Gurtu
5. West A.R. Solid State Chemistry and its Applications, Plenum
6. Solid state chemistry: introduction by Lesley E. Smart Elaine A. Moore, CRC press
7. West A.R. Solid state Chemistry, John Wiley
8. Solid State Chemistry by D.K. Chakraburti, New Edge Internation Publication 1996.
9. West A.R. Solid State Chemistry and its Applications, Plenum

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

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

Course Code	[1903080203050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	12 hrs.

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

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■	■				■	■
CO2	■	■			■	■		■		■	■	
CO3	■	■	■		■	■			■	■		
CO4	■	■		■	■	■				■	■	

Course Content	
Full experiment (Instrumental/ non-instrumental)	4-Credit
Half experiment (Instrumental)	
Half experiment (Non-instrumental)	4-Credit
Viva-Voce	

FULL EXPERIMENT (Any Seven)

1. To Study the kinetics of reaction between $K_2S_2O_8$ and KI. Determine rate constant, order ofreaction and influence of ionic strength on rate constant
2. Determination of CMC of surfactant by conductance method and calculate thermodynamic parameters for micellization
3. To study the kinetics of hydrolysis of ethyl acetate by NaOH at two different temperatures by conductance measurement and find out energy of activation of the reaction.
4. Determine the effect of salts on the cloud point of nonionic surfactant.
5. Determination of constants of Mark-Houwink equation for polymer by viscosity method
6. Determine ionic composition of synthetic sea water samples by flame photometer.

7. Determine parachor/density/refractive index of binary solutions.
8. To determine the Ca^{+2}, Mg^{+2} and Fe^{+2} content in a sample of dolomite ore.
9. Study influence of ionic strength on solubility of $CaSO_4$ and determine thermodynamic solubility product and mean ionic strength.

HALF EXPERIMENT (Any Seven)

1. Study the ratio of complex formation formed by titration of Zn^{2+} with potassium ferrocyanide potentiometrically.
2. Electrogravimetric determination of copper from solution
3. Equivalence conductance of solutions of strong electrolytes and weak electrolytes. Application of Kohlrausch's law. Onsager constant.
4. K_a of weak organic acid [benzoic acid] conduct metrically.
5. Study stability constant of complex formation between Fe (III) and salicylic acid
6. Determine ionization constant of bromophenol blue using pH meter.
7. Preparation of simple colloids and determination flocculation value for different salts.
8. Study Hydrolysis constant of methyl acetate catalysed by HCl and equi-normal urea hydrochloride, determine degree of hydrolysis for the salt.
9. Determine basicity of organic acid by conductometer
10. Structure Identification and Elucidation by IR/NMR/MS spectroscopy

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand preparation of solutions.
2.	Theory of complex formation.
3.	Calculate the concentration of unknown solution by Spectrometrically.
4.	Molecular weight concept of polymer
5.	Concept of conductance and pH for mixed solution.
6.	Theories of Indicators

Suggested 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

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Physical Chemistry
M.Sc. Physical Chemistry, Semester-IV
Paper-I

Course Code	[2003080204010004]	Title of the Course	**Advanced Chemical Kinetics**
Total Credits of the Course	4	Hours per Week	4 hrs.

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

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■		■	■			■	■	■	
CO2	■	■	■		■	■				■	■	■
CO3	■	■	■	■	■	■					■	■
CO4	■		■	■			■		■	■		

Course Content		
Unit	Description	Weightage* (%)
1.	**THEORIES OF REACTION RATES** Arrhenius theory of reaction rates, collision theory of bimolecular gaseous reaction, limitations and extension of collision theory, Rate theories based on thermodynamics, rate theories based on statistical mechanics, conventional transition-state theory (CTST), statistical mechanics and chemical equilibrium, Derivation of the rate equation, Thermodynamic formulation of CTST, few Applications of CTST, Assumptions and limitation of CTST, Extension of CTST: Vibration CTST.	25
2.	**REACTIONS IN SOLUTION PHASE AND GAS PHASE** Solution Phase Reaction: Solvent effects on reaction rates, factors determining reaction rates in solution, reaction between ions, ion dipole and dipole-dipole reactions. Effect of ionic strength. Substituent and correlation effects – Hammett equation. Linear free energy relationship. Gas Phase Reaction: Theories of unimolecular gaseous	25

	reaction: Lindemann-Christiansen hypothesis, Hinshelwood treatment, Rice Ramsperger Kassel (RRK) theory, RRKM theory.	
3.	**KINETICS OF CATALYSIS AND ADSORPTION** Catalysis Characteristic and types of catalyst, Homogeneous and heterogeneous catalysis and their commercial processes, General catalytic mechanisms: Equilibrium treatment (Arrhenius Intermediates), Steady state treatment (Van't Hoff intermediates), Activation energies for catalyzed reaction. Acid-base catalysis, General acid base catalysis, Mechanism of acid base catalysis, Bronsted catalysis law and acidity functions. Kinetics of Adsorption: Isotherm for simple, Dissociation, competitive adsorption, statistical thermodynamics of Adsorption, mechanism for unimolecular and bimolecular surface reaction.	25
4.	**KINETICS OF COMPLEX REACTIONS** Kinetics of (I) Reversible reaction: when first order reaction opposed by second order reaction, when second order reaction opposed by first order reaction, Second order reaction opposed by one of the same order (II) Parallel reaction (III) Feedback, non- linearity and Oscillation reactions: (i) The Lotka - Volterra mechanism (ii) The Brusselator mechanism (IV) Explosion (V) Photochemistry: Photo physical Processes, Fluorescence and Fluorescence Quenching, Measurement (T_f), Fluorescence Resonance Energy Transfer (VI) Electron transfer, Kinetic Model of Electron Transfer.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	To learn statistical thermodynamic approach to chemical kinetics. The factors responsible for rate of reaction. Thermodynamic concept to understand the rate constant of the reaction.
2.	Gives guidelines to understand control of reaction condition, increase reaction

	rate to increase production, effect of catalysis, slow down side reaction and improve separation process.
3.	To learn about mechanism of various catalytic reactions Arrhenius and Van't-Hoff concept of catalytic mechanism.
4.	To learn about kinetics of control of solution and gas phase reaction.

Suggested Reference Books:

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

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Physical Chemistry
M.Sc. Physical Chemistry, Semester-IV
Paper-II

Course Code	[2003080204020004]	Title of the Course	**Atomic Spectroscopy**
Total Credits of the Course	4	Hours per Week	4 hrs.

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

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■			■	■		
CO2	■	■		■	■	■					■	■
CO3	■	■	■	■	■	■			■	■	■	
CO4	■	■	■	■	■	■			■	■		

Course Content		
Unit	Description	Weightage* (%)
1.	**ATOMIC X-RAY SPECTROSCOPY** Emission of X-ray, continuum and line spectra, X-ray absorption, absorption spectra, Apparatus, Source (monochromatic X-ray), Sample handling, Wavelength and energy dispersive device, Detector, Chemical analysis by X-ray absorption, X-ray fluorescence: Theory, instrumentation and applications, X-ray diffraction: Theory, instrumentation and applications.	25
2.	**ATOMIC ABSORPTION AND FLAME EMISSION SPECTROSCOPY** a) **Atomic Absorption Spectroscopy (AAS)** Principle of AAS, Instrument, Continuous sources and line sources, Flames, Flame atomizers, non-flame atomizers (furnaces),	25

	Monochromator and Detector, Interference with AAS Quantitative, Analysis with AAS, Applications, Numerical. (b) **Flame Emission Spectroscopy (FES)** Flame as a source of atomic vapour, Flame atomization, Flame photometer, Applications and limitations comparison with AAS.	
3.	**ELECTRON SPIN RESONANCESPECTROSCOPY** Introduction, Factors affecting the g-value, Limitations of ESR, Difference between ESR and NMR, Instrumentation, Electron nucleus coupling, Hyperfine interactions-isotropic and anisotropic coupling constants, The spin Hamiltonian, Quantitative analysis, Sensitivity, Choice of solvent, applications of ESR, Study of free radicals, Electronic and Hyperfine splitting, Triplet states- zero field splitting and Kramer's degeneracy, Analytical applications of ESR, Structural determination by ESR, Study of inorganic compounds by ESR, Transition elements, Biological systems.	25
4.	**ATOMIC EMISSION AND FLUORESCENCE SPECTROSCOPY** **Atomic Emission Spectroscopy:** Emission spectroscopy with plasma sources, Instrument, AES with electrical discharge, Electrodes of AES, DC- arc, spark, Laser microprobe, Salient features of the emission spectrograph, Qualitative and Quantitative analysis applications. **Fluorescence Spectroscopy:** Atomic fluorescence, apparatus for AFS, EMR source for AFS, LASERS, Cells for AFS, Plasmas, Wavelength selection for AFS, Detectors for AFS, Theory of AFS, Analysis with AFS, Interference with AFS.	25

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

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

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

Suggested Reference Books:

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

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Physical Chemistry
M.Sc. Physical Chemistry, Semester-IV
Paper-III

Course Code	[2003080204030004]	Title of the Course	**Separation Techniques**
Total Credits of the Course	4	Hours per Week	4 hrs.

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

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■			■	■		
CO2	■	■	■	■	■	■			■	■	■	
CO3	■	■	■	■	■	■					■	■
CO4	■	■			■	■			■	■		

Course Content		
Unit	Description	Weightage* (%)
1.	**SOLVENT EXTRACTION** Principle of solvent extraction, Nernst distribution law, Distribution coefficient, Equations for the solute dissociating or associating in one phase, limitations of distribution law, Application: partition chromatography, Distribution ratio, selectivity ratio, Successive extractions, Extraction of metal ion with chelating agent with necessary equation, Extraction involving association of ion pairs, extraction by solvation, types of Multiple extractions, multiple extraction with successive portion, basic concept, Apparatus and binominal distribution for Craig pseudo / continuous counter current extractions. True counter current extraction: Fractional distillation, Use of crown ethers and Cryptands for extraction, extraction equilibria with crown ethers, factors affecting extraction with crown ether, numerical of distribution coefficient and multiple extraction.	25
2.	**THEORY OF CHROMATOGRAPHY**	25

	Methods of elution, Ideal and non-ideal chromatography, Plate theory, Rate theory, Reasons for broadening of peaks, Van Deemter equation and significance of terms involved, Optimum velocity, Resolution, Methods to improve resolution, GLC, Supports for liquid stationary phases, Selection of columns, FSOT, Selective Detectors- FPB, TID, Temperature programming in GC, Derivatization in GC, Qualitative analysis from retention parameters, Quantitative analysis, Headspace Analysis, Thermal Desorption.	
3.	**LIQUID CHROMATOGRAPHY** **a. Ion-exchange Chromatography:** Resins used, Principle of exchange, Factors affecting the exchange, Capacity of resin and its determination, Techniques, IEC with eluent suppressor columns, Applications. **b. Gel-permeation Chromatography:** Principle, Types of gels, Theoretical principles, Techniques and applications. **c. Adsorption Chromatography:** Principle, column packings, adsorbents, mobile phase, technique of separation, detectors, identification of compounds, applications, Chiral Chromatography. **d. Affinity Chromatography:** Introduction, classification, column matrices, affinity ligands, elution methods, applications.	25
4.	**SOLID PHASE EXTRACTION AND MICROEXTRACTION** **a) Solid Phase extraction (SPE):** Introduction, Types of SPE media, SPE formats and apparatus, method for SPE operation, solvent selection, factors affecting SPE, selected methods of analysis for SPE, Automation and On-Line SPE **b) Solid phase micro-extraction (SPME):** Introduction, theoretical considerations, experimental, Methods of analysis: PMEGC, Methods of analysis: SPME-HPLC-MS, Automation of SPME, New development in micro-extraction (liquid micro-extraction, membrane micro-extraction).	25

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

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

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

Suggested Reference Books:

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

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

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

Course Code	[2003080204040004]	Title of the Course	**Polymer Chemistry**
Total Credits of the Course	4	Hours per Week	4 hrs.

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

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■		■	■			■	■	■	
CO2	■	■			■	■			■	■	■	
CO3	■	■		■	■	■		■		■	■	■
CO4	■	■			■	■			■	■		

Course Content		
Unit	Description	Weightage* (%)
1.	**SOLUTION BEHAVIOUR OF POLYMER SOLUTION** Criteria for polymer dissolution, Factors affecting swelling and dissolution: Effect of molecular weight and degree of crystallinity on dissolution, Size and shape of polymer molecules in solution, Thermodynamics aspects of polymer dissolution, cohesive energy density, Solubility parameter and its uses and determination, Flory-Huggins theory, Enthalpy of mixing, ΔS, ΔH and ΔG of mixing, Thermodynamics of dilute polymer solution, vapour pressure, Phase equilibria and phase separations in polymer solutions, Flory interaction parameter and determination. Unperturbed dimensions of polymer coil, Good/poor/theta and non-solvents, Viscosity of polymer solutions and the size of polymer coil, Effect of molecular weight on viscosity, determination of intrinsic viscosity in theta conditions. Concentrated polymer solutions and physical gelation, Newtonian & Non-Newtonian	25

	solutions.	
2.	**CHARACTERISATION OF AMORPHOUS AND CRYSTALLINE POLYMERS** Thermal stability and thermal transitions in polymers, Melting versus glass transition, Glass transition temperature, its cause and importance, Relation between T_g and T_m, Factors affecting glass transition temperature: Chain flexibility, effect of plasticizers, blending and copolymerization of T_g, Determination of glass transition method by dilatometry, Crystalline polymers, Fringe micelle model, Factors affecting polymer crystallinity, Degree of crystallinity in polymers, Polymer crystallization, Spherulites and crystallites, Polymer single crystals, Chain folding during crystal formation, Crystallizability and crystallinity, Effect of crystallinity on properties of polymer.	25
3.	**COPOLYMERIZATION AND FRACTIONATION** Kinetics of free radical copolymerization, reactivity ratios and their determination, Mayo-Lewis method, Fineman-Ross method, Disadvantages of F-R method , Kelen-Tudos (K-1) method Reactivity in copolymerization: Alfrey & Price method, Prediction of copolymer composition, Ionic copolymerization, co-polycondensation, Ideal, alternate & azeotropic copolymerization, Graft and block copolymers, Polymer mixtures: IPNs, Composites, Blends and Alloys Polymer Fractionation: fractional precipitation techniques, partial dissolution technique, gradient elution technique, GPC technique.	25
4.	**POLYMER DEGRADATION AND REACTIONS** Polymer degradation: Definition, Types: thermal, mechanical, degradation by ultrasonic waves, photo degradation, degradation by high-energy radiations, oxidative and hydrolytic degradation, Polymer reactions: Hydrolysis, acetolysis, aminolysis, hydrogenation, addition and substitution reaction, reaction of various specific groups, cyclization reaction and cross-linked reactions, reaction leading to graft and block copolymers, miscellaneous reactions.	25

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage

1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

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

Suggested Reference Books:

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

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

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

Course Code	[2003080204050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	12 hrs.

Course Objectives:	• To impart basic knowledge for preparation of solution and instrumental set up for the experiments. • Understand theories of the experiments. • To understand the factors affecting desirable results of the experiments. • The graphicalrepresentation of results and their interpretation.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■				■	■	■	
CO2	■	■		■	■	■			■	■		
CO3	■	■		■	■	■			■	■	■	■
CO4	■	■		■	■	■					■	■

Course Content	
Full Experiment (Instrumental/ non-instrumental)	4-Credit
Half experiment (Instrumental)	
Half experiment (non-instrumental)	4-Credit
Viva-Voce	

FULL EXPERIMENT (Any Seven)

1. Determination of the primary salt effect on the kinetics of ionic reactions (Persulphate-iodide reaction) by isolation method.
2. To calculate the surface area of adsorbed molecule in a monolayer, CMC, effectiveness from surface tension measurements of aqueous solutions of surfactant.
3. Determinations of pK_a value of acid-base Methyl red indicator by spectrophotometry.
4. To carry out fractionation of a polydispersed polymer by viscosity method.
5. Ion exchange separation of Fe^{+3} and Co^{+2} and determination of Fe^{+3} spectrophotometrically.
6. Determine partition function of two organic compounds in ether – water system and find out molecular condition of organic compound in ether.
7. Determine equilibrium constant of reversible reaction between Ag^{+2} and $CaSO_4$.
8. Determine relative strength of two acids (HCl and H_2SO_4) and study hydrolysis of ester.

9. Potentiometric titration of halide mixture of KCl, KBr, KI against std. $AgNO_3$ solution.

HALFEXPERIMENT (Any Seven)

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

Teaching-Learning Methodology	Introduction, interaction with students in calculation of solution preparations, carry out experiments at each step according to the respective practical, stoichiometry calculation.

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand effect of factors on kinetics of reactions.
2.	Understand complexometric titration.
3.	Calculate the concentration of unknown solution by pH, potentiometer and spectrometrically.
4.	The extraction of compounds in solvent water system.
5.	Theories of polymer fractionation.
6.	Theories of indicators.

Suggested 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

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

M.Sc. Semester-III (ANALYTICAL CHEMISTRY)

Sr. No.	Course Title	L	T/C/S	Credit
1	Analytical Methods of Analysis	4		4
2	Molecular Spectroscopy	4		4
3	Electro Analytical Techniques	4		4
4	Applied Analysis	4		4
5	Practical	12	4	8
		28	4	24

External Examination Time Duration: 03 hrs.

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	III	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Core	04	30	70	100
			Practical	08	60	140	200
			Total	24	180	420	600

M.Sc. Semester-IV (ANALYTICAL CHEMISTRY)

Sr. No.	Course Title	L	T/C/S	Credit
1	Advance Analytical Techniques	4		4
2	Atomic Spectroscopy	4		4
3	Separation Techniques	4		4
4	Applied Analysis	4		4
5	Practical	12	4	8
		28	4	24

External Examination Time Duration: 03 hrs.

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	IV	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Core	04	30	70	100
			Practical	08	60	140	200
			Total	24	180	420	600

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester-III
Paper-I

Course Code	[1903080203010001]	Title of the Course	**Analytical Methods of Analysis**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand advancement in thermal methods of analysis with various factors affecting the results and their application in various field. • To learn the basic concepts of electrical methods such as coulometry, electrogravimetry with their application in various titrations. • To understand basic principles and theory of various voltammetry methods such Rapid scan, hydrodynamic, anodic stripping, cyclic with their application. • To learn basic principles, theory of radio chemical methods, half- life and different uses of radioactive substance in various application.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■	■	■			■	■
CO2	■	■	■	■	■	■				■	■	■
CO3	■	■	■	■	■	■			■	■	■	
CO4	■	■		■	■	■	■		■	■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**THERMAL METHODS OF ANALYSIS** Differential thermal analysis (DTA), Differential scanning calorimetry (DSC), Instrument, Reference materials, Diluents, Factors affecting DTA results, Applications, Evolved gas detection and analysis, Instrumentation, application, hyphenation with other techniques, Direct Injection Enthalpimetry, Applications, Numerical.	25
2.	**ELECTRICAL METHODS OF ANALYSIS** Liquid Junction Potential, Mass transfer, Electric Double layer,	25

	Faradic and Non-faradic Current, Polarization effect, Types of Polarization, Electrogravimetry, Constant Potential and current Electrolysis, Factors affecting the quality of deposits, Applications. Principle of Coulometry, Controlled current coulometry, Instrumentation and application of Controlled potential coulometry, Coulometric titrations (primary and secondary), endpoint detection in coulometry titration, applications and Problems.	
3.	**VOLTAMETRY METHODS OF ANALYSIS** **Rapid Scan Voltammetry:** Principle, Rapid voltage scan at the end of the drop life, Peak current equation, Relation of peak current with the scanning rates, Summit potential equation, Comparison with DC polarography, Limitations. **Hydrodynamic Voltammetry:** Principle and similarity with DC polarography, Types of electrodes used, Applications of the technique in determination of rate constant of the reaction. **Anodic Stripping Voltammetry:** Concentration and stripping steps, Importance of Hanging mercury drop electrode and MTFE, Sensitivity of the technique, Adsorptive stripping, Applications, Cathodic stripping. **Cyclic Voltammetry:** Principle, Forward and reverse scan, cyclic voltammogram, Detection limits, Applications.	25
4.	**RADIO-CHEMICAL METHODS OF ANALYSIS** Interaction of radiation with matter, Units of radioactivity, Statistics of counting, Background corrections, Neutron activation analysis, Sources of neutrons, Theory of instrumental neutron activation analysis, Experimental considerations, Isotope dilution analysis (Direct and Inverse), Radio immuno assay, Radiometric titrations, Radio release methods, Radiation safety, Numericals.	25

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

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

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

Suggested Reference Books:

1. Vogel's Text book Quantitative Chemical Analysis 5th edition by G.H.Jeffery, J. Bassett, J.Mendham, R.C. Denney.
2. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage lerning, 7th edition)
3. Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2nd edition.
4. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th edition.
5. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (VanNostrand Reinhold Co., New York), 6th edition.
6. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company),New Delhi.
7. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).
8. Introduction to Modern Liquid Chromatography: L. R. Shyder & J. J. Kirkland (John Wiley & Sons, New York).
9. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
10. Basic concepts of Analytical Chemistry by S.M. Khopkar
11. Standard Methods of Chemical Analysis: Vol. I & II (6th edition), D. Van Nostrand Co. Inc.(London).
12. Instrumental Methods of Chemical Analysis: B. K. Sharma (Goel Publishing House, Meerut).
13. Instrumental methods of Chemical Analysis by H. Kaur.
14. "Polarography", J. D. Talati (In Gujarati), University Granth Nirman Board.
15. "Polarography": Kolthoff I. M. and Lingane J. J. (Vol. I & II) (Interscience Publishers, NewYork).
16. "Polarographic Techniques": L. Meites (Interscience Publishers, New York).
17. Principles of Instrumental Analysis (5th ed.) by Skoog, Holler and Nieman (Saunders

College Publishing's).
18. Undergraduate Instrumental Analysis (5^{th} ed.), J. W. Robinson (Marcel Dekker Inc.).

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester-III
Paper-II

Course Code	[1903080203020001]	Title of the Course	**Molecular Spectroscopy**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To familiarize with the basic properties, theory & interpretation of IR and Raman edge in the theory and principles of spectroscopic techniques for characterization and differentiation of various molecules. • To familiarize with the basic properties, theory and interpretation of NMR edge in the theory and principles of spectroscopic techniquesfor characterization differentiation of various molecules. • To familiarize with the basic properties, theory and interpretation molecular mass edge in the theory and principles of spectroscopic techniques for characterization and differentiation of various molecules. • To familiarize with the basic properties, theory and interpretation of luminescence edge in the theory and principles of spectroscopic techniques for characterization and differentiation of various molecules.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■		■	■			■	■	■	■
CO2	■	■	■		■	■			■	■	■	
CO3	■	■	■		■	■				■	■	■
CO4	■	■	■		■	■			■	■	■	

Course Content		
Unit	Description	Weightage* (%)
1.	**IR AND RAMAN SPECTROSCOPY** Theory of IR and Raman, selection rules, IR absorption, Raman scattering, Mutual exclusion rule, complimentary techniques, Instrumentation - FTIR and Raman, Cells and sampling techniques, Resonance Raman spectroscopy, Interpretation of IR spectra using	25

	correlation charts, Advantages of FTIR spectroscopy, Mid-IR Reflection – DRS, ATR, Data processing in Near IR, Applications in structure, elucidation of inorganic and organic molecules.	
2.	**NMR SPECTROSCOPY** Theory of NMR, Relaxation, population of energy levels, Larmor precession, chemical shift and factors affecting it, references and solvents, Spin-spin splitting, Coupling constant, Magnetic Anisotropy, Instrumentation, Shift Reagents, Interpretation of simple NMR spectra,Signal averaging, FT-NMR, Pulse FT-NMR spectroscopy, ^{13}C NMR spectra, Calculation of chemical shift in ^{13}C NMR, NMR in medical diagnostics, Double resonance technique, Multi-dimensional NMR, Problems to elucidate structure from NMR spectra.	25
3.	**MOLECULAR MASS SPECTROSCOPY** (Instrumentation, Methods of ion production (EI, CI, FI, FD, Electrospray, MALDI), Ion separators, Ion collection and recording, Double focusing, Time of flight analyser, Quadruple-mass spectrometer, Sample handling techniques, Resolution, Parent peak, Base peak, Metastable ions isotope effect, Molecular formula from mass spectra, Nitrogen rule, Ring rule, Fragmentation rules, Behavior of classes of compounds, Interpretation of mass spectra, Additional applications, Problems to elucidate structure from mass spectral data.	25
4.	**MOLECULAR LUMINESCENCESPECTROSCOPY** Introduction to molecular luminescence (fluorescence, phosphorescence and chemiluminescence); theory of luminescence, energy level diagram, Deactivation process, instruments for measuring fluorescence (fluorometer and spectrofluorometer); factor affecting, Emission and excitation spectra, wavelength selector, detector, application and problems.	25

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

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

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

Suggested Reference Books:

1. Vogel's Text book Quantitative Chemical Analysis 5th edition by G.H.Jeffery, J. Bassett, J.Mendham, R.C. Denney.
2. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage learning, 7th edition)
3. Principle of Activation Analysis- P. Kruger, John Wiley and sons, (1971).
4. Nuclear Analytical Chemistry – J. Tolgyessy and S. Verga vol. 2, university Park press (1972)
5. Radiochemistry and Nuclear methods – W.D. Ehmann and D.E. Vance, John Wiley and Sons.
6. Indian Pharmacopeia Volume I and II.
7. Extraction technique in analytical science, John R. Dean, Wiley (2009)
8. Standard methods of chemical analysis, Sixth Edition, F.J. Welcher.
9. Quantitative Inorganic Analysis including Elementary Instrumnetal analysis, By A. I. Vogel,3rd ed., ELBS, 1964.
10. Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2nd edition.
11. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th edition.
12. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (VanNostrand Reinhold Co., New York), 6th edition.
13. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2nd edition.
14. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company),New Delhi.
15. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).
16. Introduction to Modern Liquid Chromatography: L. R. Shyder & J. J. Kirkland (John

Wiley & Sons, New York).
17. Treatise on Analytical Chemistry: I. M. Kohthoff & P. J. Elving (John Wiley & Sons, NewYork).
18. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
19. Basic concepts of Analytical Chemistry by S.M. Khopkar
20. Standard Methods of Chemical Analysis: Vol. I & II (6^{th} edition), D. Van Nostrand Co. Inc.(London).
21. Official Methods of Analysis: Published by Association of Official Analytical Chemists,Washington.
22. Instrumental Methods of Chemical Analysis: B. K. Sharma (Goel Publishing House, Meerut).
23. Instrumental methods of Chemical Analysis by H. Kaur.
24. Principles of Instrumental Analysis (5^{th} ed.) by Skoog, Holler and Nieman (Saunders College Publishing's).
25. Undergraduate Instrumental Analysis (5^{th} ed.), J. W. Robinson (Marcel Dekker Inc.).
26. Fundamentals of Molecular Spectroscopy, by Banwell.
27. Electronic Absorption Spectroscopy and related techniques, D.N. Sathyanarayan, (New AgeInternational ND. 1996) Uni. Press, Hyderabad.
28. Introduction to Spectroscopy (3^{rd} ed.) by Pavia Lampman Kriz, Cengage Learning Harcourt College Publishers

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

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

Course Code	[1903080203030001]	Title of the Course	**Electroanalytical Techniques**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To familiarize with the basic principles, theory in potentiometry and chronopotentiometry techniques for various titration and applications. • To learn about basic theory and principles of DC-polarography, amperometry, bio-amperometry methods, their instrumentation and applications. • To learn about basic principle and instrumentation as well as theory of modern polarographic technique such as A.C, Square wave and Pulse Polarography for application in determination of various metal ions in the solution. • To understand the basic principles and theory of ion selective electrodes and their application for the determination of various ions in the solution with their instrumentation.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■			■	■	■	■
CO2	■	■	■		■	■			■	■	■	
CO3	■	■	■		■	■	■		■	■	■	
CO4	■	■	■	■	■	■	■			■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**POTENTIOMETRIC TITRATION AND CHRONOPOTENTIOMETRY** Fundamentals of potentiometry, Instrumentation, electrode system, accuracy of direct potentiometric measurements and its limitations, potentiometric titrations, neutralization titrations, end- point detection, oxidation- reduction, precipitation titrations, complexometric titrations with example, applications and advantages. **Chronopotentiometry**	25

	Principle, Instrumentation and procedure, applications.	
2.	**DC-POLAROGRAPHY** Theory and Applications of Polarography, Types of currents: Residual Current, Migration Current and Diffusion Current, Natureof the Limiting Current: 1) Kinetic currents, 2) Catalytic currents and 3) Adsorption currents, Electro capillary maxima, Maxima of first kind and second kind, Maxima suppressors, DME as electrode, Wave equation, Ilkovic equation (derivation), Reversible electrode reactions at DME half wave potential, Interference and removal of oxygen, Reversible Electrode Reactions of Metal Complexes at D.M.E (Ligane method) Determination of stability constants of complexes. **Amperometric titrations:** Principle, DME & RPE, curves, Bio-Amperometric titration.	25
3.	**MODERN POLAROGRAPHIC METHODS** **A.C. Polarography:** Principle of Sinusoidal alternating applied potential, AC peak polarogram, Peak current equation, Characteristic of AC polarographic peak, Importance of signal to noise ratio for the sensitivity, Comparison with DC polarography. **Square-wave Polarography:** Principle of alternating rectangular wave voltage applied, Frequency of square wave applied, Problems of large condenser currents in A.C., Peak polarogram, Peak current equation, Limitations of techniques. **Pulse Polarography:** Effect of capillary response with frequencyof applied square wave potential, Principles and difference between Normal Pulse Polarography and Differential Pulse Polarography, Importance of charging and Faradaic currents.	25
4.	**ION SELECTIVE ELECTRODES** Classification of ion selective electrodes, Solid state electrodes – Glass electrode effect of glass structure on selectivity function of the glass electrode. Acid error, Alkali error, Silver halide, Sulphide, Lanthanum fluoride ion selective electrodes. Liquid ion exchange electrode – Calcium selective ion electrodes. Gas electrodes, ammonia, sulphur dioxide, oxygen and CO_2 sensing electrode, Micro ion selective electrode, enzyme electrodes.Application and Numerical.	25

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

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

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

Suggested Reference Books:

1. Vogel's Text book Quantitative Chemical Analysis 5th edition by G.H.Jeffery, J. Bassett, J.Mendham, R.C. Denney.
2. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage learning, 7th edition)
3. Radiochemistry and Nuclear methods – W.D. Ehmann and D.E. Vance, John Wiley and Sons.
4. Extraction technique in analytical science, John R. Dean, Wiley (2009)
5. Quantitative Inorganic Analysis including Elementary Instrumental analysis, By A. I. Vogel,3rd ed., ELBS, 1964.
6. Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2nd edition.
7. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th edition.
8. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (VanNostrand Reinhold Co., New York), 6th edition.
9. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2nd edition.
10. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company),New Delhi.
11. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall

Internationaledition).
12. Treatise on Analytical Chemistry: I. M. Kohthoff & P. J. Elving (John Wiley & Sons, NewYork).
13. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
14. Basic concepts of Analytical Chemistry by S.M. Khopkar
15. Standard Methods of Chemical Analysis: Vol. I & II (6^{th} edition), D. Van Nostrand Co. Inc.(London).
16. Official Methods of Analysis: Published by Association of Official Analytical Chemists,Washington.
17. Instrumental Methods of Chemical Analysis: B. K. Sharma (Goel Publishing House, Meerut).
18. Inorganic Quantitative Analysis: A. I. Vogel (Orient Longman).
19. "Polarography", J. D. Talati (In Gujarati), University Granth Nirman Board.
20. "Polarography": Kolthoff I. M. and Lingane J. J. (Vol. I & II) (Interscience Publishers, NewYork).
21. "Polarographic Techniques": L. Meites (Interscience Publishers, New York).
22. Principles of Instrumental Analysis (5^{th} ed.) by Skoog, Holler and Nieman (Saunders College Publishing's).
23. Undergraduate Instrumental Analysis (5^{th} ed.), J. W. Robinson (Marcel Dekker Inc.).
24. Fundamentals of Molecular Spectroscopy, by Banwell.
25. Electronic Absorption Spectroscopy and related techniques, D.N. Sathyanarayan, (New Age International ND. 1996) Uni. Press, Hyderabad.
26. Introduction to Spectroscopy (3^{rd} ed.) by Pavia Lampman Kriz, Cengage Learning HarcourtCollege Publishers

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester-III
Paper-IV

Course Code	[1903080203040001]	Title of the Course	**Applied Analysis**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand basic concepts of ores and cements, their properties and analysis of various elements present in ore and cements by various methods. • To understand basic concepts of air and soil, their properties and analysis of various pollutants and minerals present in air and soil by various methods. • To understand basic concepts of clinical and food, their properties and analysis of various adulteration present in food and molecules present in blood serum by various methods. • To understand basic concepts of paints and pigments, their properties and analysis of various elements present in paints and pigments by various methods.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■			■	■	■	
CO2	■	■		■	■	■			■	■	■	■
CO3	■	■	■	■	■				■	■	■	
CO4	■	■	■	■	■				■		■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**ANALYSIS OF ORES AND CEMENT** **Ores:** Dolomite (For silicate, Mg and Ca content), Ilmenite (for silicate, Ti and Fe content), Monazite (Ce and Th metals), Hematite and Magnetite (silicate and Fe content), Pyrolusite (for silicate and Mn content) and bauxite (for Al and Silicate content). **Cement:** Composition of cement and characterization, setting and hardening of cement, Analysis of cement for silica, calcium, magnesium, iron, sodium and potassium using ISI method.	25
2.	**ANALYSIS OF AIR AND SOIL**	25

	Air: Sampling, Analysis of air borne particulates using emission spectroscopy, Determination of CO, SO_2, CO_2, NO_x, H_2S, O_3 in air sample. Non-dispersive IR spectrophotometry to determine CO and CO_2. **Analysis of Soil:** Moisture, pH, Total nitrogen, phosphorous, silica, lime, magnesia, sulfur, manganese.	
3.	**CLINICAL CHEMISTRY AND FOOD PRODUCT ANALYSIS** **Clinical Chemistry:** Determination of glucose, electrolytes, urea, cholesterol, uric acid in blood serum. **Food Products:** Analysis of (i) Oils and fats, Iodine value, Saponification value, RM value, (ii) reducing and non-reducing sugars (iii) butter, honey, fruit, juices, non-alcoholic beverages, (iv) adulteration in oil, ghee, butter.	25
4.	**ANALYSIS OF PAINTS AND PIGMENT** Introduction, test of Volatile and Non-volatile content, separationof pigment binder, Analysis of pigments, Identificationof inorganic pigments, Analysis of white and tinted pigments, HCL insoluble, Titanium dioxide, total lead, acid soluble Al and Fe, acidsoluble calcium, total zinc, antimony oxide, total sulfate, totalcarbonate) analysis of ultramarine blue, Black pigments, Red Lead pigments.	25

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

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

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

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

Suggested Reference Books:

1. Vogel's Text book Quantitative Chemical Analysis 5th edition by G.H.Jeffery, J. Bassett, J.Mendham, R.C. Denney.
2. Radiochemistry and Nuclear methods – W.D. Ehmann and D.E. Vance, John Wiley and Sons.
3. Extraction technique in analytical science, John R. Dean, Wiley (2009)
4. Quantitative Inorganic Analysis including Elementary Instrumental analysis, By A. I. Vogel,3rd ed., ELBS, 1964.
5. Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2nd edition.
6. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th edition.
7. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2nd edition.
8. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company),New Delhi.
9. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall Internationaledition).
10. Treatise on Analytical Chemistry: I. M. Kohthoff & P. J. Elving (John Wiley & Sons, NewYork).
11. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
12. Basic concepts of Analytical Chemistry by S.M. Khopkar
13. Standard Methods of Chemical Analysis: Vol. I & II (6th edition), D. Van Nostrand Co. Inc.(London).
14. Official Methods of Analysis: Published by Association of Official Analytical Chemists,Washington.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

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

Course Code	[1903080203050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	12 hrs.

Course Objectives:	• To impart basic knowledge for carrying out analysis of some ore and cements • Understand the importance of various instrumental techniques in analysis. • To learn about the calculation in analysis. • To learn about the stoichiometry used in analysis of compounds. • Preparation of solution used in determination of various compounds.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■			■	■			■	■	■	
CO2	■	■			■	■				■	■	■
CO3	■	■	■		■	■			■	■	■	
CO4	■	■	■		■	■	■		■		■	■

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

Major Exercise: (any Eight)

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

Minor Exercise: (Any Eight)

1. Determination of fluoride in a given solution / tooth paste by Zirconyl-Alizarin red method colorimetrically.
2. Analysis of organic materials: Glycerol, Glycine.
3. Determination of Pb^{+2} as PbCrO4 after precipitation from homogeneous solution.
4. Analysis of Chloride in bleaching material.
5. Determination of COD of water sample.
6. Determination of DO of water sample.
7. Determination of Ka_1 and Ka_2 of phosphoric acid.
8. Simultaneous determination of Cr^{+3} + Co^{+2} in a mixture.
9. Determination of Nitrite spectrophotometrically.
10. Biuret in the sample of urea
11. Thin layer chromatographic separation.
12. Interpretation of IR, NMR, Mass Spectra (Dry lab)
13. Constant current Coulometric titration of (i) As_2O_3 (ii) Phenol (iii) $Na_2S_2O_3$.
14. Analysis of dye intermediate containing $–NH_2$ by Potentiometric titration.
15. Electrogravimetric determination of Cu^{+2} in brass.

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

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

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

Suggested Reference Books:

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

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester-IV
Paper-I

Course Code	[2003080204010001]	Title of the Course	**Advance analytical techniques**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To learn the basic concept, theory, principles and instrumentation of electron spectroscopy and microscopic techniques which is applied for characterization of alloys and surface morphology of compounds. • To understand the principles, instrumentation of advanced chromatography and extraction techniques and also learn the comparison and application in the various fields. • Role of various electrophoresis techniques in the separation of ions in analytical chemistry, importance of micellar elctrokinetic chromatography and application in separation of protein and amino acids. • Study of combination of two techniques and their advantages over single techniques and their application in various fields.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■					■	■
CO2	■	■		■	■	■	■				■	■
CO3	■	■	■		■	■	■		■	■		
CO4	■	■		■	■	■			■		■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**ELECTRON SPECTROSCOPY AND MICROSCOPY** Introduction, Types of surface measurements, General techniques in surface spectroscopy, Sampling surfaces, Surface contamination, X-ray Photo electron spectroscopy- Principle, instrumentation and Application. Auger electron Spectroscopy- Principles, Instrumentation, application. Ion, laser and electron microprobe spectrometry, Application, Electron Microscope, SEM, STM and AFM, Numerical.	25

2.	**ADVANCED CHROMATOGRAPHY AND EXTRACTION** **Supercritical Fluid Chromatography (SFC):** Properties of supercritical fluid, Instrumentation and operating variables like effect of pressure, stationary phase, mobile phase, detectors, comparison with other chromatography, application. **Super Critical fluid extraction:** Introduction, Advantages, Instrumentation, Choice of SFC, Offline and Online Extraction, Application, Numerical.	25
3.	**ELECTROPHORESIS AND ELECTROCHROMATOGRAPHY** Definition, types, Free solution electrophoresis, Moving boundary electrophoresis, Zone electrophoresis, paper electrophoresis, typesof stabilizing medium, location of components, electrode, source of current, requirement of electrophoretic chamber, Immunoelectrophoresis Continuous (Curtain) flow electrophoresis, Gel electrophoresis. Capillary Electrophoresis, Column, Electro Chromatography, Field Flow Fraction (FFF),Micellar electrokinetic capillary Chromatography, Application.	25
4.	**HYPHENATED TECHNIQUES AND AUTO ANALYSER** MS-FTIR, ICP-MS, GC- MS, LC-MS, MS-MS, Tandem Mass Spectra, GC-FTIR. TG- FTIR, TG-MS. Auto analyser: Need for auto analyser, Instrument used in clinical laboratory, Flow Injection Analysis, Micro Fluid Disk, Discreet Automatic System, Oxygen Analyser.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand fundamental & theory of electron spectroscopy and microscopy. Learn the interaction of electron with matter, with different surfaces and its contaminations. Understand the working of microscope to find out the morphology of surfaces.

2.	Learn the advancement in chromatography with use of supercritical fluid CO_2, learn selection of stationary phase as well condition in operating, understand the online and offline extraction with super critical fluid.
3.	Understand fundamental concepts of the separation of charged particles, amino acids, ions with different electrophoresis techniques, learn the separation of molecules with the help of Field Flow Fraction.
4.	Understand limitation of single technique and advantages of hyphenated techniques over it, learn the need or types of auto analyser for clinical analysis.

Suggested Reference Books:

1. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage learning, 7th edition)
2. Quantitative Inorganic Analysis including Elementary Instrumental analysis, By A. I. Vogel,3rd ed., ELBS, 1964.
3. Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2nd edition.
4. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th edition.
5. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (VanNostrand Reinhold Co., New York), 6th edition.
6. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2nd edition.
7. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company),New Delhi.
8. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall Internationaledition).
9. Treatise on Analytical Chemistry: I. M. Kohthoff & P. J. Elving (John Wiley & Sons, NewYork).
10. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
11. Basic concepts of Analytical Chemistry by S.M. Khopkar
12. Standard Methods of Chemical Analysis: Vol. I & II (6th edition), D. Van Nostrand Co. Inc.(London).
13. Official Methods of Analysis: Published by Association of Official Analytical Chemists,Washington.
14. Instrumental Methods of Chemical Analysis: B. K. Sharma (Goel Publishing House, Meerut).
15. Inorganic Quantitative Analysis: A. I. Vogel (Orient Longman).
16. Principles of Instrumental Analysis (5th ed.) by Skoog, Holler and Nieman (Saunders College Publishing's).
17. Undergraduate Instrumental Analysis (5th ed.), J. W. Robinson (Marcel Dekker Inc.).
18. Fundamentals of Molecular Spectroscopy, by Banwell.
19. Electronic Absorption Spectroscopy and related techniques, D.N. Sathyanarayan, (New Age International ND. 1996) Uni. Press, Hyderabad.

20. Introduction to Spectroscopy (3rd ed.) by Pavia Lampman Kriz, Cengage Learning Harcourt College Publishers

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VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester-IV
Paper-II

Course Code	[2003080204020001]	Title of the Course	**Atomic Spectroscopy**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand and familiarize the basic principles, theory and instrumentation of atomic X-ray spectroscopy, to impart knowledge in theory and principles of spectroscopy, spectroscopic technique for characterization and differentiation of various elements/ions. • To understand and familiarize the basic principles, theory and instrumentation of absorption and emission spectroscopy, to impart knowledge in theory and principles of spectroscopy, spectroscopic technique for characterization and differentiation of various elements/ions. • To understand and familiarize the basic principles, theory and instrumentation of ESR spectroscopy, to impart knowledge in theory and principles of spectroscopy, spectroscopic technique for characterization and differentiation of various elements/ions. • To understand and familiarize the basic principles, theory and instrumentation of emission and fluorescence, to impart knowledge in theory and principles of spectroscopy, spectroscopic technique for characterization and differentiation of various elements/ions.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■			■	■		
CO2	■	■		■	■	■					■	■
CO3	■	■	■	■	■	■			■	■	■	
CO4	■	■	■	■	■	■			■	■		

Course Content		
Unit	Description	Weightage* (%)
1.	**ATOMIC X-RAY SPECTROSCOPY**	25

	Emission of X-ray, continuum and line spectra, X-ray absorption, absorption spectra, Apparatus, Source (monochromatic X-ray), Sample handling, Wavelength and energy dispersive device, Detector, Chemical analysis by X-ray absorption, X-ray fluorescence: Theory, instrumentation and applications, X-ray diffraction: Theory, instrumentation and applications.	
2.	**ATOMIC ABSORPTION AND FLAME EMISSION SPECTROSCOPY** a) **Atomic Absorption Spectroscopy (AAS)** Principle of AAS, Instrument, Continuous sources and line sources, Flames, Flame atomizers, Non flame atomizers (furnaces), Monochromator and Detector, Interference with AAS Quantitative Analysis with AAS, Applications, Numerical. (b) **Flame Emission Spectroscopy (FES)** Flame as a source of atomic vapour, Flame atomization, Flame photometer, Applications and limitations comparison with AAS	25
3.	**ELECTRON SPIN RESONANCESPECTROSCOPY** Introduction, Factors affecting the g-value, Limitations of ESR, Difference between ESR and NMR, Instrumentation, Electron nucleus coupling, Hyperfine interactions-isotropic and anisotropic coupling constants, The spin Hamiltonian, Quantitative analysis, Sensitivity, Choice of solvent, applications of ESR, Study of free radicals, Electronic and Hyperfine splitting, Triplet states- zerofield splitting and Krammer's degeneracy, Analytical applications of ESR, Structural determination by ESR, Study of inorganic compounds by ESR, Transition elements, Biological systems	25
4.	**ATOMIC EMISSION AND FLUORESCENCE SPECTROSCOPY** **Atomic Emission Spectroscopy:** Emission spectroscopy with plasma sources, Instrument, AES with electrical discharge, Electrodes of AES, DC- arc, spark, Laser microprobe, Salient features of the emission spectrograph, Qualitative and Quantitative analysis applications, **Fluorescence Spectroscopy:** Atomic fluorescence, apparatus for AFS, EMR source for AFS, LASERS, Cells for AFS, Plasmas, Wavelength selection for AFS, Detectors for AFS, Theory of AFS, Analysis with AFS, Interference with AFS.	25

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%
Course Outcome: Having Completed this course, the learner will be able to		
1.	Understand fundamental & theory of atomic x-ray spectroscopy, learn the interaction of x-ray with matter, understand the difference between two techniques. Understand the use of x-ray spectroscopy for qualitative and quantitative analysis.	
2.	Understand fundamental & theory of atomic absorption and emission spectroscopy, learn the phenomenon involved in absorption and emission, understand the use of absorption and emission spectroscopy for qualitative and quantitative analysis.	
3.	Understand fundamental & theory of ESR spectroscopy, learn the difference between ESR and NMR, coupling constant and spin of signal, application in inorganic chemistry.	
4.	Understand fundamental & theory of atomic fluorescence and emission spectroscopy, learn the phenomenon involved in fluorescence and emission, understand the use of fluorescence and emission spectroscopy for qualitative and quantitative analysis.	

Suggested Reference Books:

1. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage learning, 7th edition)
2. Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2ndedition.
3. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th edition.
4. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (VanNostrand Reinhold Co., New York), 6th edition.
5. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company),New Delhi.
6. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
7. Basic concepts of Analytical Chemistry by S.M. Khopkar
8. Instrumental Methods of Chemical Analysis: B. K. Sharma (Goel Publishing House, Meerut).

9. Instrumental methods of Chemical Analysis by H. Kaur.
10. Undergraduate Instrumental Analysis (5^{th} ed.), J. W. Robinson (Marcel Dekker Inc.).
11. Fundamentals of Molecular Spectroscopy, by Banwell.
12. Introduction to Spectroscopy (3^{rd} ed.) by Pavia Lampman Kriz, Cengage Learning Harcourt College Publishers

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester-IV
Paper-III

Course Code	[2003080204030001]	Title of the Course	**Separation Techniques**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand the distribution of liquid in two immiscible liquids, to impart the knowledge of doing extraction of different compounds and their application. • To understand the theory behind the separation of molecules by chromatography, various factors affecting separation and their solution, application the theory in validation of the results obtained. • To learn principles, theory and instrumentation of various liquid chromatography techniques such as gel and ion exchange, adsorption and affinity, their application in identification/separation of compounds. • To learn theory and concepts of the extraction of molecules from solid surfaces as well as their application and limitation.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■			■	■		
CO2	■	■	■	■	■	■			■	■	■	
CO3	■	■	■	■	■	■					■	■
CO4	■	■			■	■			■	■		

Course Content		
Unit	Description	Weightage* (%)
1.	**SOLVENT EXTRACTION** Principal of solvent extraction, Nernst distribution law, Distribution coefficient, Equations for the solute dissociating or associating in one phase, limitations of distribution law, Application : partition chromatography, Distribution ratio, selectivity ratio, Successive extractions, Extraction of metal ion with chelating agent with necessary equation, Extraction involving association of ion pairs, extraction by solvation, types of Multiple extractions, multiple	25

	extraction with successive portion, basic concept, Apparatus and binominal distribution for Craig pseudo/ continuous counter current extractions. True counter current extraction: Fractional distillation, Use of crown ethers and Cryptands for extraction, extraction equilibria with crown ethers, factors affection extraction with crown ether, numerical of distribution coefficient and multiple extraction.	
2.	**THEORY OF CHROMATOGRAPHY** Methods of elution, Ideal and non-ideal chromatography, Plate theory, Rate theory, Reasons for broadening of peaks, Van Deemter equation and significance of terms involved, Optimum velocity, Resolution, Methods to improve resolution, GLC, Supports for liquid stationary phases, Selection of columns, FSOT, Selective Detectors- FPB, TID, Temperature programmingin GC, Derivatization in GC, Qualitative analysis from retention parameters, Quantitative analysis, Headspace Analysis, Thermal Desorption.	25
3.	**LIQUID CHROMATOGRAPHY** **a. Ion-exchange Chromatography:** Resins used, Principle of exchange, Factors affecting the exchange, Capacity of resin and its determination, Techniques, IEC with eluent suppressor columns, Applications. **b. Gel-permeation Chromatography:** Principle, Types of gels, Theoretical principles, Techniques and applications. **c. Adsorption Chromatography:** Principle, column packings, adsorbents, mobile phase, technique of separation, detectors, identification of compounds, applications, Chiral Chromatography. **d. Affinity Chromatography:** Introduction, classification, column matrices, affinity ligands, elution methods, applications.	25
4.	**SOLID PHASE EXTRACTION AND MICROEXTRACTION** **a) Solid Phase extraction (SPE):** Introduction, Types of SPE media, SPE formats and apparatus, method for SPE operation, solvent selection, factors affecting SPE, selected methods of analysis for SPE, Automation and On-Line SPE. **b) Solid phase micro-extraction (SPME):** Introduction, theoretical considerations, experimental, Methods of analysis: PMEGC, Methods of analysis: SPME-HPLC-MS, Automation ofSPME, New development in micro	25

	extraction (liquid micro extraction, membrane micro extraction).	

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand fundamental and principles of solvent extraction, basic theory of distribution law, use of the extraction techniques for cryptands and crown ethers, working of Craig vessels extractions.
2.	Understand fundamental & theory involved in the separation of compound by chromatographic techniques, reason behind the band broadening and their resolution, use of chromatography for qualitative and quantitative analysis.
3.	Understand the separation of different types of molecules with the help of different chromatographic techniques, choice of different stationary phase and mobile phase and application of chromatography.
4.	Understand fundamental & theory of solid phase extraction, factors affecting the extraction, techniques involved in extraction and their application.

Suggested Reference Books:

1. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage learning, 7th edition)
2. Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2ndedition.
3. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th edition.
4. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (VanNostrand Reinhold Co., New York), 6th edition.
5. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2nd edition.
6. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company),New Delhi.
7. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).

8. Introduction to Modern Liquid Chromatography: L. R. Shyder & J. J. Kirkland (John Wiley & Sons, New York).
9. Treatise on Analytical Chemistry: I. M. Kohthoff & P. J. Elving (John Wiley & Sons, NewYork).
10. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
11. Basic concepts of Analytical Chemistry by S.M. Khopkar
12. Official Methods of Analysis: Published by Association of Official Analytical Chemists,Washington.
13. Instrumental Methods of Chemical Analysis: B. K. Sharma (Goel Publishing House, Meerut).
14. Instrumental methods of Chemical Analysis by H. Kaur.
15. Principles of Instrumental Analysis (5^{th} ed.) by Skoog, Holler and Nieman (Saunders CollegePublishings).
16. Undergraduate Instrumental Analysis (5^{th} ed.), J. W. Robinson (Marcel Dekker Inc.).
17. Fundamentals of Molecular Spectroscopy, by Banwell.
18. Electronic Absorption Spectroscopy and related techniques, D.N. Sathyanarayan, (New Age International ND. 1996) Uni. Press, Hyderabad.
19. Introduction to Spectroscopy (3^{rd} ed.) by Pavia Lampman Kriz, Cengage Learning Harcourt College Publishers

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester-IV
Paper-IV

Course Code	[2003080204040001]	Title of the Course	**Applied Analysis**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand basic concepts of soaps, detergents and alloys, their properties and analysis of various elements present in them by various methods. • To understand basic concepts of pesticides and fertilizer, their properties and analysis of various compounds and elements present in pesticides and fertilizer by various methods. • To understand basic concepts of drug products, types of drugs and capsules, their properties and analysis of various drug present in markets by various methods. • To understand basic concepts of vitamins, their properties and analysis of various vitamins by different methods.

Mapping between CO and PSO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■			■	■	■	
CO2	■	■		■	■	■			■		■	■
CO3	■	■	■		■	■			■		■	■
CO4	■	■			■	■			■	■	■	

Course Content		
Unit	Description	Weightage* (%)
1.	**ANALYSIS OF SOAPS, DETERGENTSAND ALLOYS** **Soaps and Detergents:** Classification of detergents, Action of detergents, Determination of alcohol soluble materials, moisture, active constituents, silicates, phosphates, borates etc. **Alloys:** Analysis of brass, German silver, stainless steel. Bronze, Ferromanganese, Alloys of Al, Mg and Ti (Emphasis should be given on major constitute and instrumental methods such as AAS,molecular spectrophotometry, fluorescence, emission, spectroscopy for analysis of trace elements).	25
2.	**ANALYSIS OF PESTISIDE AND FERTILIZER**	25

	Pesticides: Analysis of Benzene hexachloride, Analysis of DDT in mixture by colorimetric methods, Determination of Dieldrin in formulation by partition chromatography, Total phosphorous in phosphorous containing pesticides, Determination of traces of pesticides using GC and HPLC, Determination of Aldrin using IR spectrophotometry. **Fertilizer:** Sampling and sample preparation, water, total nitrogen by Kjeldahl method, total nitrogen by reduced iron method, Urea nitrogen by urease methods, Total phosphorous by differential spectroscopic methods, water soluble phosphorous, Potassium: potassium by flame photometric methods, Acid –base forming quantity of Fertilizer.	
3.	**ANALYSIS OF DRUG PRODUCT** Analytical methods for the following- Tablets, different types of tablets, uniformity in weight (aspirin) additives used in tablet manufacture, capsules, types of capsules, Identification, assay and Test: Rifampicin capsule, Sodium benzoate Powders, Sodium Chloride Injection, barium sulphate Suspensions, Mouthwashes (Ointments (salicylic acid) and creams Dimethicone by IR) Mannitol Injections, Sulphacetamide Eye Drops, Salbutamol Inhalation, Penicillin, Problems based on assay of these materials.	25
4.	**ANALYSIS OF VITAMINS** Carr-price method of Vitamin A, Spectroscopic method for Vitamin D, Determination of total assay Vitamin E, Stability study of Vitamin K_3, Determination of Vitamin B_1, Determination of Assay of Vitamin B_2 by fluorometric method, Determination of Nicotinic Acid by cyanogen bromide method, Determination of Nicotinamide by cyanogen bromide method, Determination of Pyridoxine by Non-aqueous titration method, Spectroscopic determination of Vitamin B_{12}, Folic Acid by colorimetric method, Ascorbic Acid by iodate titration method.	25

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

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

2.	University Examination	70%

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand fundamental & theory of the sources and available contents in alloys and surfactants. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.
2.	Understand fundamental & theory of the sources and available contents in fertilizer and pesticides. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.
3.	Understand fundamental & theory of the drugs and capsules. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.
4.	Understand fundamental & theory of the sources of vitamins. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.

Suggested Reference Books:

1. Vogel's Text book Quantitative Chemical Analysis 5th edition by G.H.Jeffery, J. Bassett, J.Mendham, R.C. Denney.
2. Indian Pharmacopeia Volume I and II.
3. Standard methods of chemical analysis, Sixth Edition, F.J. Welcher.
4. Quantitative Inorganic Analysis including Elementary Instrumnetal analysis, By A. I. Vogel,3rd ed., ELBS, 1964.
5. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2nd edition.
6. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company),New Delhi.
7. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall Internationaledition).
8. Treatise on Analytical Chemistry: I. M. Kohthoff & P. J. Elving (John Wiley & Sons, NewYork).
9. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
10. Basic concepts of Analytical Chemistry by S.M. Khopkar
11. Standard Methods of Chemical Analysis: Vol. I & II (6th edition), D. Van Nostrand Co. Inc.(London).
12. Official Methods of Analysis: Published by Association of Official Analytical Chemists,Washington.
13. Instrumental Methods of Chemical Analysis: B. K. Sharma (Goel Publishing House, Meerut).
14. Instrumental methods of Chemical Analysis by H. Kaur.
15. Environmental Chemistry: B. R. Sharma, H. Kaur (Goel Publishing House, Meerut).
16. Inorganic Quantitative Analysis: A. I. Vogel (Orient Longman).
17. Principles of Instrumental Analysis (5th ed.) by Skoog, Holler and Nieman (Saunders

College Publishing's).

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

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

Course Code	[2003080204050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	12 hrs.

Course Objectives:	• Able to identify the elements presents in various alloys, soap and detergents. • Understand the importance of various instrumental techniques in analysis. • To learn about the calculation in analysis. • To learn about the stoichiometry used in analysis of compounds. • Preparation of solution used in determination of various compounds.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■			■	■	■	
CO2	■	■		■	■	■	■		■	■	■	■
CO3	■	■		■	■	■			■		■	■
CO4	■	■			■	■			■	■	■	
CO5	■	■			■	■			■	■	■	

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

Major Exercise:

1. Analysis of brass alloys for Copper, Zinc and Iron Content.
2. Analysis of German silver for Copper, Nickel and Zinc Content.
3. Analysis of stainless steel for simultaneously determination of Cr and Mn content.
4. Ion exchange separation of (Fe^{+3} + Co^{+2}) and determination of Fe^{+3} colorimetric.
5. Determination of total salt content by ion exchange chromatography.
6. Ion exchange separation of (Zn^{+2} and Mg^{+2}) and determination of Zn^{+2} by EDTA titration.
7. Determination of pK_{In} of Methyl red indicator.
8. Determination of pK_{In} of Bromo Phenol Blue Indicator.

Minor Exercise (Any eight):

1. Analysis of Drugs (any three):
   a) Sulpha drugs by non-aqueous titration and argentometric titration.
   b) Analysis of Penicillin
   c) Iron formulation for iron content.
   d) Aspirin tablet
   e) Analysis of APC tablets for its aspirin and phenacetin content using UV spectrophotometry.
2. Analysis of Insecticides: Analysis of BHC.
3. Determination of Protein content of wheat flour by Kjeldahl Method.
4. Analysis of Detergent sample for PO_4 and other constituents.
5. Analysis of fertilizers by determination of nitrogen content.
6. Analysis of fruit juice for Vitamin-C.
7. Determination of saponification value of Oil and fat.
8. Spectroscopic determination of Ni^{+2} with D.M.G.
9. Conductometric determination of vanillin in Vanilla.
10. Photometric titration of (Cu^{+2}+ Ca^{+2}) in a mixture
11. Determination of Metal: Ligand ratio in complex.
12. Flame photometric determination of Na^{+} and K^{+}.
13. Colorimetric estimation of titanium in the given solution by hydrogen peroxide.
14. Estimation of amino acids by colorimetry.
15. TLC separation.

Teaching-Learning Methodology	Introduction, interaction with students in calculation of solution preparations, carry out experiments at each step according to the respective practical, stoichiometry calculation.

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Performing mole and mole ratio calculations in practice requires an understanding of the fundamentals.
2.	Understanding the basics is essential for performing practical calculations of mole.
3.	Prepared the stoichiometry of the reaction involved in the titration.
4.	Observe, chart, and compare unknown and known concentrations.
5.	Recognize proper lab procedures.

Suggested Reference Books:

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

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

M.Sc. Semester-III (ENVIRONMENTAL CHEMISTRY)

Sr. No.	Course Title	L	T/C/S	Credit
1	Fundamentals of environment and ecology	4		4
2	Environmental pollution	4		4
3	Waste, waste management and toxicology	4		4
4	Environmental studies- instrumental techniques	4		4
5	Practical	12	4	8
		28	4	24

External Examination Time Duration: 03 hrs.

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	III	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Core	04	30	70	100
			Practical	08	60	140	200
			Total	24	180	420	600

M.Sc. Semester-IV (ENVIRONMENTAL CHEMISTRY)

Sr. No.	Course Title	L	T/C/S	Credit
1	Water and Soil Analysis and Pollution Remedies	4		4
2	Air analysis and Pollution control methods	4		4
3	Green Technology	4		4
4	Audit, laws and case studies	4		4
5	Practical	12	4	8
		28	4	24

External Examination Time Duration: 03 hrs.

Name of Exam	Semester	Paper No	Course group	Credit	Internal Marks	External Marks	Total Marks
M. Sc.	IV	I	Core	04	30	70	100
		II	Core	04	30	70	100
		III	Core	04	30	70	100
		IV	Core	04	30	70	100
			Practical	08	60	140	200
			Total	24	180	420	600

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Environmental Chemistry
M.Sc. Environmental Chemistry, Semester-III
Paper-I

Course Code	[1903080203010005]	Title of the Course	**Fundamentals of Environment and Ecology**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand the fundamentals of environmental principles, the scope of environmental science and to learn their importance through studying various components of environment which will helpful to be aware of Global environmental problems. • To study the natural resources and its associated problems, the renewable and non-renewable sources and to learn various resources of natural resources of ecosystem • To understand the concept, structure and function of ecosystem, the components of ecosystem that leads to grasp the knowledge of ecological succession and to understand the characteristic features and function of various type of ecosystem. • To learn the causes, effect, prevention, correction and protection ofvarious natural hazards.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■			■	■		■
CO2	■	■		■	■	■			■	■	■	
CO3	■	■	■		■	■				■		■
CO4	■	■		■	■	■				■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**ENVIRONMENTAL SCIENCE** • Environmental Science: An Interdisciplinary Science *Fundamentals, Definition, principles, scope and importance • Environmental components: ○ Atmosphere	25

	○ Lithosphere ○ Hydrosphere ○ Biosphere • Global Environmental Problems, Man and Environment	
2.	**NATURAL RESOURCE** Natural Resources: Renewable and non-renewable sources: Natural resources and associated problems both • Forest resources • Water Resources • Mineral resources • Land Resources • Energy Resources - Energy flow, Fossil Fuels, Geothermal energy, Nuclear, Wind, Solar and Biomass energy, Hydropower, Ocean Thermal Energy Conversion, Tidal power. • Food Resources - Agriculture-fertilizer and the green revolution, Environmental degradation, Nutrition energy and calories, protein, minerals and vitamins, antioxidants.	25
3.	**ECOSYSTEMS** • Concepts of an ecosystem • Structure and function of an ecosystem • Producers, Consumer and decomposers • Ecological succession • Food chains, Food webs and ecological pyramid • Types, Characteristic features, structure and function of the ecosystems: Forest ecosystem, Grassland ecosystem, Dessert ecosystem	25
4.	**NATURAL HAZARDS** • **River flooding:** Causes, Nature and frequency of flooding, Nature and extent of flood hazard, urbanization and flooding, Environmental effects of flooding, Flood mitigation methods. • **Landslides:** Causes, human use and landslides, Prevention and correction. • **Coastal Hazards:** Tropical cyclone and tsunamis, Coastal erosion, Sea level changes and its impacts on coastal areas. • **Earthquakes:** Causes, Intensity and magnitude of earthquakes, Nature of destruction, Ground Subsidence, Protection from earthquake hazards. • **Volcanism:** Nature, extent and causes of volcanism, Volcanismand climate.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Thoroughly understand the principles, fundamental, definition, scope and importance of environmental science, obtains the knowledge of various environmental components and learns the global environmental problem.
2.	Establish the knowledge of various natural resources like renewable and non-renewable sources, develops the grip of various natural resources and its associated problems.
3.	Gain an understanding of Ecosystem, its concept, structure, components and functions, which leads to understand the importance of ecological succession and learns the characteristic features and function of different ecosystem.
4.	Know about the various Natural hazards such as river flooding, landslides, Coastal hazard, earthquake, volcanism and their causes, protection and prevention.

Suggested Reference Books:

1. Environmental Chemistry by Dr. A. K. De
2. Environmental Chemistry, Goel Publishing house Meerut, by B. K. Sharma and H. Kaur.
3. Basic Concept of environmental Chemistry by Des. W. Connell.
4. Chemistry for environmental engineering and science, 5th Ed., by sawyer, McCarty and Parkin.
5. Environmental Chemistry, 7th Ed., By S. E. Manahan.
6. Chemistry for environmental Engineering 4th Ed., By sawyer, McCarty and Parkin.
7. Instant note in ecology by Mackenzie, Ball and virdee.
8. Marine biology: An Ecological approach, 2nd Ed., By James W. Nybakken.
9. Chemistry of Environment, 2nd Ed., By Thomas G. Spiro and William M. Stigliani.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Environmental Chemistry
M.Sc. Environmental Chemistry, Semester-III
Paper-II

Course Code	[1903080203020005]	Title of the Course	**Environmental Pollution**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand and familiarize with classification, properties, sources of air pollution and learn chemistry of ozone and climate. • To learn about various pollution-water & air and effluent treatment. Contamination of water through heavy minerals, halogens, pathogens, air pollution, detection of various components and hydrocarbons, effluent treatment of sugar, paper & pulp and distilleries. • To understand basic concepts of air and soil, their properties and analysis of various pollutants and minerals present in soil by various methods. • To understand the properties of sound waves, nuclear concepts and Thermal pollution.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■			■	■	■	
CO2	■	■	■	■	■	■	■			■	■	■
CO3	■	■	■	■	■	■	■		■		■	■
CO4	■	■		■	■	■				■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**AIR POLLUTION** • Definition, Chemical composition and Air quality, Classification and Properties of air pollutants, Sources of air pollutants. • Ozone Chemistry formation and destruction, Ultraviolet Protection by Ozone, Catalytic Destruction of Ozone hydroxyl radical, chlorine and bromine, nitric oxide, Polar Ozone Destruction, Ozone Projections.	25

	• Climate- Radiation balance, Albedo- particles and clouds, Greenhouse Effect-IR absorption and molecular vibrations, greenhouse gas trends. • Global Warming, Acid Rain, Vehicular pollution, Photochemical smog, Radiation, Effects of Air pollution on health, Vegetation and Materials.	
2.	**WATER POLLUTION** • Characteristics of bodies of water, Aquatic life- Eutrophication, Water pollution- Definition, Sources, Categories, Nature and Types and sources of water Pollution, Types of Water Pollutants - Inorganic pollutants, Elemental Pollutants, Heavy Metals, Metalloids, Organically Bound Metals and Metalloids, Inorganic Species, Organic Pollutants: Pesticides in Water, Polychlorinated Biphenyls, Radionuclides in the Aquatic Environment, • Effect of oil pollution in marine water • Adverse effects of water pollution.	25
3.	**SOIL POLLUTION** • Nature and Composition of soil • Characterization of Soil • Soil Contaminants- Sources and Chemical Nature • Important environmental Properties of Soil Contaminants • Ecological and Health effects of soil Contaminants	25
4.	**NOISE, RADIATION AND THERMAL POLLUTION** • Noise Pollution-Basic Properties of sound waves-Plane and spherical waves, Sound Pressure and intensity levels, Decibel, Effects of meteorological parameters on sound propagation, Measurement and analysis of sound. A weighted sound level, Noise pollution level, Sound exposure level, Traffic noise index, Day-Night level, Noise criteria curves, Noise sources, Noise control and abatement measures. • Radiation Pollution- Introduction: Definition, Sources, Nuclear concepts and terminology and ecological importance, Maximum Permissible limit, Effects of radiation- Acute, Chronic and Genetic. • Thermal Pollution- Introduction-Definition, Sources of thermal pollution, Biological and other effects of thermal pollution, hazardous effects, Thermal Stratification, Management of waste heat.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	To learn about air pollution and its adverse effects. Learn about ozone layer and Global Warming.
2.	Learn water & air pollution, basic concepts of Eutrophication, water contamination with heavy materials, halogens, hydrocarbons and water purifying techniques and purification of water, sewage treatment, determination of air pollutants SO_X, NO_X, CO_X and hydrocarbons. Development of technologies to compart gaseous pollutants, effluent treatment of various paper pulp & distillation.
3.	To understand the basic concept about soil and to derive the different characteristics and composition of soil. Understand fundamental & theory of the sources and available minerals in soils. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.
4.	Understand the chemistry involved in noise, radiation and thermal pollution and their hazardous effects.

Suggested Reference Books:

1. Basic Concept of environmental Chemistry by Des. W. Connell.
2. Environmental Chemistry, 7th Ed., By S. E. Manahan.
3. Environmental Chemistry by Dr. A. K. De

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Environmental Chemistry
M.Sc. Environmental Chemistry, Semester-III
Paper-III

Course Code	[1903080203030005]	Title of the Course	**Waste, Waste Management and Toxicology**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand different types of hazardous waste and recycling it by different methods. Basic concepts of the physical and chemical properties of hazardous waste. • To learn about radioactive waste and new waste technologies for reduction of radioactive waste. Thorough study of properties of the nuclear waste. • To understand what e-waste is and various wastewater treatments. • To understand the environmental guidelines and standards for management. • To study the different toxic effects of different metals and gases and to understand genotoxicity.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■	■				■	■
CO2	■	■		■	■	■			■	■	■	
CO3	■	■	■		■	■	■	■	■	■		
CO4	■	■		■	■	■	■				■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**SOLID AND HAZARDOUS WASTE** • **Sources of solid waste** (Domestic, Industrial, Municipal, Hospital, Nuclear,Agriculture), • Characteristic of Solid waste- Physical, Chemical and Biological Properties • Processing - Physical, Chemical and Biological treatment of solid waste ○ Recycling of waste	25

	○ Disposal of solid waste Methods, Site selection of disposals, Solid waste management and handling rules. • Classification and sources of Hazardous Wastes - Flammable and Combustible Reactive and Corrosive Substances, Physical Forms and Segregation of Wastes, Hazard Ranking System, Physical and Chemical Properties of Hazardous Wastes, Transport, Effects, and Fates of Hazardous Wastes.	
2.	• **Radioactive Waste** Nuclear or Radioactive Waste- Principles of radioactivity, Sources of radioactivity in environment, Characteristics of nuclear waste, Radioactive materials and its decay, Half-life, Health effects of ionizing Radiation, Safety standards. • **Disposal and Analysis of radioactive waste** Detection and Analysis of radioactive materials, Mining and Recovery, Low-level Radioactive waste, High-level radioactive waste, transport of Radioactive Materials, Storage and Disposal of radioactive waste, new waste reduction technologies.	25
3.	• **Biomedical and e-waste** Introduction, characterization of biomedical waste, handling and disposal of biomedical waste, medical waste treatment techniques, Biomedical waste: Environment standards and guidelines for management, Management and disposal of electronics waste, Basel convention. • **Waste treatment Technologies** Waste destruction technologies, waste concentration technologies, TSDF, cradle to grave concepts, solidification and stabilization technologies, biological treatment, bio-treatment by sequencing batch reactors, thermal processes, storage and leak detection-underground storage tanks, leak detection and remediation.	25
4.	**TOXICITY** • **Chemical Toxicology:** Introduction, Principles of toxicology, Types of Toxic pollutants, TLV (Threshold limiting Value), Common toxic effects, Dosage-potency vs Toxicity, Lethal dosage (LD), Toxic chemicals in the environment, Biochemical Effects of Metals and gases (Pb, Cd, Hg, As, Cr, CO, NO_X and SO_2, Cyanide, Pesticides, Carcinogens, Bio-Warfare Agents, • **Genotoxicity:** Teratogens and Teratogenesis, Teratogens (Alcohol, Methylmercury, Rubella, Thalidomide), Mutagens and	25

	Mutagenesis, Carcinogens.	

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the source, classification, characteristics and disposal of hazardous waste.
2.	Learn radioactive waste and principle of radioactivity, its decay, health effects of ionization, to storage, transport and disposal of radioactive waste.
3.	Understand introductory part of biomedical waste and its disposal by different methods.
4.	Understand about chemical toxicity and genotoxicity in detail.

Suggested Reference Books:

1. Environmental Chemistry, 7th Ed., By S. E. Manahan.
2. Chemistry for environmental Engineering 4th Ed., By Sawyer, McCarty and Parkin.
3. The Chemistry of Industrial Toxicology; By Hervey B. Elkins, John Wiley & Sons,New York. (2nd Ed.)

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Environmental Chemistry
M.Sc. Environmental Chemistry, Semester-III
Paper-IV

Course Code	[1903080203040005]	Title of the Course	**Environmental Studies and Instrumental Techniques**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To learn spectroscopic determination of compounds by ^{13}C NMR, ^{1}H NMR, and ^{2}D NMR and important concepts like chemical shift, coupling constants for different types of compounds. • To understand different types of spectroscopic techniques for water analysis. • To separate the various substances that make up a mixture. The applications range from a simple verification of the purity of a given compound to the quantitative determination of the components of a mixture. • To learn principles of different electrical techniques like coulometry, voltammetry etc. and Supercritical Fluid Chromatography.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■				■	■		
CO2	■	■		■	■	■				■	■	■
CO3	■	■	■		■	■			■	■	■	
CO4	■	■			■	■				■	■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**NMR SPECTROSCOPY** • **^{1}H NMR Spectroscopy** Proton resonance condition, Aspects of PMR spectra – number of signals, chemical shift, factors influencing chemical shift, deshielding, chemical shift values and correlation for protons bonded to carbons (aliphatic, olefinic, aldehydic, aromatic) and other nuclei (alcohols, phenols, enols, acids, amides and	25

	mercaptans), effect of deuteration, spin- spin coupling, (n+1) rule,factors effecting coupling constant "J". • **^{13}C NMR spectroscopy** Types of ^{13}C NMR Spectra: proton coupled and decoupled ^{13}C spectra, chemical shift, calculations of chemical shifts of aliphatic, olefinic, alkyne, aromatic, hetero aromatic and carbonyl carbons, factors affecting chemical shifts.	
2.	**INSTRUMENTAL TECHNIQUES FOR AIR AND WATER ANALYSIS** • **Spectroscopic Technique for Water Analysis –** U.V. – Visible spectroscopy FT-IR, Mass Spectroscopy, Flame Photometry, X-ray Fluorescence, ICP-OES, Chemiluminescence methods. • **Atomic Absorption and Atomic Fluorescence Spectrometry** SampleAtomization and Atomic Absorption instrumentation, Interference AAS, Atomic Fluorescence Spectroscopy, Applications. • Atomic Emission Spectrometry- Emission Spectroscopy based on plasma sources, Emission Spectroscopy Based Arc and Spark Sources.	25
3.	**CHROMATOGRAPHIC TECHNIQUES:** • GC, HPLC, Headspace GC, GC-MS, LC-MS, Ion Exchange Chromatography- Resins used –Principle of exchange, Factors affecting the exchange – Capacity of resin and its determination, Techniques – IEC with eluent suppressor columns –Applications. • Capillary Electrophoresis Types of electrophoresis, The basis of electrophoresis Separations, Capillary zone and gel electrophoresis, Application.	25
4.	• **Supercritical Fluid Chromatography** - Introduction, Supercritical Fluid Chromatography- Instrumentation and Operating Variables, Comparison of Supercritical to other types of Chromatography, Advantages, Applications of Supercritical Fluid Chromatography. • **Electrical Techniques** Coulometry, Anodic Stripping Voltammetry, Ion Selective Electrodes, Principle and Applications.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand fundamental & basic terms involved in ^{1}H NMR, ^{13}C NMR, know effects of various factors on the spectra, interpretation from spectral data, identify structure of organic compounds by using combined spectral data, distinguish isomers and other closely related compounds by using spectral techniques.
2.	Able to understand spectroscopic techniques, Atomic Absorption and Atomic Fluorescence Spectrometry, Atomic Emission Spectrometry for water analysis.
3.	Recognize the use of different stationary and mobile phase for the separation of organic molecule and identify the problems and their solution during the analysis and learn the use of the chromatography for those which can't be identified by the techniques.
4.	Understand the basic theory of coulometer, voltammetry electrogravimetry and their working. Also learn in-depth of coulometry methods and their application in various titrations, Supercritical Fluid Chromatography and ion selective electrodes.

Suggested Reference Books:

1. Instrumental Analysis by R. D. Braun, McGraw-Hill.
2. Modern Methods of Chemical Analysis (2nd ed.), Pecsok, Shields, Cairns & McWilliam, John Wiley & Sons.
3. High Performance Liquid Chromatography, Dr. P.D. Sethi.
4. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.
5. Spectrometric identification of Organic compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley.
6. Introduction to NMR Spectroscopy, R.J. Abraham, J. Fisher and P. Loftus, Weily.
7. Application of Spectroscopy of Organic compounds, J.R. Dyer, Prentice Hall.
8. Spectroscopy Methods in Organic Chemistry, D.H. Williams, I. Fleming, Tata McGraw-Hill.
9. Spectroscopy of Organic compounds, P.S. Kalsi, New Age International Ltd.
10. Environmental Chemistry, De A.K.

11. Spectroscopy by Jagmohan
12. Analytical Chemistry by Gary D. Christian, Sixth Edition, Wiley Sons.
13. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Analytical Chemistry – An Introduction,7th ed. (2000), S. C. Publishing, Philadelphia, London.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

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

Course Code	[1903080203050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	12 hrs.

Course Objectives:	• To impart basic knowledge for carrying out analysis of some environmental water sample. • Understand the importance of various instrumental techniques in analysis. • To learn about the calculation in analysis. • To learn about the stoichiometry used in analysis of compounds. • Preparation of solution used in determination of various compounds.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■			■	■	■	
CO2	■	■		■	■	■	■			■	■	■
CO3	■	■	■	■	■	■				■	■	■
CO4	■	■	■		■	■			■	■	■	
CO5	■	■	■	■	■	■					■	■

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

Major Experiments:

1. Removal of hazardous dyes/metals by Cloud Point Extraction using non-ionic surfactant. [TX-100]
2. Determination of the Chemical Oxygen Demand (COD) value of KHP sample using conventional method.
3. Determination of the Dissolved Oxygen (DO) in given water sample.
4. Analysis of water sample.
5. Determination of K_{sp} of AgI and AgCl and find out amount of KCl and KI in a given (KI+ KCl) using potentiometric titration.
6. Determination of total salt content by ion exchange chromatography.

7. Determination of pK_{In} of Methyl red indicator.
8. Determination of pK_{In} of Bromophenol Blue Indicator.
9. Ion-Exchange separation of Fe^{+3} and Co^{+2} and determination Fe^{+3} by Spectrophotometer.

Minor Experiments:

1. Precipitation Titration: Determination of Chloride by the Mohr's Method.
2. Determination of Aniline.
3. Determination of % purity of Aspirin in given tablet.
4. Determination of sulphate using complexometric titration.
5. Determination of the R_f value of amino acids in a given mixture by the technique of ascending Paper chromatography.
6. Spectroscopic determination of Ni^{+2} with D.M.G.
7. Conductometric determination of vanillin in Vanilla.
8. Analysis of Insecticides: Analysis of BHC.
9. Colorimetric estimation of titanium in the given solution by hydrogen peroxide.
10. Estimation of amino acids by colorimetry.
11. Electro gravimetric determination of Cu^{+2} in given unknown/Brass solution.
12. Determination of the amount of As_2O_3 in the given solution by coulometric titration.
13. Determination of the amount of PO_4^{-3} in given sample of soil by spectrophotometrically.
14. Determination of the Iodine value of given fat sample.
15. Determination of saponification value of given oil fat sample.

Note:

- Practical examination will be for 2 days in each semester.
- 6 hours duration on each day.

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	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the basics to carry out practical.
2.	Done the titration or instrumental method for quantitative analysis.
3.	Done the stoichiometry of the reaction involved in titration.

4.	Draw the graph and find out the unknown concentration by comparison with known compound.
5.	Appreciate good laboratory practices.

Suggested Reference Books:

1. Quantitative Inorganic Analysis including Elementary Instrumental analysis, By A. I. Vogel, 3rd ed., ELBS, 1964.
2. Vogel's Quantitative Chemical Analysis; J. Mendham, R. C. Denney, J. D. Barnes, M.Thomas, B. Sivasankar; Pearson Publication.
3. Analytical Chemistry; Gary D. Christian; Wiley India Pvt. Ltd.
4. Environmental Pollution, A.K. De
5. Environmental Pollution, B.K. Sharma & H. Kaur
6. Quantitative Analysis by R.A. Day and A. L. Underwood, (Sixth Edition)
7. Standard methods of chemical analysis, Sixth Edition, F.J. Welcher.
8. Standard Methods of Chemical Analysis: Vol. I & II (6th edition), D. Van Nostrand Co. Inc. (London).
9. Official Methods of Analysis: Published by Association of Official Analytical Chemists,Washington.
10. Advance practical physical chemistry by J. B. Yadav
11. Advanced University Practical chemistry by P.C. Kamboj (Part-1)
12. Advance Practical Chemistry by R. Mukhopadhyay and P. Chatterjee
13. Official Methods of Analysis: Published by Association of Official Analytical Chemists,Washington.
14. APHA Standard methods 21st Edition.

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Environmental Chemistry
M.Sc. Environmental Chemistry, Semester-IV
Paper-I

Course Code	[2003080204010005]	Title of the Course	**Analysis of Water Pollutants**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To understand the detailed analysis of water on the basis of Color, pH, Test, Odour, Hardness, TDS, Alkalinity, Chloride, Fluoride, Sulphate, Ammoniacal Nitrogen, Nitrite, Nitrate, Phosphate, Iron, Fluoride Heavy Metals, Silica. • To understand different treatment methods for waste water classified in primary, secondary and tertiary waste water treatment. • To learn which problems arise with industrial waste water and remedies. • To Understand fundamental & theory of the sources and available minerals in soils. Also learn the different approaches and classical as well as instrumental techniques used for the analysis.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■			■	■	■	
CO2	■	■		■	■				■	■		
CO3	■	■	■	■	■	■	■				■	■
CO4	■	■		■	■	■	■		■	■		

Course Content		
Unit	Description	Weightage* (%)
1.	**SAMPLING METHODS AND PRESERVATION** DO, BOD and COD- Signification, Analytical Methods, Interferences and their elimination, Modifications, Color, pH, Test, Odour, Hardness, TDS, Alkalinity, Chloride, Fluoride, Sulphate, Ammoniacal Nitrogen, Nitrite, Nitrate, Phosphate, Iron, Fluoride Heavy Metals, Silica	25
2.	**WATER TREATMENT**	25

	• **Water purification:** Natural Water Purification Processes- Treatment for Potable Water, Preliminary treatment, Primary treatment: Sedimentation, Flocculation. • **Secondary treatment:** Trickling filters, Activated, Sludge, Tertiary treatment: Chlorination, Wet Oxidation, adsorption, Reverse Osmosis, Electrodialysis, Ion exchange and water disinfection. • **Sewage treatment:** Removal of Solids, metals (Ca, Fe, Mn), Removals of dissolved organic and inorganic compounds, Sludge dewatering and disposal. • **Water management:** Water Reuse and Recycling, Rainwater harvesting.	
3.	**INDUSTRIAL WATER POLLUTION PROBLEMS AND REMEDIES** **Industrial water pollution-** Site of pollution and remedies with flowcharts in • Pharmaceutical Industry • Fertilizers Industry • Pulp and Paper Industry • Sugar Industry • Distillery Industry • Textile Industry.	25
4.	**SOIL ANALYSIS** • pH • Lime requirement of soil • Nitrogen analysis • Phosphorous analysis • Exchangeable Cation Analysis • Micro nutrient analysis • Trace element in soil analysis • Analysis of pesticides- Standard and polarographic analysis	25

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per	30%

	CBCS R.6.8.3)	
2.	University Examination	70%

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand Sampling methods and preservation DO, BOD and COD-Signification, Analytical Methods, Interferences and their elimination, Modifications.
2.	To learn various water purification methods, sewage treatment, and water management.
3.	Water pollution occurs in different industries like Pharmaceutical Industry Fertilizers Industry, Pulp and Paper Industry, Sugar Industry, Distillery Industry, Textile Industry and its remedies with flowchart diagram.
4.	Understand the analysis of soil on the basis of pH, Lime requirement of soil, Nitrogen analysis, Phosphorous analysis, Exchangeable Cation Analysis, Micro nutrient analysis.

Suggested Reference Books:

1. Environmental Chemistry by Manhanan.
2. Environmental Pollution Monitoring and control by S. M. Khopkar
3. Introduction to Environmental Analysis by Roger N. Reere. John Wiley & Sons.
4. Industrial Safety and Pollution control handbook. Published by National Safety Council and Associate (Data) Publishers Pvt. Ltd.
5. Environmental Chemistry, Goel Publishing house meerut, by B. K. Sharma and H. Kaur
6. APHA Standard Methods 21st Edition

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Environmental Chemistry
M.Sc. Environmental Chemistry, Semester-IV
Paper-II

Course Code	[2003080204020005]	Title of the Course	**Air Analysis and Pollution Control Methods**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To study the analysis of gaseous air pollutants, air sampling methods, preservation of samples. • To learn Air pollution Control Methods and Equipment: Source, Collection methods, cleaning of gaseous effluent, particulate emission, absorption, adsorption, Odour control units • To study the Removal, Recovery and Destruction of SO_2, NO_2, H_2S, Organic Vapors and Particulates matters from production houses • To detailed study about bioremediation process.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■				■	■	■
CO2	■	■	■	■	■	■	■		■	■	■	■
CO3	■	■		■	■	■			■	■	■	
CO4	■	■			■	■			■	■		

Course Content		
Unit	Description	Weightage* (%)
1.	**ANALYSIS OF AIR POLLUTANTS** Sampling of Particulate matter and Gaseous air pollutants- Sedimentation, HVS, Tape Sampler Impingement, Electrostatic precipitation, Adsorption in Liquid and solids, Thermal precipitation, Stack sampling system (Train), Preservation of samples. Analysis of Oxides of Sulphur, Nitrogen Oxygen and Carbon, H_2S, Mercaptans, Hydrocarbons, and Organics, Elemental Analyser Analysis of Particulate Matter, Direct Spectrophotometric Analysis of Gaseous Air Pollutants Atmospheric Monitoring	25

2.	**AIR POLLUTION CONTROL METHODS ANDEQUIPMENTS** Air pollution Control Methods and Equipment: Source, Collection methods, cleaning of gaseous effluent, particulate emission, absorption, adsorption, Odour control units, Limestone injection and fluidized bed combustion, Desulfurization; Gravitysettling chamber, Centrifugal collectors- cyclone collector and dynamic precipitators; Electrostatic precipitators; wet and dry Scrubbers, filters, Fabric filters. Combustion, Absorption and Adsorption Devices, Catalytic converter and control of vehicular emission.	25
3.	**INDUSTRIAL AIR POLLUTION PROBLEMS AND REMEDIES** Removal, Recovery and Destruction of SO_2, NO_2, H_2S, Organic Vapours and Particulates matters from production houses. Microbial cleaning. Petroleum refinery, Cement industries, Fertilizers Industry, Thermal power plants Iron and Steel industries, Chemical Process industries- Mineral Acid manufacturing and Chloralkali Plants, Microbial cleaning of gases(Bio-filtration and bio-scrubbing).	25
4.	**BIOREMEDIATION** Microbial systems of bioremediation; factors influencing bioremediation (Environmental, Physical and chemical actors), Application of genetically engineered microorganisms for waste management, Microbial aerobic and anaerobic bio transformations, Bioremediation systems and processes (Solid, Liquid and Slurry phase) Microbial detoxification of specialty chemicals (Insecticides, Herbicides, Fungicides, Polychlorinated biphenyls, Heavy metals).	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the Analysis of Oxides of Sulphur, Nitrogen, Oxygen and Carbon, H_2S, Mercaptans, Hydrocarbons and Organics in different air sampling and compare the samples of different polluted areas.
2.	Learn about the different equipment like cyclone collector and dynamic precipitators; Electrostatic precipitators; wet and dry Scrubbers, filters.
3.	Learn the different air pollutants from Petroleum refinery, Cement industries, Fertilizers Industry, Thermal power plants, Iron and Steel industries, Chemical Process Industries-Mineral Acid manufacturing and Chloralkali Plants.
4.	Study about bioremediation process, systems, applications and Microbial detoxification of specialty chemicals (Insecticides, Herbicides, Fungicides.

Suggested Reference Books:

1. Basic Concept of environmental Chemistry by Des. W. Connell.
2. Chemistry for environmental Engineering 4th Ed., By Sawyer, McCarty andParkin.
3. Environmental Pollution Monitoring and control by S. M. Khopkar.
4. C.S. Rao, Environmental Pollution Control Engineering. Wiley Eastern Ltd. 1991.
5. John H. Seinfeld Air pollution: Physical and Chemical Fundamental McGrawHill1, 998.
6. M.N. Rao and H.V. Rao Air Pollution, Tata McGraw Hill Book Co. 1989.
7. Hand book of Air Pollution, Prevention and control: Nicholas P. CheremisinoffElesvier 2nd edition.
8. C.S. Rao, Environmental Pollution Control Engineering. Wiley Eastern Ltd. 1991.
9. John H. Seinfeld Air pollution: Physical and Chemical Fundamental McGraw-Hill 1998.
10. M.N. Rao and H.V. Rao Air Pollution, Tata McGraw Hill Book Co. 1989.
11. Hand book of Air Pollution, Prevention and control: Nicholas P. CheremisinoffElsevier 2nd edition

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Environmental Chemistry
M.Sc. Environmental Chemistry, Semester-IV
Paper-III

Course Code	[2003080204030005]	Title of the Course	**Green Technology**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• The goal of green tech is to protect the environment, repair damage done to the environment in the past, and conserve the Earth's natural resources • Its foremost objective is to protect and preserve the environment. Examples include technologies that recycle waste, purify water, or reduce pollution in water sources and air. But these aren't limited to industrial use and may apply to household items as well • Green nanotechnology has two goals: producing nanomaterials and products without harming the environment or human health, and producing nano-products that provide solutions to environmental problems. • To use Biocatalysis, to produce green buildings and use less hazardous substances in technology.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■	■	■				■	■
CO2	■	■		■	■	■				■	■	■
CO3	■	■	■		■	■			■	■	■	
CO4	■	■	■	■	■	■	■				■	■

Course Content		
Unit	Description	Weightage* (%)
1.	**GREEN TECHNOLOGY** Overview of green chemistry, principles of sustainable and green chemistry. Basic principles of green technology, concepts of atom economy and carbon trading, tools of green technology. Waste minimization and climate change, zero waste technology,concept of environmentally balanced industrial complexing and industrial ecology.	25

2.	**GREEN SYNTHETIC METHODS AND DESIGNS** Catalytic methods in green synthesis, safer chemicals – different basic approaches; selection of auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements-use of microwaves, ultrasonic energy; selection of starting materials; use of blocking/protecting groups, catalytic reagents; designing of biodegradable products.	25
3.	**GREEN NANOTECHNOLOGY** Introduction to Nanomaterials and green nanotechnology, Fullerene, carbon nanotubes, Nanoparticles; Green nanoparticle production and characterization; Biocompatibility; Nanomedical applications of green nanotechnologies; use of nanotechnologies and materials impact on biodiversity, resource conservation, ecosystems and human.	25
4.	**GREEN TECHNOLOGY APPLICATIONS** Biocatalysis, green chemistry in industries, fuel cell and electric vehicles, solar energy and hydrogen production, energy from alternate sources; Solar photovoltaic technology, Biofuel production (bio-ethanol and biodiesel), Biomass, prevention/minimization of hazardous/ toxic products. Agricultural related practices and food processing, Production of biodegradable materials, concept of green building and Pollution free engineering processes.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Study Overview of green chemistry, principles of sustainable and green chemistry. Basic principles of green technology, concepts of atom economy and carbon trading, tools of green technology.
2.	Understand the Catalytic methods in green synthesis, use of green solvents

	and solventless processes.
3.	Understand Nanomaterials and green nanotechnology, Fullerene, carbon nanotubes, Nanoparticles and its characterization.
4.	Understand how green technology is applicable in industries and other production methods, fuel cell and electric vehicles, solar energy and hydrogen production.

Suggested Reference Books:

1. Lynn Goldman, Christine Coussens, Implications of nanotechnology for environmental health research, National Academic Press, Washington, 2007
2. Matlack, A. S. Introduction to Green Chemistry. Marcel Dekker: New York,2001
3. Anastas, P. T.; Warner, J. C. Green Chemistry: Theory and Practice. OxfordUniv. Press: Oxford.
4. Caye Drapcho, Nhuan Phú Nghiêm, Terry Walker (2008). Biofuels Engineering Process Technology. [McGraw-Hill].

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Environmental Chemistry
M.Sc. Environmental Chemistry, Semester-IV
Paper-IV

Course Code	[2003080204040005]	Title of the Course	**Audit, Laws and Case Studies**
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• To learn definition and terminologies of Environmental Impact Assessment. • To understand Pollution control boards, EPA-US, The Environment (Protection) Acts enacted by CPCB-India for water, air, noise and waste management. • To study the rules and acts for hazardous waste management. • To study the Environmental Movements and Case Studies.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■		■	■	■			■	■	■	■
CO2	■	■	■		■	■	■			■	■	■
CO3	■	■	■		■	■					■	■
CO4	■	■	■		■	■			■	■		

Course Content		
Unit	Description	Weightage* (%)
1.	**ENVIRONMENTAL IMPACT ASSESSMENT** Definition and terminologies, Basic Description of EIA processes. Biosolid management practices and regularity requirements. Environmental facility and assessment and Audit.	25
2.	**ENVIRONMENTAL PROTECTION LEGISLATIONS** Pollution control boards, EPA-US, The Environment (Protection) Acts enacted by CPCB-India for water, air, noise and waste management. GPCB, Legislation and legal aspects: Water (Prevention and control of Pollution) Act 1974, Air (Prevention and control of Pollution) Act 1981, Wild Life protection act, 1972,The India Forest Act, 1927, The Environment protection Act, 1986.	25
3.	**HAZARDOUS WASTE MANAGEMENT:**	25

	Description of the Environmental settling, Prediction and Assessment of impact on air, water, Noise and Biological environment. Laws and regulations, E- waste management and Handling Rule 2011, Plastic Manufacture, Sale, Usage sale Rule 2011, 2016 and issues involved in enforcement of environmental legislation.	
4.	**ENVIRONMENTAL MOVEMENTS AND CASE STUDIES** Chernobyl disaster, The Exxon Valdez Oil Spill, Bhopal gas Tragedy, Movements related to Environment Sacred groves, Bishnoi tradition, Chipko movement, Tehri dam, Sardar Sarovar, Narmada dam, Almatti dam, Silent Valley. Supreme Court Cases – Ratlam Municipality, Ganga Action Plan, Taj Trapezium, Delhi CNG, Tamil Nadu Tanneries, Doon Valley, Span motels private limited case, Oleum gas case.	25

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

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Study detailed description about ENVIRONMENTAL IMPACT ASSESSMENT.
2.	To study the various acts for ENVIRONMENTAL PROTECTION LEGISLATIONS.
3.	To understand Description of the Environmental settling, Prediction and Assessment of impact on air, water, Noise and Biological environment.
4.	To understand the case studies of Movements related to Environment Sacred groves, Bishnoi tradition, Chipko movement, Tehridam, Sardar Sarovar, Narmada dam, Almatti dam, Silent Valley.

Suggested Reference Books:

1. Environment impact assessment: David P Lawrence, Wiley inter-science 2003.
2. Environment impact assessment handbook: Barbara Carroll, Trevor Turpin, Thomas Telford 2003.
3. Case Studies in the Environment Editor-in-Chief: Wil Burns, Vol 3, 2019, ISSN:2473-9510

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

VEER NARMAD SOUTH GUJARAT UNIVERSITY

Master of Science, Environmental Chemistry
M.Sc. Environmental Chemistry, Practical
Semester-IV

Course Code	[2003080204050001]	Title of the Course	
Total Credits of the Course	4	Hours per Week	4 hrs.

Course Objectives:	• Understand the importance of various instrumental techniques in analysis. • To learn about the calculation in analysis. • To learn about the stoichiometry used in analysis of compounds. • Preparation of solution used in determination of various compounds.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■		■	■					■	■
CO2	■	■		■	■	■			■	■		
CO3	■	■	■	■	■	■	■		■	■	■	■
CO4	■	■	■		■	■	■			■	■	■

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

Major Experiments:

1. Analysis of dolomite ore by gravimetry.
2. Determination of the amount of Fe in Cement by optical method.
3. Analysis of Portland cement for the major constitute.
4. Separation of Zn^{+2}& Mg^{+2} ion by an anion exchange resin.
5. Potentiometric determination of Chloride, Bromide and Iodide in a mixture.
6. Analysis of Pyrolusite ore for the major constitute.
7. Separation and determination of total pigment in a paint sample.
8. Determination of volatile thinner in a paints sample.
9. Determination of Cr and Mn in a steel sample photospectrometry.
10. Determination of the total salt amount content in given Water using Ion Exchange Chromatography (IEC). (Dowex cation).

Minor Experiments:

1. Determination of the thiosulphate in a given solution

2. Analysis of dye intermediate containing $-NH_2$ by Potentiometric titration.
3. Determination of Nitrite spectrophotometrically.
4. Biuret in the sample of urea.
5. Determination of fluoride in a given solution / tooth paste by Zirconyl-Alizarin red method colorimetrically.
6. Analysis of organic materials: Glycerol, Glycine, phenol.
7. Determination of the % of Ca & Mg both combined volumetrically.
8. Estimation of Fe by colorimetry.
9. Determination of the concentration of Cr^{+3} and Co^{+2} in a given mixture using spectrophotometer.
10. Titrimetric determination of L-ascorbic acid. (Vitamin C)
11. Determination of the individual concentration of $Cu^{+2}$and Ca^{+2} in a mixture using by EDTA solution and complexometric titration.
12. Determination of Ka_1 and Ka_2 of phosphoric acid.
13. Determination of Ca present in $CaCO_3$ with Vitamin D_3 tablet using EDTA by volumetrically.
14. Paper Chromatography.

Teaching-Learning Methodology	Introduction, interaction with students in calculation of solution preparations, carry out experiments at each step according to the respective practical, stoichiometry calculation.

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

Course Outcome: Having Completed this course, the learner will be able to	
1.	Understand the basics of practical.
2.	Understand reaction and monitoring specified reaction condition.
3.	Learn to work-up after the completion of practical.
4.	Confirm the results with the references.
5.	Understand the calculation with reference to respective factors.
6.	Appreciate good laboratory practices.

Suggested Reference Books:

1. Vogel's Textbook of quantitative analysis fifth edition by Longman scientific and technical, UK.

2. Indian Pharmacopeia, Vol-I, II and III.
3. Standard methods of Chemical analysis sixth edition edited by Frank J. Welcher by D. VanNostrand Company, Inc.

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