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

	PO9: Participation in scientific discussions showing respect and lead interdisciplinary work with experts from other fields. PO10: To understand and adopt the best safety practices in research.
Program Specific Outcomes	Students need to build up foundation in the fundamentals & application of current chemical and scientific theories in the concerned branches of Inorganic, Organic, Analytical, Physical, Environmental and Pharmaceutical Chemistry. PSO1 : Develop scientific temper, communicate scientific information in a clear, concise and precise manner. PSO2 : Find job opportunities at all level of chemical industries(dyes & pharmaceutical), national laboratories & research centers. PSO3 : Apply the knowledge in sustainable and eco friendly technologies. PSO4 : Inculcate logical thinking to addressess the problem and become result oriented. PSO5 : Development of research culture in persuasion of Ph.D. program at national & international institute/university. PSO6 : Participate in specific competitive examination conducted by various public service commission and other public sector. PSO7 : Develop and apply the fundamental knowledge to build small scale industry in context to Atma Nirbhar Bharat. PSO8 : Scale up the synthetic product to a pilot level plant and gradually to bulk. PSO9 : Enhance the scientific temperament among the students in anticipation of developing research culture and implementation of policies at global & local level. PSO10 : Communicate scientific information clear in both writing and orally. PSO11 : Students shall start to become better readers, thinkers and learners in their discipline by processing their ideas through writing. PSO12 : Will build new scientific understanding as it provides students the opportunity to articulate their thinking as they engage in the science practices during an investigation.
Mapping between POs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
PO1		■	■				■	■	■	■		
PO2	■		■		■		■	■	■	■		■
PO3	■		■	■	■				■	■	■	■
PO4	■	■	■	■			■		■	■	■	■
PO5		■	■	■			■			■		■
PO6	■		■	■	■				■	■		■
PO7		■	■	■	■			■		■		■
PO8	■	■		■		■	■	■	■		■	■

	PO9												
	PO10												
Medium of Instruction	English												

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		Practicals + 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 +3	60	140	200
			Total	25	180	420	600

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 concept of symmetry and group theory with its application. • To understand 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 mechanism and also various types of transition state theory. • Understanding of concepts of metal cluster, 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 matrics 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 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)	25
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 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 rules. Halides types clusters: dinuclear clusters, trinuclear clusters, tetranuclear clusters, hexanuclear cluster. Chevrel phases and zintl ions, Carboranes, metalloboranes, metallo carboranes, 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 comprise classroom teaching, use of e-resources, library books , IT tools, encouraging students to participate in seminars/ workshops, presentations by students, assignments etc.

Evaluation Pattern		
Sr.	Details of the Evaluation	Weightage

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

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the 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 mechanism, 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 References:

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. Principales 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 Ltd., 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, Inorganic Chemistry
M.Sc.Inorganic Chemistry, Practicals

Course Code	[1803081001050001]	Title of the Course	**INORGANIC CHEMISTRY**
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 • 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. Inorganic Qualitative Analysis: (Six elements including ONE rare element)
2. Inorganic Preparation.
   - I. Hexa-ammine nickel (II) chloride
   - II. Mohr's salt (Ferrous Ammonium sulphate)
   - III. Sodium trioxalato ferrate trihydrate
   - IV. Sodium cobaltinitrite

V. Tetra amine cupric sulphate
VI. Reineck's salt (Ammonium tetrathiocyanate diammine Chromate)

Teaching-Learning Methodology	Introduction, demonstration of handling equipments, 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%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand basics analysis of Inorganic mixtures.
2.	Identify anions by dry test of the mixture.
3.	Separation of each anions 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 References:

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

On-line Resources

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 concept of reactive intermediate and their application in organic synthesis. • To understand basics of pericyclic reaction, familiarize with various theories of pericyclic reaction to access the feasibility of various pericyclic reaction and implant the knowledge to predict stereo chemical outcome of various pericyclic reactions. • To learn anchimeric assistance, stereo chemistry and internal substitution reaction of aliphatic and allylic compounds. Aromatic nucleophilic substitution, cine substitution, elimination reactions, their stereo chemistry and mechanisms. • Understanding of concepts of chirality, topicity, prochirality, dynamic resolutions, types of stereo selective and stereo specific reactions, 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 –	25

	Carbocations (Classical and non-classical): Phenonium ion, norbornyl system, common carbocation rearrangements- Demjanov, Pinacole-Pinacolone, Rupe. **Carbanions:** Mechanism of condensation involving enolates - Aldol, 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 allylsystems. **Electrocyclic Reactions:** Woodward-Hoffman Correlation diagram and derivation of selectionrules Conrotatory and disrotatory motions, FMO and PMO approach for 4n and (4n+2)Πelectron system and allyl systems. **Cycloaddition Reactions** : Antarafacial and suprafacial additions. FMOand PMO approach for 4n and (4n+2)Πelectron Systems(No correlation diagram),Diels-Alder reaction, stereoselectivity,Effect of substituents. **Sigmatropicrearrangements:**Suprafacial and antarafacialshifts involving H & C moieties, retention and inversion of configurations. The Cope and Claisen rearrangements, Ene reaction, 1, 3- dipolar cydoadditions. Examples of electrocyclic, cycloaddition and sigmatropic rearrangements.	25
3.	**SUBSTITUTION AND ELIMINATION REACTIONS** **A: Aliphatic Nucleophilic Substitution:** The SN1 , SN2 , SNi mechanisms. Reactions of Allylic halides, neighbouring group participation by -OH, -NH2, -COO- , -RS, - halogen, aromatic ring. **B: Aromatic Nucleophilic Substitution:** The SN2 , SN1 and benzyne mechanisms, Reactivity - effect of substrate structure, leaving group and attaching nucleophile, The Von Richter rearrangement. **C: Elimination reaction:** Hoffmann and Zaitsev's rule of elimination, E1, E2 and E1CB Reaction mechanism and orientation.	25
4.	**STEREOCHEMISTRY:** Stereo chemical principles; Enantiomeric relationships; Distereomeric relationship; R-S and E-Z nomenclature; Dynamic stereochemistry; Chiral-Prochiral relationships; Stereo selective and Stereo specific 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 comprise classroom teaching, use of e-resources, library books , IT tools, encouraging students to participate in seminars/ workshops, presentations by students, assignments etc.

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

Course Outcomes: 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.	Recognise 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 difference between eliminations and addition reaction, 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 moleculer structure, recognize the relationship between enantiomeric and diastereomeric structures, understand and distinguis h stereoselective and stereospecific reactions, dynamic resolution, confirmative study of various substituted aromatic and fused aromatic rings and their application inn pharmaceutical industry.

Suggested References:

Unit I:

1. Carbenes, Benzynes and Nitrenes by Gilchrist, T. L. and Rees.
2. Advanced Organic Chemistry-Reactions, Mechanism and Strucuture, Jerry March, John Wiley.
3. Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976).
4. Organic Chemistry (3/e) by J. B. Hendrickson, Donald J. Crem and George S. Rammond (McGraw-Hill Book Co. &Kogekusha Co. Ltd., 1970).
5. Organic Chemistry (5/e) by Morrison & Boyd (Prentice Hall).
6. Advanced Organic Chemistry by Carey &Sundberg (3rd edition).
7. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
8. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
9. Organic chemistry 2nd ed. Jonathan clayden, Nick greeves, Stuart Warren.
10. 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 AndTheory 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 AndPericyclic Reactions 3rd ed. by Jagdamba Singh 2010. New Age International Publishers Ltd. New Delhi.
6. Pericyclic Reactions A mechanistic and problem solving approach Sunil Kumar, Vinod Kumar, S.P.Singh Academic Press 2015

UNIT III:

1. Advanced Organic Chemistry-Reactions, Mechanism and Strucuture, 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. Organic Chemistry by Carey &Sundberg (3rd edition).
6. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
7. Physical organic chemistry by Jack Hyne
8. Reaction mechanism by Jagdambasingh.
9. Organic chemistry - Reaction mechanism, by P.S. Kalsi, New age international publishers.

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

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

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

Course Code	[1803081001050001]	Title of the Course	**ORGANIC CHEMISTRY**
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

3. 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)
4. Paper Chromatography

Teaching-Learning Methodology	Introduction, demonstration of handling equipments, 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%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learnerwill be able to	
1.	Understand basics of separation of organic tertary mixtures.
2.	Identify and chemical nature of mixture.
3.	Separate of each component from mixture.
4.	Identify each component through their functional group test, elemental analysis and M.P/BP.
5.	Purify the compounds using different techniques including distillation, crystallization etc.
6.	Record physical constants for individual compounds.

7.	Appreciate good laboratory practices.

Suggested References:
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
On-line Resources

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 concept of thermodynamics in solution. • To understand 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 reaction. • To lean 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 catalysed reactions, Kinetics of general Chain reaction, Kinetics of photochemical reactions(H_2-$Cl_2$and H_2-Br_2) , Kinetics , Mechanism ,determination of activation energy and chain length of some organic decomposition (i) decomposition of ethane (ii) decomposition of acetaldehyde, 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,Canonica l ensemble, occupation numberstatistical weight factor, probabilit y) , 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) Equilibr ium constant Molecular partition functions for an ideal gas , Derivation for Translational, Rotationaland 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	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%
3.	University Examination	70%

Course Outcomes: Having completed this course	
1.	Students learn thermodynamic terminology, fundamental thermodynamic properties, properties of solution, fundamental knowledge assist student to understand related topic in next semester.
2.	Understand kinetics of different types of reaction. Understand the factors responsible for behaviour of different kind of chemical reaction
3.	Learn relation between quantum chemistry and statistical thermodynamics. Understand basic terminology and their application in calculation of thermodynamic function.
4.	Understand the method for synthesis of polymer and their characterization

Suggested References:

Unit I:

1. Chemical Kinetics, Laidler K.J. TATAMcGRAW-HILL PUBLISHING COMPANY LTD

2. Principles of Chemical Kinetics, James E. House, Elsevier Publication
3. Kinetics and Mechanism of Chemical Transformations, Rajaraman, J. and Kuriacose, J., McMillan (2008)b
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 ChemistryPuri 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

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

Course Code	[1803081001050001]	Title of the Course	**PHYSICAL CHEMISTRY**
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 behaviour of surfactant in aqueous solution • 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 distribution method.

6. Investigation the reaction between H2O2 and HI at two different temperatures and calculate the energy of activation for the reaction
7. Determine the formula of a complex between Cu+2and NH3 by distribution method.
8. Determine CST of Phenol -Water system
9. Determine CST of Phenol –NaCl system

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

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

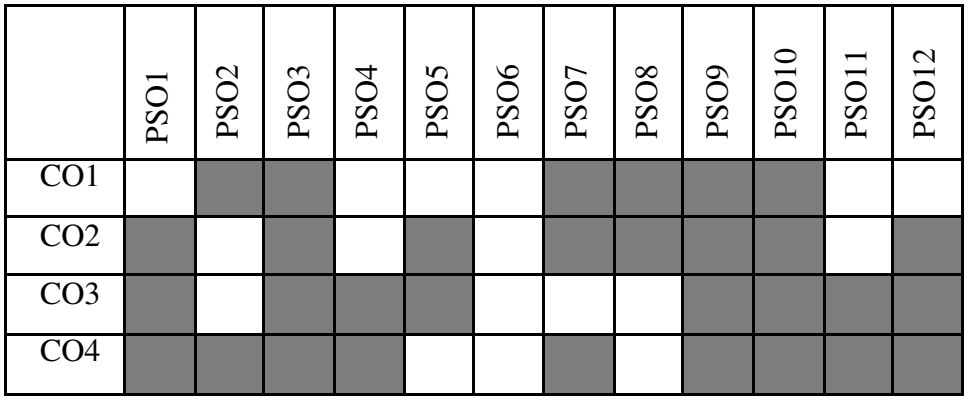
Course Outcomes: Having completed this course, the learnerwill be able to	
1.	Understand preparation of solutions.
2.	Qualitative analysis of compound
3.	calculate the concentration of unknown solution by pH, potentiometer and colorimeter
4.	Understand behaviour of surfactant and polymer
5.	Separation of solvent using phase diagram

Suggested References:

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

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

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

Course Objectives:	• To understand concept of electromagnetic radiation, auxochrome, chromophores, various factors affect 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 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, various factors effect 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 Code	[18030802010040001]	Title of the Course	**INSTRUMENTAL AND CHEMICAL ANALYSIS**
Total Credits of the Course	4	Hours per Week	4 hrs

Course Content		
Unit	Description	Weightage* (%)
1.	**UV-VISIBLE SPECTROPHOTOMETRY** Types of electronic transition, auxochrome, chromophore, Bathochromic effect, Hypso chromic effect, Hyper chromic effect, Hypo chromic effect, Factor affecting λ_{max} like resonance, hyper conjugation, hydrogen bonding, steric effect, Woodward's rules for α, β-unsaturated ketones, Diene systems, aromatic system, Effect of solvent on absorption bands, law of absorption with derivation, Elementary idea of double beam automatic recording, Spectrophotometer, Application.	25
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 – Derivatisation 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** **(A) THERMOGRAVIMETRY** Thermogravimetry, Instruments for TGA- thermobalace and furnace, Calibration of temperature scale, Factors affecting TGA results instrumental and experimental, Applications. **(B) THERMOMETRIC TITRATION:** Thermometric Titration (TT), Advantages, Instrument, Applications of TT in Neutralization Titration, Precipitation Titration, Complexometry Titration and Redox Titration.	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 participate in seminars/ workshops, presentations by students, assignments etc.

Course Outcomes: 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 whose don't 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 the techniques and identified the problems arise during the analysis.

Evaluation Pattern

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

Suggested References:

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 & McWilliom, John Wiley & Sons.
7. Instrumental Analysis by R. 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. Modern Method of Chemical Analysis by Pecsok, Shield, Cairns, McWilliam, John Wiley and Sons.
15. Quantitative Analysis, 6th Ed., R. A. Day and A. L. Underwood, Prentice – Hall of India, 1993.
16. Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2nd edition.
17. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th edition.
18. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (Van Nostrand Reinhold Co., New York), 6th edition.
19. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2nd edition.
20. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company), New Delhi.
21. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).
22. Introduction to Modern Liquid Chromatography: L. R. Shyder & J. J. Kirkland (John Wiley & Sons, New York).
23. Treatise on Analytical Chemistry: I. M. Kohthoff & P. J. Elving (John Wiley & Sons, New York).
24. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).

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

Structure of M. Sc, Syllabus
Semester-II

Sr. No.	Course Code	Course Title	L	T/C/S	Credit
1	1903080202010001	Inorganic Chem	4		4
2	1903080202020001	Organic	4		4
3	1903080202030001	Physical	4		4
4	1903080202040001	Instrumental and chemical analysis	4		4
5		Practicals + 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 + 3	60	140	200
			Total	25	180	420	600

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 the properties of non-transition metal elements. • To learn the synthesis, bonding, properties and applications of main group elements. • To understand the Bio inorganic 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.	**ELEMENTS OF MAGNETOCHEMISTRY** Definitions of magnetie 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 (s) 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 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.	25
3.	**INORGANIC POLYMERS** Definition of polymers and their depiction. Characteristics of inorganic polymer. Characterization of inorganic polymers (physical properties) by molecular weight, number average and weight average. Structural features of polymers: (1) Backbone bonding (2) Branching and cross-linking (3) Chemical and Stereo chemical variability 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 effecting 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	25

	polynuclear complexes, Determination of composition of complex ions	

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

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

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the definitions of magnetic properties, type 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 effecting 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 References:

1. Magneto chemistry by R. L Carlin
2. Element of Magnetochemistry by A. Syamal and R. L. Dutta, Affileted East-West press,

new Delhi, 1993.
3. Introduction to metal pi-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
On-line Resources

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

Course Code	[19030811002050001]	Title of the Course	**INORGANIC CHEMISTRY**
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 $CaC_2O_4H_2O$ 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, 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%
3.	University Examination	70%

Course Outcomes: 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 References:

1. A textbook of practical inorganic chemistry - A.L.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

On-line Resources

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 catalyst 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, azzulene 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: (i) Heck reaction (ii) Dakin reaction (iii) Darzen'sglycidic ester synthesis (iv) Leuckart reaction (v) Suzuki reaction (vi) Willgerodt reaction (vii) Buchwald-Hartwig reaction (viii) H. V. Z reaction (ix) Vilsmeyer-Hack reaction (x) Mitsunobu reaction (xi) Sonagashira reaction (xii) Dickmann reaction.	25
2.	**AROMATICITY** A. Aromaticity and Aromatic character; structure and stability of benzene, Frost circle diagram, concept of aromaticity; Resonance and chemical stabilization; criteria to checkaromatic character-IR, NMR, heat of hydrogenation; Huckel's rule; HMO method B. Antiaromaticity, homoaromaticity, nonaromaticity; aromaticity in benzanoid compounds: naphthalene, pyrene, acepleialdelene. C. Aromaticity non-benzenoid compounds: azulene, tropolones, charged rings,annulenes fullerenes, and hmesoionic compounds.	25
3.	**ORGANIC TRANSFORMATION AND REAGENTS** I. Sharplessepoxidation II. Umpolung reagent (1,3-dithiane) III. Dess martin periodinane IV. DDQ V. Tri-n-butyltinhydride (C4H9)3SnH VI. Diisobutyl aluminum hybride (DIDAL-H) VII. Lithium disoprpyl amide (LDA) VIII. OZONE / IX. K3Fe(CN)6and DMSO X. Merrifield Peptide Synthesis\	25

	XI. Crown ethers XII. Wilkinson's Catalyst	
4.	**PHOTO CHEMISTRY** A. Energy of molecules, photochemical energy, electronic excitation, Jablonski diagram, laws of photochemistry, quantum efficiency. B. Photochemistry of carbonyl compounds- α- cleavage of acyclic, cyclicand α-β unsaturated cleavage of carbonyl compounds, β-cleavage of, inter and intramolecularhydrogen abstraction, addition to carbon- carbon doublr bond, photo reduction of carbonylcompounds. C. Photo induce rearrangement of enones, dienones and alkenes. Photochemistry of alkenesand aromatic compounds- isomerization, dimerization and addition reactions D. Photochemistry of visiob, singletoxygenoxygenations,solar energy conversion and storage	25

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

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

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the role of transition metal in organic synthesis by studying Heck, Suzuki, Sonogashira and Buchwald Hartwing 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 one self familiarize with usual photochemical reactions, terms of photochemistry, understanding fluorescence, phosphorence by photoexcitation decay/discipation of energy. Types photochemical reactions like Norrish type-I & II, Paterno-Buchi etc., Photodimensation and their application in organic synthesis.

Suggested References:

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 machanisms 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 byM.S. Singh
12. Organic chemistrybyCram, 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 byCarey & Francis
18. Organic Chemistry byJonathanClayden

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

On-line Resources

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

Course Code	[19030811002050001]	Title of the Course	**ORGANIC CHEMISTRY**
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												

Course Content

Preparation of organic compounds :

i) Nitration
ii) Bromination
iii) Acylation
iv) Reduction
v) Oxidation
vi) Condensation reaction
vii) Diazotization reaction
viii) Friedl-Craft's reaction
ix) Cannizzaro reaction
x) Aldol condensation

Quantitative Estimations

a. Estimation of ester + acid
b. Estimation of formaldehyde
c. Estimation of glycine
d. Estimation of amide + acid

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%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learnerwill 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 monitora 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 References:

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
On-line Resources

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.	**UNIT-I:THEORIES OF ELECTROLYTIC CONDUCTANCE AND OVER VOLATEGE** Debye-Huckel theory of strong electrolytes, relaxation effect and electrophoretic effect, Debye Falkenhagen effect, Weineffect.Ionic strength and its determination ,Debye-Huckel limiting law. Activity and activity coefficient,	25

	determination of activity coefficient by (i) solubility (solubilit y 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.	
2.	**UNIT-II: SURFACE CHEMISTRY** Adsorption Multilayer Adsorption, the BET adsorption isotherms, derivation of BET equation, determination of surface area and area of cross section of molecules by BET equation.Derivation of Langmuir equation from BET equation. Explanation of different adsorption isotherms, Change in enthalpy ,entropy and free energy of adsorption, Adsorption at the surface of liquid : Gibbs adsorption isotherms (derivation).Thermodynamic treatment of adsorption,Surface –Active substances, orientations of surfactants on the surface of solution , surface inactive substances, surface pressure,Insoluble surface films on liquid Numerical	25
3.	**UNIT-III: 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, elecroosmosis. Surface active agents, critical micellar concentration (CMC), factors affecting the CMC of surfactants, thermodynamics of micellization: mass action and phase separation model, solubilisation, emulsion, types of emulsion, methods for determination of types of emulsion, microemulsion, types of microemulsion, theories of microemulsion.	25
4.	**UNIT IV: 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	25

	interaction with radiation, selection rule, determination of force constant, Amplitude of vibration, The anharmonicvibrationor 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	

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

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

Course Outcomes: Having completed this course, the learnerwill be able to	
1.	Understand the electrolytes in conductance of solutions. Importance of polorizat ion 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 explain the importance of micelle formation for colloidal industry
4.	Identify the molecular interactions and concentration and identification of componds

Suggested References:

UNIT : 1.

1. Atkins, P.W., Physical Chemistry, W.H. Freeman (2017) 10 th editon
2. Samuel Glsstone, Introduction to Electro chemistry, East-West Press Pvt. Ltd. (2008)
3. Puri, B.R., Sharma, L.R., and Pathania, M.S., Principles of Physical Chemistry, 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 : 2

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 : 3

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 4

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
On-line Resources

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

Course Code	[19030811002050001]	Title of the Course	**PHYSICAL CHEMISTRY**
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 behaviour of surfactant in aqueous solution • 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- + I2 = I3- by distribution method.
6. Investigation the reaction between H2O2 and HI at two different temperatures and calculate the energy of activation for the reaction
7. Determine the formula of a complex between Cu^{+2} and NH_3 by distribution method.
8. Determine CST of Phenol -Water system
9. Determine CST of Phenol –NaCl system

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

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

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

Suggested References:

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

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

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

Course Code	1903080202040001	Title of the Course	**INSTRUMENTAL AND CHEMICAL ANALYSIS**
Total Credits of the Course	[1903080202040001]	Hours per Week	4 hrs

Course Objectives:	• To understand theory and instrumentation of infra-red 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 twelve principle 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 nonlinear molecule, equation for vibrational frequency, selection rule, coupling interactions, hydrogen bonding information, Fermi resonance. IR spectra: group frequency, group frequency region, finger print region, spectra interpretations and structure elucidation.	25
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** **(A) 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. **(B) 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 ELEMENTAL ANALYSIS** **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 Sulpher 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 participate in seminars/ workshops, presentations by students, assignments etc.

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

Course Outcomes: 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 References:

1. Fundamental of molecular spectroscopy, C.N. Banwell, Tata McGraw Hill Pub. Camp.
2. Spectrometric Identification of Organic Compounds (4th edition/5th edition), Silverstein,Bassler&Morril,JohnWiley&Sons.
3. IntroductiontoMolecularSpectroscopy,G.M.Barrow, McGraw – Hill.
4. Modern Spectroscopy, J.M.Hollas, John Wiley.
5. Basic Principles of Spectroscopy, R.Chang, McGraw-Hill.
6. ModernMethodsofChemicalAnalysis(2nd ed.),Pecsok,Shields,Cairns&McWilliom, JohnWiley&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, McGrawHill.
10. Introductionto Instrumental Analysis by R. D. Brawn, McGraw-Hill Book.
11. FundamentalsofAnalyticalChemistry:SkoogD.R.andWestD.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. ModernMethodofChemicalAnalysisbyPecsok,Shield,Cairns,McWilliam,John Wiley and Sons.
15. Quantitative Analysis, 6th Ed.,R.A.DayandA.L.Underwood, Prentice– Hall of India, 1993.
16. Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn& Bacon Inc., NewYork, 2ndedition.
17. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, NewYork), 5thedition.
18. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (Van Nostrand Reinhold Co., New York), 6thedition.
19. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2ndedition.
20. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company), New Delhi.
21. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).
22. Introduction to Modern Liquid Chromatography: L. R. Shyder& J. J. Kirkland (John Wiley & Sons, New York).
23. Treatise on Analytical Chemistry: I. M. Kohthoff& P. J. Elving (John Wiley & Sons, New York).
24. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
25. Environmental Chemistry: B. R. Sharma, H. Kaur (Goel Publishing House, Meerut).
26. Environmental Chemistry by A.K.de

27. Spectrometric Identification of Organic Compounds; By Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce, Eight edition, Published by Wiley
28. Introduction to Spectroscopy; By Donald L. Pavia, Gary M. Lampman, George S. Kriz, James A. 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, Ne 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
On-line Resources

M.Sc. Sem-III (Analytical Chemistry)

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

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 affects 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 striping, 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, hypernation with other techniques, Direct Injection Enthalpimetry, Applications, Numerical.	25
2.	**ELECTRICAL METHODS OF ANALYSIS** Liquid Junction Potential, Mass transfer, Electric Double layer, Faradic and Non-faradic Current, Polarization effect, Types of Polarization, Electrogravimetry, Constant Potential and current Electrolysis, Factors affecting the quality of deposits, Applications. Principle of Coulometry, Controlled current coulometry, Instrumentation and application of Controlled potential coulometry, Coulometric titrations (primary and secondary), endpoint detection in coulometry titration, applications and Problems	25
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.	25

	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 voltamogram, Detection limits, Applications.	
4.	**RADIO-CHEMICAL METHODS OF ANALYSIS** Interaction of radiation with matter, Units of radioactivity, Statistic of counting, Background corrections, Neutron activation analysis, Sources of neutrons, Theory of instrumental neutron activation analysis, Experimental considerations, Isotope dilution analysis (Direct and Inverse), Radioimmuno 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 participate in seminars/ workshops, presentations by students, assignments etc.

Evaluation Pattern

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

Course Outcomes: Having completed this course, the learner will be able to

1.	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 References:

17. Vogel's Text book Quantitative Chemical Analysis 5th edition by G.H.Jeffery, J. Bassett, J. Mendham, R.C. Denney.
18. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage lerning, 7th edition)
19. Principle of Activation Analysis- P. Kruger, John Wiley and sons, (1971).
20. Nuclear Analytical Chemistry – J. Tolgyessy and S. Verga vol. 2, university Park press,(1972)
21. Radiochemistry and Nuclear methods – W.D. Ehmann and D.E. Vance, John Wiley and Sons.
22. Indian Pharmacopeia Volume I and II.
23. Extraction technique in analytical science, John R. Dean, Wiley (2009)
24. Standard methods of chemical analysis, Sixth Edition, F.J. Welcher.
25. Quantitative Inorganic Analysis including Elementary Instrumnetal analysis, By A. I. Vogel, 3ed, ELBS, 1964.
26. Instrumental Analysis: G. D. Caristian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2nd edition.
27. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5th edition.
28. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (Van Nostrand Reinhold Co., New York), 6 th edition.
29. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2nd edition.
30. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company), New Delhi.
31. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).
32. Introduction to Modern Liquid Chromatography: L. R. Shyder & J. J. Kirkland (John Wiley & Sons, New York).
33. Treatise on Analytical Chemistry: I. M. Kohthoff & P. J. Elving (John Wiley & Sons, New York).
34. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
35. Basic concepts of Anlytical Chemistry by S.M. Khopker
36. Standard Methods of Chemical Analysis: Vol. I & II (6th edition), D. Van Nostrand Co. Inc. (London).
37. Official Methods of Analysis: Published by Association of Official Analytical Chemists, Washington.
38. Instrumental Methods of Chemical Analysis: B. K. Sharma (Goel Publishing House, Meerut).
39. Instrumental methods of Chemical Analysis by H. Kaur.
40. Environmental Chemistry: B. R. Sharma, H. Kaur (Goel Publishing House, Meerut).
41. Inorganic Quantitative Analysis: A. I. Vogel (Orient Longman).
42. "Polarography", J. D. Talati (In Gujarati), University Granth Nirman Board.
43. "Polarography": Kolthoff I. M. and Lingane J. J. (Vol. I & II) (Interscience Publishers, New York).
44. "Polarographic Techniques": L. Meites (Interscience Publishers, New York).
45. Principles of Instrumental Analysis (5th ed.) by Skoog, Holler and Nieman (Saunders College Publishings).
46. Undergraduate Instrumental Analysis (5th ed.), J. W. Robinson (Marcel Dekker Inc.).
47. Fundamentals of Molecular Spectroscopy, by Banwell.
48. Electronic Absorption Spectroscopy and related techniques, D.N. Sathyanarayan, (New Age International ND. 1996) Uni. Press, Hyderabad.

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

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 IR and Raman edge in the theory and principals of spectroscopic techniques for characterization and differentiation of various molecules. • To familiarize with the basic properties, theory and interpretation NMR edge in the theory and principals of spectroscopic techniques for characterization differentiation of various molecules. • To familiarize with the basic properties, theory and interpretation molecular Mass edge in the theory and principals of spectroscopic techniques for characterization and differentiation of various molecules. • To familiarize with the basic properties, theory and interpretation luminescence edge in the theory and principals 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 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 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, 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 LUMINESCENCE SPECTROSCOPY** Introduction to molecular luminescence (fluorescence, phosphorescence and chemiluminescence); theory of luminescence, energy level diagram, Deactivation process,; instruments for measuring fluorescence (fluorometer and spectrofluorometer);, factor affecting, Emission and excitation spectra, wavelength selector, detector, application and problems	25

Teaching-Learning	To meet the effective teaching and the learning requirements, teaching-learning methodology comprise classroom teaching, use of e-resources, library books, IT

Methodology	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 Examination (As per CBCS R.6.8.3)	30%
3.	University Examination	70%

Course Outcomes: 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 References:

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. 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, 3ed, ELBS, 1964.

10. Instrumental Analysis: G. D. Caristian 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 (Van Nostrand Reinhold Co., New York), 6 th edition.
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28. "Polarographic Techniques": L. Meites (Interscience Publishers, New York).
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30. Undergraduate Instrumental Analysis (5th ed.), J. W. Robinson (Marcel Dekker Inc.).
31. Fundamentals of Molecular Spectroscopy, by Banwell.
32. Electronic Absorption Spectroscopy and related techniques, D.N. Sathyanarayan, (New Age International ND. 1996) Uni. Press, Hyderabad.
33. Introduction to Spectroscopy (3rd ed.) by Pavia Lampman Kriz, Cengage Learning Harcourt College Publishers

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

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

Course Code	[1903080203030001]	Title of the Course	**Electroanalytic al 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-polarographic, amperometry, biamepometry 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** (a) 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. (b) 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, Nature of the Limiting Current: 1) Kinetic currents, 2) Catalytic currents and 3) Adsorption currents, Electro capillary maxima, Maxima of first kind and second kind, Maxima suppressors, DME as electrode, Wave equation, Ilkovic equation (derivation), Reversible electrode reactions at DME half wave potential, Interference and removal of oxygen, Reversible Electrode Reactions of Metal Complexes at D.M.E (Ligane method) Determination of stability constants of complexe s. Amperometric titrations: Principle, DME & RPE, curves, Biamperometric 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 frequency of 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,	25

	ammonia, sulphur dioxide, oxygen and CO_2 sensing electrode, Micro ion selective electrode, enzyme electrodes. Application and Numericals	

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

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

Course Outcomes: 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, knows 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 use 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 References:

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

Course Code	[19030802030400001]	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	25

	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.	
2.	**ANALYSIS OF AIR AND SOIL** **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.	25
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, separation of pigment binder, Analysis of pigments, Identification of inorganic pigments, Analysis of white and tinted pigments, HCL insoluble, Titanium dioxide, total lead, acid soluble Al and Fe, acid soluble calcium, total zinc, antimony oxide, total sulfate, total carbonate) analysis of ultramarine blue, Black pigments, Red Lead pigments.	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 participate in seminars/ workshops, presentations by students, assignments etc.

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

3.	University Examination	70%

Course Outcomes: 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 References:

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

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

Course Code	[1903080203050001]	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 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

1	Major Exercise	4- Credit
2	Viva-Voce	
3	Minor Exercise	4- Credit
4	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 $PbCrO_4$ after precipitation from homogeneous solution.
4. Analysis of Chloride in bleaching material.
5. Determination of COD of water sample.
6. Determination of DO of water sample.
7. Determination of Ka1 and Ka2 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. Elecrtogravimetric 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 Practical Examination (As per CBCS R.6.8.3)	30%
3.	University Examination	70%

Course Outcomes: 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.	Drw the graph and find out the unknown concentration by comparision with known compound.
5.	Appreciate good laboratory practices.

Suggested References:

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. Van Nostrand Company, Inc.

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M.Sc. Semester-IV (Analytical Chemistry)

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

Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester IV
Paper 1

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 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	25

	microprobe spectrometry, Application, Electron Microscope, SEM, STM and AFM, Numerical	
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 ELECTRO CHROMATOGRAPHY** Definition, types, Free solution electrophoresis, Moving boundar electrophoresis, Zone electrophoresis, paper electrophoresis, types of stabilizing medium, location of components, electrode, source of current, requirement of electrophoretic chamber, Immunoelectrophoresis Continuous (Curtain) flow electrophoresis, Gel electrophoresis. Capillary Electrophoresis, Column, Electro Chromatography, Field Flow Fraction (FFF), Micellar electrokinetic capillary Chromatography, Application.	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 participate in seminars/ workshops, presentations by students, assignments etc.

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

3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand fundamental & theory 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 of auto analyser for clinical analysis, types of analysis.

Suggested References:

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)
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28. "Polarographic Techniques": L. Meites (Interscience Publishers, New York).
29. Principles of Instrumental Analysis (5th ed.) by Skoog, Holler and Nieman (Saunders College Publishings).
30. Undergraduate Instrumental Analysis (5th ed.), J. W. Robinson (Marcel Dekker Inc.).
31. Fundamentals of Molecular Spectroscopy, by Banwell.
32. Electronic Absorption Spectroscopy and related techniques, D.N. Sathyanarayan, (New Age International ND. 1996) Uni. Press, Hyderabad.
33. Introduction to Spectroscopy (3rd ed.) by Pavia Lampman Kriz, Cengage Learning Harcourt College Publishers

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

Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester IV
Paper I1

Course Code	[2003080204020004]	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** Emission of X-ray, continuum and line spectra, X-ray absorption, absorption spectra, Apparatus, Source (monochromatic X-ray),	25

	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 RESONANCE SPECTROSCOPY** 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 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 FLUORESCENC E 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	To meet the effective teaching and the learning requirements, teaching-learning methodology comprise classroom teaching, use of e-resources,

Methodology	library books, IT tools, encouraging students to participate in seminars/ workshops, presentations by students, assignments etc.

Course Outcomes: 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.

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

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. 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)
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Vogel, 3ed, ELBS, 1964.
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18. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
19. Basic concepts of Anlytical Chemistry by S.M. Khopker
20. Standard Methods of Chemical Analysis: Vol. I & II (6th edition), D. Van Nostrand Co. Inc. (London).
21. Official Methods of Analysis: Published by Association of Official Analytical Chemists, Washington.
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23. Instrumental methods of Chemical Analysis by H. Kaur.
24. Environmental Chemistry: B. R. Sharma, H. Kaur (Goel Publishing House, Meerut).
25. Inorganic Quantitative Analysis: A. I. Vogel (Orient Longman).
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32. Electronic Absorption Spectroscopy and related techniques, D.N. Sathyanarayan, (New Age International ND. 1996) Uni. Press, Hyderabad.
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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 liquid, 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/separat ion 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 extraction with successive portion, basic concept, Apparatus and bi nominal distribution for Craig pseudo/ continuous counter current extractions. True counter current extraction: Fractional distillation, Use of crown ethers and Cryptans for extraction, extraction equilibria with crown ethers, factors affection extraction with crown ether, numerical of distribution coefficient and multiple extraction	25
2.	**THEORY OF CHROMATOGRAPHY** Methods of elution, Ideal and non-ideal chromatography, Plate theory, Rate theory, Reasons for broadening of lands, Van Deemter equation and significance of terms involved, Optimum velocity, Resolution, Methods to improve resolution, GLC, Supports for liquid stationary phases, Selection of columns , FSOT, Selective Detectors- FPB, TID, Temperature programming in GC, Derivatisation in GC, Qualitative analysis from retention parameters, Quantitative analysis, Headspace Analysis, Thermal Desorption.	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 MICRO EXTRACTION** **(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 participate in seminars/ workshops, presentations by students, assignments etc.

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

Course Outcomes: 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 cryptons 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 References:

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. Principle of Activation Analysis- P. Kruger, John Wiley and sons, (1971).
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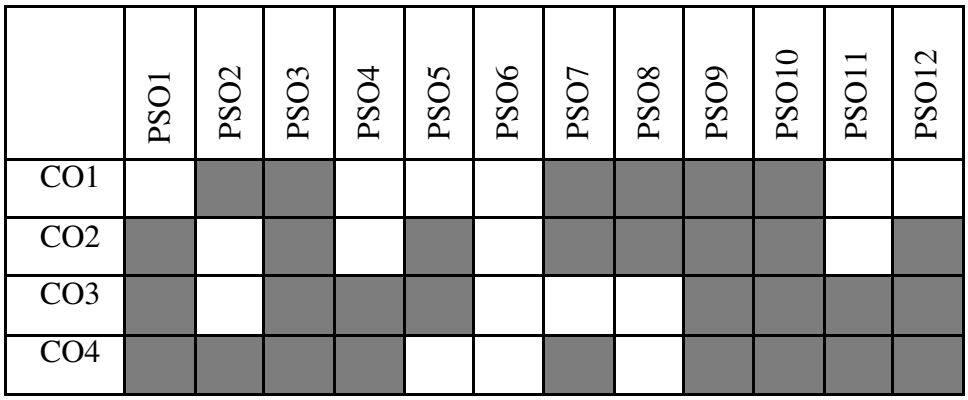
Master of Science, Analytical Chemistry
M.Sc. Analytical Chemistry, Semester IV
Paper IV

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 diffrent 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, DETERGENTS AND 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** **Pesticides:** Analysis of Benezene hexachloride, Analysis of DDT in mixture by colorimetric methods, Determination of Dieldrin in formulation by partition chromatography, Total phosphorous in phosphorous containing pesticide s, 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.	25
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 participate in seminars/ workshops, presentations by students, assignments etc.

Evaluation Pattern

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

Course Outcomes: 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 References:

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

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

Course Content

1	Major Exercise	

2	Viva-Voce	4- Credit
3	Minor Exercise	4- Credit
4	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 Chromium and manganese.
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 Penicilin
2. Iron formulation for iron content.
3. Aspirin tablet
4. Analysis of APC tablets for its aspirin and phenacetin content using UV spectrophotometry.
5. Analysis of Insecticides: Analysis of BHC.
6. Determination of Protein content of wheat flour by Kjeldahl Method.
7. Analysis of Detergent sample for PO_4 and other constituents.
8. Analysis of fertilizers by determination of nitrogen content.
9. Analysis of fruit juice for Vitamin-C.
10. Determination of saponification value of Oil and fat.
11. Spectroscopic determination of Ni^{+2} with D.M.G.
12. Conductometric determination of vanillin in Vanilla.
13. Photometric titration of (Cu^{+2}+ Ca^{+2}) in a mixture
14. Determination of Metal: Ligand ratio in complex.
15. Flame photometric determination of Na^{+} and K^{+}.
16. Colorimetric estimation of titanium in the given solution by hydrogen peroxide.
17. Estimation of amino acids by colorimetry.
18. 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%
3.	University Examination	70%

Course Outcomes: 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 References:

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. Van Nostrand Company, Inc.