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%

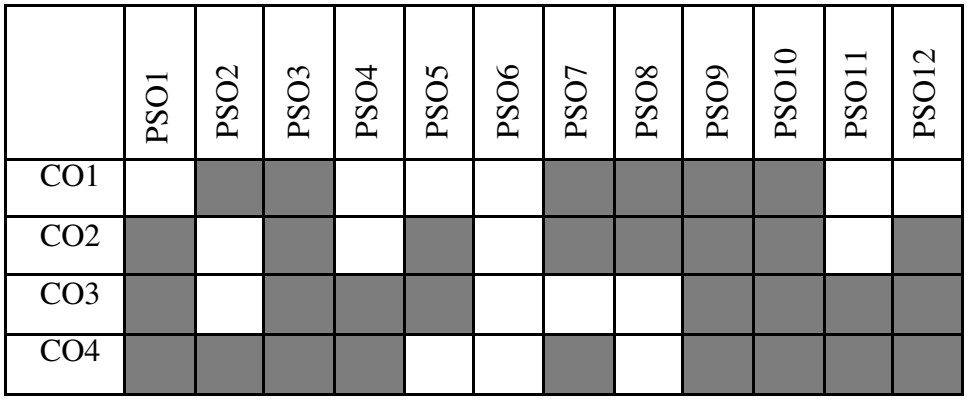
Course Outcomes: Having completed this course, the learnerwill be able to	
1.	Understand preparation of solutions.
2.	Qualitative analysis of compound
3.	calculate the concentration of unknown solution by pH, potentiometer and colorimeter
4.	Understand behaviour of surfactant and polymer
5.	Separation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

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

Course Code	[19030802010004]	Title of the Course	**Advanced Thermodynamics**
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:

- Application of statistical thermodynamics to gas , liquid and solid
- To learn the calculation of partition function for different ensembles and gaseous systems
- Theore[illegible]nation on therm[illegible] of liquid mixture
- T[illegible]havio[illegible]gaseo[illegible]ms in[illegible]uatio[illegible]

Mapping between CO and PSO

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

Course Content

Unit	Description	Weightage* (%)
1.	**STATISTICAL THERMODYNAMICS OF ENSEMBLES** Phase Space, The Liouville theorem, Ergodic Hypothesis, Ensemble and probability, ensemble averages and postulates. Details of types of ensemble: Canonical and Microcanonical and Grand canonical ensemble. Probability distribution, partition function and thermodynamic function of canonical ensemble, Equilibrium constant and canonical ensemble, Partition function for Grand canonical ensemble, Fluctuations, Mean distribution and mean square deviation, Fluctuation in energy in a canonical ensemble	25

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

Teaching-Learning Methodology	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 contribution of different partition function to the assigned system. Calculation of thermodynamic functions for the systems
2.	Understand sets of partition functions and calculation for various gaseous systems. The fluctuations in calculation of thermodynamic functions
3.	To learn different types of interactions in liquid mixtures the derivation of empirical equation for excess thermodynamic functions for liquid mixtures
4.	To understand critical phenomena of gaseous systems.

Suggested References:

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

Master of Science, Physical Chemistry
M.Sc.Physical 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 understand the familiarize with the basic properties, theory & interpretation of IR, ^{1}H NMR, Mass and Luminescence Spectroscopy. • To impart knowledge in the theory & principals of spectroscopic techniques for characterization & differentiation of various molecules. • To impart knowledge on identification of compounds using spectroscopy
Mapping between CO and PSO	

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

Course Content		
Unit	Description	Weightage* (%)
1.	**IR AND RAMAN SPECTROSCOPY** Theory of IR and Raman, selection rules, IR absorption, Raman scattering, Mutual exclusion rule, complimentary techniques, Instrumentation - FTIR and Raman, Cells and sampling techniques, Resonance Raman spectroscopy, Interpretation of IR spectra using correlation charts, Advantages of FTIR spectroscopy, Mid-IR Reflection – DRS, ATR, Data processing in Near IR, Applications in structure elucidation of inorganic and organic molecules.	25
2.	**NMR SPECTROSCOPY**	25

	Theory of NMR, Relaxation, population of energy levels, Larmor precession, chemicalshift 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, 13C NMR spectra, Calculation of chemical shift in 13C NMR, NMR in medical diagnostics, Double resonance technique, Multi-dimensional NMR, Problems to elucidate structure from NMR spectra.	
3.	**MOLECULAR MASS SPECTROSCOPY** Instrumentation, Methods of ion production (EI, CI, FI, FD, Electro Spray, MALDI), Ion separators, Ion collection and recording, Double focusing, Time of flight analyser, Quadruple-mass spectrometer, Sample handling techniques, Resolution, Parent peak, Base peak, Metastable ions isotope effect, Molecular formula from mass spectra, Nitrogen rule, Ring rule, Fragmentation rules, Behavior of classes of compounds, Interpretation of mass spectra, Additional applications, Problems to elucidate structure from mass spectral data.	25
4.	**MOLECULAR 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 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.	Understandfundamental & basic terms involved in IR, ^{1}H NMR, Mass and Luminescence Spectroscopy, know effects of various factors on the spectra, interpretation from spectral data, identify structure of organic compounds by using combined spectral data, distinguish isomers and other closely related compounds by using spectral techniques.
2.	Identify drug testing contamination in food, isotope ratio determination and protein identification with the help of spectroscopy
3.	Identify the name of compounds using spectroscopy
4.	Understand the instrumental set up for all instruments.

Suggested References:

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

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

Course Code	[1903080203030001]	Title of the Course	Electro Analytical Techniques
Total Credits of the Course	4	Hours per Week	4 hrs

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

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

Course Content

Unit	Description	Weightage* (%)
1.	**POTENTIOMETRIC TITRATION AND CHRONOPOTENTIOMETRY** (a) Fundamentals of potentiometry, Instrumentation, electrode system, accuracy of direct potentiometric measurements and its limitations, potentiometric titrations, neutralization titrations, end-	25

	point detection, oxidation- reduction, precipitation titrations, complexometry titrations with example, applications and advantages. (b) Chronopotentiometry Principle, Instrumentation and procedure, applications.	
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 complexes. 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**	25

	Classification of ion selective electrodes, Solid state electrodes – Glass electrode effect of glass structure on selectivity function of the glass electrode. Acid error, Alkali error, Silver halide, Sulphide, Lanthanum fluoride ion selective electrodes. Liquid ion exchange electrode – Calcium selective ion electrodes. Gas electrodes, ammonia, sulphur dioxide, oxygen and CO2 sensing electrode, Micro ion selective electrode, enzyme electrodes. Application and Numericals	

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 concept of POLAROGRAPHY and its importance in analysis of elctro active compounds
2.	Learn types of various electrodes their characteristics and their uses
3.	Understand the application of different Polarography in identification of compunds
4.	Understand the Potentiometric Titration and Chronopotentiometry

Suggested References:

Reference Books Recommended

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

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

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

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

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

Course Content

Unit	Description	Weightage* (%)
1.	**BIOPHYSICAL CHEMISTRY** Bioenergetics: Standard free energy change in biochemical reactions (exergonic and endergonic). Coupled reaction, Energy rich compounds and energy coupling (Formation and hydrolysis of energy rich bonds in energy rich molecule), Enzyme Kinetics: MichaelisMenten, Michaelis-Menten for Inhibition and Activation, Lineweaver-Burke plots. Enzyme inhibition reversible and irreversible inhibition, Immobilized enzymes, Techniques and methods of immobilization of enzymes, Application of immobilized enzymes. Cell Membrane: Structure and Transport functions of cell membrane.	25
2.	**PHASE EQUILIBRIA OF MULTI COMPONENT SYSTEMS** Reduced Phase rule, Application of reduced phase rule to Two component systems: System with congruent and incongruent M.P., Phase rule for three component systems, Representation, methods of computing composition of ternary systems : methods of parallel and perpendicular lines, lever arm rule, Systems of three liquid component exhibiting partial miscibility (Formation of (a) one pair, (b) two pair and (c) three pairs of partially miscible liquids System composed of two solids and liquid components (a) crystallization of pure components (b) double salt formation (c) hydrate formation (d) formation of solid solution (Phase transitions in the ternary system	25
3.	**SOLID STATE CHEMISTRY** Ionic Crystals & Their structures, detailed explanation of types of packing and co ordination number, Radius ratio rule and prediction of packing of crystals, Polarization, Crystalline solids: Geometry of AB_2 type: Fluorite (CdI_2), antifluorites ($CdCl_2$), Rutile structures (TiO_2). AB_2 type: ReO_3, BiI_3, A_2B_3 type: Fe_2O_3 ,Corundum Al_2O_3,	25

	Ternary Compounds ABO_3 type: Perovskite, AB_2O_4 type : Spinelstructure Perfect & Imperfect crystals, Schottky defect, Frenkel defect, thermodynamics of Schottky& Frankel defects, Line defects: Dissociation, Extended defects: Lineage boundary, grain boundary, stacking fault	
4.	**ELECTRONIC BEHAVIOR OF MATERIALS** Metals, Insulators and Semiconductors, Electronic structure of solid, bond theory, band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping of semiconductors and conduction mechanism, the band gap. Temperature dependence of conductivity, carrier density and carrier mobility in semiconductors, synthesis and purification of semiconducting materials, single crystal growth, zone refining, fractional crystallization.Superconductivity: Introduction, theory of super conductivity, Meissner effect, Type I&II superconductors, crystal structure of high temperature semiconductors.	25

Teaching-Learning Methodology	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 biophysical chemistry of enzyme catalysed reaction. Immobilization of enzymes and role of cell membrane.
2.	Identify the separation of solid or liquid using phase diagram.
3.	Designing of new compounds using concept of solid state
4.	Different theories help to understand the behaviour of Electronic materials in depth

Suggested References:

Reference Books Recommended

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

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Master of Science, Physical Chemistry
M.Sc.Physical 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 preparation of solution and instrumental set up for the experiments. • Understand theories of the experiments • To learn about the interpretation of results and graphical

	representation of results. • To understand the purpose of experiments to meet the objectives of the experiments.
Mapping between CO and PSO	

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

Course Content

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

FULL EXPERIMENT (Any Seven)

1. To Study the kinetics of reaction between $K_2S_2O_8$ and KI. Determine rate constant, order of reaction and influence of ionic strength on rate constant
2. Determination of CMC of surfactant by conductance method and calculate thermodynamic parameters for micellization
3. To study the kinetics of hydrolysis of ethyl acetate by NaOH at two different temperatures by conductance measurement and find out energy of activation of the reaction.
4. Determine the effect of salts on the cloud point of nonionic surfactant.
5. Determination of constants of Mark-Houwink equation for polymer by viscosity method
6. Determine ionic composition of synthetic sea water samples by flame photometer.
7. Determine parachor/density/refractive index of binary solutions.
8. To determine the Ca^{+2}, Mg^{+2} and Fe^{+2} content in a sample of dolomite ore.

9. Study influence of ionic strength on solubility of $CaSO_4$ and determine thermodynamic solubility product and mean ionic strength.

HALF EXPERIMENT (Any Seven)

1. Study the ratio of complex formation formed by titration of Zn2+ with potassium ferrocyanidepotentiometrically.
2. Electrogravimetric determination of copper from solution
3. Equivalence conductance of solutions of strong electrolytes and weak electrolytes. Application of Kohlrausch's law. Onsager constant.
5. Ka of weak organic acid [benzoic acid] conduct metrically.
6. Study stability constant of complex formation between Fe (III) and salicylic acid
7. Determine ionization constant of bromophenol blue using pH meter.
8. Preparation of simple colloids and determination flocculation value for different salts.
9. Study Hydrolysis constant of methyl acetate catalysed by HCl and equi-normal urea hydrochloride, determine degree of hydrolysis for the salt.
10. Determine basicity of organic acid by conductometer
11. Structure Identification and Elucidation by IR/NMR/MS spectroscopy

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
6.	Separation of compounds using different solvent systems
7.	Theories of indicators
8.	

Suggested References:

Reference Books Recommended:

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

M.Sc. Semester-IV (PHYSICAL CHEMISTRY)

Sr. No.	Course Title	L	T/C/S	Credit
1	Advanced Thermodynamics	4	1	4
2	Atomic Spectroscopy	4	1	4
3	Separation Techniques	4	1	4
4	Polymer Chemistry	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, Physical Chemistry
M.Sc. Physical Chemistry, Semester IV
Paper 1

Course Code	[2003080204010004]	Title of the Course	**Advanced chemical kinetics**
Total Credits of the Course	4	Hours per Week	4 hrs

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

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

Course Content		
Unit	Description	Weightage* (%)
1.	**THEORIES OF REACTION RATES** Arrhenius theory of reaction rates, collision theory of bimolecular gaseous reaction, limitations and extension of collision theory, Rate theories based on thermodynamics, rate theories based on statistical mechanics, conventional transition-state theory (CTST), statistical mechanics and chemical equilibrium, Derivation of the rate equation, Thermodynamic formulation of CTST, few	25

	Applications of CTST, Assumptions and limitation of CTST, Extension of CTST: Vibration CTST	
2.	**REACTIONS IN SOLUTION PHASE AND GAS PHASE** Solution Phase Reaction: Solvent effects on reaction rates, factors determining reaction rates in solution, reaction between ions, ion dipole and dipole-dipole reactions. Effect of ionic strength. Substituent and correlation effects – Hammett equation. Linear free energy relationship. Gas Phase Reaction: Theories of unimolecular gaseous reaction: Lindmann-Christia nsen hypothesis, Hinselwood treatment, Rice Ramsperger Kassel (RRK) theory, RRKM theory	25
3.	**KINETICS OF CATALYSIS AND ADSORPTION** Catalysis Characteristic and types of catalyst, Homogeneous and heterogeneous catalysis and their commercial processes, General catalytic mechanisms: Equilibrium treatment (Arrhenius Intermediates), Steady state treatment (Van't Hoff intermediates), Activation energies for catalysed reaction. Acid-base catalysis, General acid base catalysis, Mechanism of acid base catalysis, Bronsted catalysis lawand acidity functions. Kinetics of Adsorption: Isotherm for simple, Dissociation, competitive adsorption, statistical thermodynamics of Adsorption, mechanism for unimolecular and bimolecular surface reaction.	25
4.	**KINETICS OF COMPLEX REACTIONS** Kinetics of (I) Reversible reaction: when first order reaction opposed by second order reaction, when second order reaction opposed by first order reaction, Second order reaction opposed by one of the same order (II) Parallel reaction (III) Feedback, non-linearity and Oscillation reactions: (i) The Lotka - Volterra mechanism (iii) The Brusselator mechanism (V) Explosion (VI) Photochemistry: Photo physical Processes, Fluorescence and Fluorescence Quenching, Measurement Tf, Fluorescence Resonance Energy Transfer (V) Electron transfer, Kinetic Model of Electron Transfer	25

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.	To learn statistical thermodynamic approach to chemical kinetics. The factors responsible for rate of reaction. Thermodynamic concept to understand the rate constant of the reaction
2.	Gives guidelines to understand control of reaction condition, increase reaction rate to increase production, effect of catalysis, slow down side reaction and improve separation process
3.	To learn about mechanism of various catalytic reactions Arrhenius and vont hoff concept of catalytic mechanism
4.	To learn about kinetics of control of solution and gas phase reaction.

Suggested References:

Reference Books Recommended:

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

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

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

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

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

Course Content		
Unit	Description	Weightage* (%)
1.	**ATOMIC X-RAY SPECTROSCOPY** Emission of X-ray, continuum and line spectra, X-ray absorption, absorption spectra, Apparatus, Source (monochromatic X-ray), Sample handling, Wavelength and energy dispersive device, Detector, Chemical analysis by X-ray absorption, X-ray fluorescence: Theory, instrumentation and applications, X-ray diffraction: Theory, instrumentation and applications.	25

2.	**ATOMIC ABSORPTION AND FLAME EMISSION SPECTROSCOPY** (a) Atomic Absorption Spectroscopy (AAS) Principle of AAS, Instrument, Continuous sources and line sources, Flames, Flame atomizers, Non flame atomizers (furnaces), 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 FLUORESCENCE SPECTROSCOPY** Atomic Emission Spectroscopy: Emission spectroscopy with plasma sources, Instrument, AES with electrical discharge, Electrodes of AES, DC- arc, spark, Laser microprobe, Salient features of the emission spectrograph, Qualitative and Quantitative analysis applications, Fluorescence Spectroscopy: Atomic fluorescence, apparatus for AFS, EMR source for AFS, LASERS, Cells for AFS, Plasmas, Wavelength selection for AFS, Detectors for AFS, Theory of AFS, Analysis with AFS, Interference with AFS	25

Teaching-Learning Methodology	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 theory, instrumentation and important terms of Atomic X-RAY Spectroscopy. Identification of compound from X ray pattern
2.	learn instrumentation and important terms of AAS and FES in identification of metal ions in industrial effluents.
3.	To learn concept of Electron Spin Resonance Spectroscopy and Qualitative and quantitative applications of EPRS.
4.	To learn instrumentation, application of Atomic Emission and Fluorescence Spectroscopy
Suggested References:	

Reference Books Recommended:

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

Master of Science, PhysicalChemistry
M.Sc.Physical 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 law for separation of compound form solution. • To understand the types of chromatographic techniques. • To learn types and applications of liquid chromatography. • To learn about basics of solid phase extraction.

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/	25

	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.	
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**	25

	(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). Development in micro extraction (liquid micro extraction, membrane micro extraction)	

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

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

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

Suggested References:

Reference Books Recommended:

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

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

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

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

Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1												
	CO2												
	CO3												
	CO4												

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

	Thermal stability and thermal transitions in polymers, Melting versus glass transition, Glass transition temperature, its cause and importance, Relation between Tg and Tm, Factors affecting glass transition temperature: Chain flexibility, effect of plasticizers, blending and copolymerization of Tg, Determination of glass transition method by dialatometry, Crystalline polymers, Fringe micelle model, Factors affecting polymer crystallinity, Degree of crystallinity in polymers, Polymer crystallization, Spherulites and crystallites, Polymer single crystals, Chain folding during crystal formation, Crystallizability and crystallinity, Effect of crystallinit y on properties of polymer.	
3.	**COPOLYMERIZATION AND FRACTIONATION** Kinetics of free radical copolymerization, reactivity ratios and their determination, Mayo-Lewis method, Fineman-Ross method, Disadvantages of F-R method , Kelen-Tudos (K-1) method Reactivity in copolymerization: Alfrey& Price method, Prediction of copolymer composition, Ionic co polymerization, copolycondensation, Ideal, alternate & azeotropic copolymerization, Graft and block copolymers, Polymer mixtures: IPNs, Composites, Blends and Alloys Polymer Fractionation: fractional precipitation techniques, partial dissolution technique, gradient elution technique, GPC technique	25
4.	**POLYMER DEGRADATION AND REACTIONS** Polymer degradation: Definition, Types: thermal, mechanical, degradation by ultrasonic waves, photo degradation, degradation by high-energy radiations, oxidative and hydrolytic degradation Polymer reactions: Hydrolysis, acetolysis, aminolysis , hydrogenation, addition and substitution reaction, reaction o0f various specific groups, cyclation reaction and cross linked reactions, reaction leading to graft and block copolymers, miscellaneous reactions	25

Teaching-Learning Methodology	Classroom teaching, use of e-resources, library, IT tools, encourages students to participate in seminars/ workshops, presentations by students, assignment 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 various thermodynamic function responsible for dissolution of polymer. Flory parameter for solubility and Flory Huggins theory of dissolution.
2.	Learn the techniques for polymer fractionation. Understand the kinetics of copolymerization for their synthesis.
3.	Learn life cycle of various polymers, types of polymer degradation and factors affecting polymer degradation.
4.	Synthesis of different polymers.

Suggested References:

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

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

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

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

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

Course Content

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

FULL EXPERIMENT (Any Seven)

1. Determination of the primary salt effect on the kinetics of ionic reactions (Persulphate- iodide reaction) by isolation method.

2. To calculate the surface area of adsorbed molecule in a monolayer, CMC, effectiveness from surface tension measurements of aqueous solutions of surfactant.
3. Determinations of pKa value of acid-base Methyl red indicator by spectrophotometry.
4. To carryout fractionation of a polydispersed polymer by viscosity method
5. Ion exchange separation of Fe^{+3} and Co^{+2} and determination of Fe^{+3} spectrophotometrically.
6. Determine partition function of two organic compounds in ether – water system and find out molecular condition of organic compound in ether.
7. Determine equilibrium constant of reversible reaction between Ag^{+2} and $CaSO_4$
8. Determine relative strength of two acids (HCl and H2SO4) and study hydrolysis of ester.
9. Potentiometric titration of halide mixture of KCl, KBr, KI against std. $AgNO_3$ solution HALF
10. EXPERIMENT (Any Seven)
    1. Determination of rate constant, order of reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.
    2. Spectrophotometric determination of - Cobalt and Chromium.
    3. Photometric titration of iron-EDTA.
    4. Investigate the formation of complex between nickel and o-phenantroline using spectrophotometer.
    5. Determination of dissociation constant of a buffer pH-metrically
    6. To determine the degree of hydrolysis and hydrolysis constant for the hydrolysis of aniline hydrochloride by conductance method.
    7. Determination of Ca+2 and Cu+2 in a mixture using EDTA titration spectrophotometrically.
    8. To determine the % purity of aspirin sample tablet
    9. Estimate concentration of H_2SO_4, CH_3COOH and $CuSO_4$ $5H_2O$ by conductometric titration with NaOH Solution

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

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30%
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
6.	Separation of compounds using different solvent systems
7.	Theories of indicators

Suggested References:

Reference Books Recommended:

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