Rayat Shikshan Sanstha's

Sadguru Gadge Maharaj College, Karad

(Empowered Autonomous College)

Affiliated to Shivaji University, Kolhapur.

Accredited 'A^{+} Grade' with CGPA 3.63 by NAAC

ISO 9001-2015 Certified, RUSA Beneficiary & NAAC Designated Mentor College

Revised Syllabus as per NEP-2020

For

M. Sc. Part-II

Analytical Chemistry

Syllabus to be implemented from

June, 2024 onwards.

Rayat Shikshan Sanstha's

Sadguru Gadge Maharaj College, Karad

(Empowered Autonomous College)

Affiliated to Shivaji University, Kolhapur

Revised Syllabus for the Master of Science in Chemistry (As per NEP - 2020)

Applicable from the Academic Year 2024–25

Name of Program: M.Sc. Analytical Chemistry

Analytical Chemistry is a pervasive and a key subject not only for Chemistry, but all the branches of Science, Engineering and Technology which involves Chemistry. It is an experimental science and students need to be trained in theory and practical dealing with fundamental and advanced analytical skills of conventional analysis and instrumental analysis so as to get expertise in doing fine experiments and handle sophisticated instruments.

The M.Sc. Analytical Chemistry program offered by Sadguru Gadge Maharaj College, Karad affiliated with Shivaji University, Kolhapur is a **Two Years** full-time program. The first and second semester gives a general background of analytical chemistry and its importance to all the branches of Chemistry to make a good theoretical background for students. The semester third and fourth is totally assigned to analytical chemistry and it covers most of the fundamental and advance aspects of modern analytical chemistry. To make students more careers-oriented and nurturing their scientific temperaments, students will get exposure to the depth of core understanding of various dimensions of analytical chemistry during these two years the study.

1. Program Outcomes (POs):

PO1. The M.Sc. analytical chemistry program at Shivaji University, Kolhapur provides the key knowledge base and laboratory resources to prepare students for careers as professionals in the field of chemistry and particularly in analytical chemistry enabling them to interface not only with various branches of chemistry (organic, inorganic, physical, biological, industrial, environmental, pharmaceuticals etc) but also with the related fields, and for professional courses and areas of research including medical, forensic, food, agriculture, dental, law, intellectual property, business programs etc.

PO2. Students will be able to solve various problems by identifying the essential parts of a problem, formulate strategy for solving the problem, applying appropriate techniques to arrive at a solution, test the precision and accuracy of the solution and interpret the results.

PO3. Students will be able to acquire domain specific knowledge and technical skills needed for employment in industries, teaching fields and pursue research. Students will be skilled in problem solving, critical thinking and analytical reasoning.

PO4. Students will be able to apply the fundamental knowledge to address the cross-cutting issues such as sustainable development.

PO5. Students will get perfect insight into qualitative and quantitative analytical chemistry and research ethics for production of quality research.

PO6. Students will be able to communicate effectively i.e. being able to articulate, comprehend and write effective reports, make effective presentations and documentation and capable of expressing the subject through technical writing as well as through oral presentation.

2. Program Specific Outcomes (PSOs):

PSO 1. Students will be able to prepare and qualify subject specific competitive exams like NET, SET and GATE and also other general public administration exams like M.P.S.C. and U.P.S.C. etc. exams.

PSO 2. Student will be able to utilize the knowledge and analytical skills in QA-QC and R&D departments in almost all the industries enabling them to secure jobs where analytical chemistry is the core requirement to ensure and ascertain the quality of the product.

PSO 3. Students will have opportunity for higher education leading to Ph.D. program.

PSO 4. Students will be able to explore contemporary research in chemistry and allied fields of science and technology, collaborate in team projects, and communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.

PSO 5. Students can start their own laboratories/startups/ chemical industry/ business (entrepreneurship).

PSO 6. Students will be able to interprete data from the state of art Analytical instruments for ascertaining the product/material.

- **Title**: M.Sc. Chemistry
- **Faculty**: Faculty of Science and Technology.
- **Year of Implementation**: For M. Sc. I (Semester I and Semester II): From July 2023 and for M. Sc. II (Semester III and Semester IV): From June 2024.

1. Framework of NEP 2.0 as per NEP-2020 for M. Sc. Degree in Analytical Chemistry

M.Sc.-I (NEP 2023-24) (Level-6)					
Sem-I					
Sr. No.	**Basket**	**Code**	**Subject**	**Credits**	**Degree**
1	Major	MJ-MCTA23-101	**Organic Chemistry-I**	04	PG Diploma after three-year Degree
2	Major	MJ-MCTA23-102	**Inorganic Chemistry-I**	04	
3	Elective	EA-MCTA23-103	**Analytical Chemistry-I**	04	
		EI-MCTA23-103	Inorganic Chemistry-II	04	
		EO-MCTA23-103	Organic Chemistry-II	04	
		EP-MCTA23-103	Physical Chemistry-I	04	
4	RM	RM-MCTA23-104	**Research Methodology**	04	
5	Lab-I	MJ-MCPA23-105	Chemistry Practical Paper-I	04	
6	Lab-II	MJ-MCPA23-106	Chemistry Practical Paper-II	02	
			Total	**22**	
Sem-II					
Sr. No.	**Basket**	**Code**	**Subject**	**Credits**	
1	Major	MJ-MCTA23-201	**Physical Chemistry-II**	04	
2	Major	MJ-MCTA23-202	**Analytical Chemistry-II**	04	
3	Elective	EI-MCTA23-203	**Inorganic Chemistry-III**	04	
		EO-MCTA23-203	Organic Chemistry-III	04	
		EP-MCTA23-203	Physical Chemistry-III	04	
		EA-MCTA23-203	Analytical Chemistry-III	04	
4	FP/OJT	FP-MCPA23-204	**Field Project**	04	
5	Lab-III	MJ-MCPA23-205	Chemistry Practical Paper-III	04	
6	Lab-IV	MJ-MCPA23-206	Chemistry Practical Paper-IV	02	
			Total	**22**	

M.Sc. II Sem III (NEP 2023-24) (Level-6.5)					
Sr. No.	**Basket**	**Code**	**Subject**	**Credits**	**Degree**
1	Major	MJ-MCTA23-301	Advanced Analytical Techniques	04	**PG Degree after 3-years or PG degree after 4-years UG (Master of Science)**
2	Major	MJ-MCTA23-302	Organo Analytical Chemistry	04	
3	Major	MJ-MCTA23-303	Electroanalytical Techniques in Chemical Analysis	04	
4	Elective	EO-MCTO23-304	Drug and Heterocycles	04	
		EA-MCTA23-304	**Environmental Chemical Analysis and Control**		
5	RP	RP-MCPA23-305	Research Project	04	
6	Lab-V	MJ-MCPA23-306	Practical Course	02	
Total				**22**	
Sem IV					
Sr. No.	**Basket**	**Code**	**Subject**	**Credits**	**Degree**
1	Major	MJ-MCTA23-401	Modern Separation Methods in Analysis	04	**PG Degree after 3-years or PG degree after 4-years UG (Master of Science) All practical and projects will be discipline specific i.e. Organic Chemistry oriented**
2	Major	MJ-MCTA23-402	Organic Industrial Analysis	04	
3	Major	MJ-MCTA23-403	Advanced Methods in Chemical Analysis	04	
4	Elective	EO-MCTO23-404	Applied Organic Chemistry	04	
		EA-MCTA23-404	**Applied Analytical Chemistry**		
5	Research Project	RP- MCPA23-405	Research Project	06	
Total				**22**	

2. Detailed Syllabus

M.Sc. Part-II (Sem-III) Analytical Chemistry

MJ-MCTA23-301: Advanced Analytical Techniques

Unit-I: Advances in Mass Spectrometry-A **15 hrs.**

Introduction to Mass spectrometry, diagram of a mass spectrometer and Instrumentation, principles, history, concept of ion free path, classification of mass spectrometry based on nature of compound to be analyzed and the ion sources viz. Electron impact (EI), chemical ionization (CI), Fast ion or atom bombardment ionization (FID/FAB), field desorption (FD), laser desorption ionization (LDI), plasma desorption ionization (PDI), thermospray ionization (TSI), electrospray (ESI), atmospheric pressure ionization, Inductively couple plasma (ICP) etc. Mass Analyzers, Quadrupolar Analyzers, Quadrupole ion trap or Quistor, Ion trap detector, development of high –Mass, High-resolution ion trap, tandem mass spectrometry in the ion trap, time of flight analyzer, magnetic and electromagnetic analyzer, ion cyclotron resonance and FT-MS, and detectors

Unit-II: Introduction to Nanotechnology and Nano Chemistry **15 hrs.**

Definition of nanomaterials and nanotechnology, significance of nanotechnology, size and properties, types of nanomaterials like 0D (quantum dots), 1D, 2D and 3D, introduction to physical, chemical and biological synthesis of nanomaterials with suitable examples, top down and bottom-up approach, chemical synthesis of nanomaterials- Different types and processes for synthesis of nanomaterials using wet chemical approaches. Fabricating nanomaterials with different morphology intended for specific applications. Applications of Nanotechnology.

Unit-III: Advanced Instrumentation Techniques-A **15 hrs.**

Scanning Electron Microscope (SEM) - Introduction, principle, instrumentation, applications Transmission Electron Microscope (TEM) - Introduction, principle, instrumentation, applications Electron Dispersion Spectroscopy (EDS) - Introduction, principle, instrumentation, applications Energy Dispersive X-ray Analysis (EDAX) - Introduction, principle, instrumentation, applications.

Scanning Tunneling Microscopy (STM) - Introduction, principle, instrumentation, applications Atomic Force Microscopy (AFM) - Introduction, principle, instrumentation, applications Practical applications and examples in analytical chemistry and research.

Unit-IV: Advanced Instrumentation Techniques-B **15 hrs.**

Raman Spectroscopy- Introduction, principle, instrumentation, applications X-Ray Fluorescence Spectroscopy (XFS) - Introduction, principle, instrumentation, applications Electron Spin Resonance Spectroscopy (ESR)- Introduction, principle, instrumentation, applications. Ray Photoelectron Spectroscopy (XPS)- Introduction, principle, instrumentation, applications Auger Electron Spectroscopy - Introduction, principle, instrumentation, applications, Secondary Ion Mass Spectrometry (SIMS)- Introduction, principle, instrumentation, applications Practical applications and examples in analytical chemistry and research.

Reference Books:

1. E. De. Hoffmann, J. Charette, V. Stroobant, Mass Spectroscopy: Principles and Applications, John Wiley & Sons, Masson, Paris 1996.
2. J. H. Gross, Mass Spectroscopy: A Text book, Springer-Verlag Berlin 2004.
3. C. G. Herbert, R. A. W. Johnstone, Mass Spectrometry Basics, CRC Press, Boca Raton, Florida, 2002.
4. K. Benjamin: Mass Spectrometry
5. A. I. Vogel: A text book of Quantitative inorganic Analysis, Lonqmans.
6. G. H. Morrison and H, Freiser: Solvent Extraction in Analytical Chemistry (John Wiley New York, 1958)
7. Willard, Merrit and Settle: Instrumental Methods of analysis.
8. Principles of instrumental analysis- Holler, Skoog and Crouch
9. Instrumental methods of Chemical analysis-H. Kaur
10. Bhushan, Bharat 2004. Handbook of Nanotechnology. Springer.
11. Niemeyer, C.M. & Mirkin, C.A. 2004. Nanobiotechnology- Concepts, Applications and Prespectives. Wiley-VCH Verlag.
12. Zander, C., Enderlein, J. & Keller, R.A. 2002 Single Molecule Detection in Solution. Wiley- VCH Verlag.
13. Avouris, P, Klitzing, K. Von, Sakaki, H. & Wiesendanger,R .2003 NanoScience and Technology
14. Series. Scanning Probe Microscopy- Analytical Methods (R. Wiesendanger eds), Springer.
15. Instrumental Analysis by Skoog
16. Nanochemistry, a chemical approach to nanomaterials, G. A. Ozin, and A. C. Arsenault, RSC Publishing, Cambridge, 2005. ISBN 0-85404-664-X.

Course Outcomes (COs):

CO1: Develop knowledge of fundamental, instrumentation and working of state of art instrumental analytical techniques, effective use and choice of technique, written and/or oral communication of the concepts of analytical chemistry which will be useful as an analytical chemist and R&D.

CO2: Acquire knowledge of mass spectrometry, type of MS, ionization types and specific practical applications of MS.

CO3: Acquire knowledge of the basics of nanochemistry, nanomaterials and nanotechnology and application-orientated synthesis and characterization of nanomaterials.

CO4: This course gives a wide understanding of the instrumental analytical techniques (SEM, TEM, EDS, STM, AFM, Raman, XFS, ESR, XPS, AES, SIMS etc.) employed for qualitative and quantitative analysis for contemporary research.

MJ-MCTA23-302: Organo Analytical Chemistry

UNIT–I: Hyphenated Techniques 15 hrs.

Advanced techniques of analysis: UV-Visible, IR, 1H-NMR (Recapitulation), 13CNMR, Mass spectrometry (Basic fundamentals of mass spectrometry, ionization, advanced organic analysis examples); Problems related to structure determination and applications of spectroscopic techniques as analytical tools.

UNIT-II: A) Drug Analysis 10 hrs.

Introduction to drugs, their classification, sources of impurities in pharmaceutical raw materials such as chemical, atmospheric and microbial contaminants etc. Limit tests: Limit test for impurities for Pb, As, Fe, Se, etc. Estimation of moisture (K-F method), halide (Schnoiger's oxygen flask method), sulfate, boron, etc. Analysis of commonly used drugs such as antihistamines, sulfa drugs, barbiturates, etc. using non-aqueous titrations, sodium nitrite titrations, differential UV methods, colorimetric and fluorimetric methods of analysis.

B) Analysis of vitamins 05 hrs.

Analysis of vitamins (thiamine, ascorbic acid, Vit. A, Vit. B6, Vit. K) and hormones (progesterone, oxytocin, insulin) chemical, instrumental and biological assay, wherever applicable.

UNIT – III: A) Clinical Analysis 08 hrs.

Biological significance, analysis of assay of enzymes (pepsin, monoamine, oxidase, tyrosinase), Composition and detection of abnormal level of certain constituents leading to diagnosis of diseases. Sample collection and preservation of physiological fluids, analytical methods to the constituents of physiological fluids (blood, urine and serum). Blood- Estimation of glucose, chlolesterol, urea, hemoglobin and bilirubin, Urine- urea, uric acid, creatinine, calcium, phosphate, sodium, potassium and chloride.

B) Body fluid analysis 07 hrs.

Composition and detection of abnormal level of certain constituents leading to diagnosis of diseases. Sample collection and preservation of physiological fluids, analytical methods to the constituents of physiological fluids (blood, urine and serum) Blood-Estimation of glucose, chlolesterol, urea, hemoglobin and bilirubin Urine- urea, uric acid, creatinine, calcium, phosphate, sodium, potassium and chloride.

UNIT–IV: A) Pesticides Analysis 07 hrs.

Introduction, classification of pesticides, sampling, sample pretreatment and processin g, analysis of DDT, gammexane, endosulphan, zinab, ziram, malathion, thiram, thiometon, simazine and chloridane. Applications of colorimetric and chromatographic techniques (GC-MS, HPLC-MS) in analysis of pesticide residue. Introduction to EPA regulatory body. Practical applications and examples in analytical chemistry and research.

B) Forensic Analysis 08 hrs.

Special features of forensic analysis, sampling, sample storage, sample dissolution, classification of poisons, lethal dose, significance of LD-50 and LC-50. General discussion of poisons with special reference to mode of action of cyanide, organophosphate and snake venom. Estimation of poisonous materials such as lead, mercury and arsenic in biological samples. Practical applications and examples in analytical chemistry and research.

Reference Books:

1. F. J. Welcher: Standard methods of Chemical analysis, 6th Ed. Vol. I and II (D. Van Nostard Comp.)
2. M. Kolthoff: Treatise on Analytical Chemistry Vol. I & II
3. F. D. Snell: Encyclopedia of industrial Chemical Analysis Vol. 1 to 20 (John Wiley)
4. Riech: Outline of Industrial Chemistry.
5. K. H. Buchel: Chemistry of Pesticides (John Wiley)
6. Indian, Pharmacopoeia, British Pharmacopoeia and U. S. Pharmacopoeia.
7. V. M. Parikh: Absorption spectroscopy of organic molecules (Addision Wesley)
8. Willard, Merrite, Dean and Settle: Instrumental methods of analysis (CBS)
9. D. H. Williams and J. Fleming: Specroscopic methods in organic chemistry (Mc Graw Hill) Silverstein: Spectroscopic Identification of organic compounds (John Wiley)
10. Jackmann and Sternhill: Applications of NMR spectroscopy of organic Chemistry (Pergamon Press)
11. J. D. Roberts : Nuclear Magnetic Resonance (Mc Graw Hill)
12. K. Benjamin : Mass Spectrometry
13. Nichollas: Aids to the Analysis of foods and Drugs.

Course Outcomes (COs):

CO 1: Students will gain knowledge of the instruments used at the interface of Analytical-Organic chemistry useful for R&D and structural elucidation using UV-Visible, IR, 1H & 13C NMR, Mass spectrometry data and interpretation of the same.

CO 2: Students will acquire knowledge about the drug, their classification, sources of impurities (chemical, atmospheric and microbial contamination) in pharmaceutical raw materials and analysis of the same.

CO 3: Students will gain knowledge about the conventional and advanced analytical approaches for analysis of drug, vitamin, body fluids and clinical samples.

CO 4: Students will have an idea of commonly used pesticides and their analysis and also about forensic science and forensic sample analysis.

MJ-MCTA23-303: Electroanalytical Techniques in Chemical Analysis

UNIT-I: Voltammetry Techniques **15 hrs**

Introduction, Principle, excitation signals in voltammetry, basic instrumentation based on operational amplifiers, voltammetric electrodes, modified electrodes. Hydrodynamic Voltammetry-Electrode profiles in stirred and unstirred solutions, Applications.

Cyclic Voltammetry: Instrumentation, Determination of analytes using cyclic voltammetry, Applications.

Pulse voltammetry: Introduction, Normal Pulse Voltammetry, Reverse pulse voltammetry, Differential pulse voltammetry, Square wave voltammetry.

Stripping voltammetry: Cathodic and Anodic stripping voltammetry, Electrodeposition step, Voltametric completion of the analysis, adsorptive striping methods.

Voltammetry with microelectrodes. Practical applications in analytical chemistry and research.

UNIT- II: Coulometry **15 hrs.**

Introduction: Theory and instrumentation, current-voltage relationship, controlled potential Coulometry, types of coulometric methods, coulometric titration, and applications. Practical applications in analytical chemistry and research.

UNIT –III: Particle Size Analysis **15 hrs.**

Introduction, Low angle LASER light scattering: Instrumentation, theoretical models, Mie theory, Fraunhofer diffraction theory, particle size distribution analysis, Applications. Dynamic Light Scattering: Introduction, Instrumentation, photodetector sample cell and sample handling, Applications, Photosedimentation: Setting velocity and particle size, Stokes equation, Instrumentation, sedimentation modes, Particle size distribution analysis, photometric measurements and applications. Comparison with particle size measurements using XRD, SEM and TEM. Practical applications in analytical chemistry and research.

UNIT –IV: A) Ion selective electrodes **10 hrs.**

Terminology, types and construction of electrodes, glass electrode, solid state and precipitate electrodes, liquid – liquid membrane electrodes, enzyme and gas electrodes, and applications.

B) Electrophoresis **05 hrs.**

Introduction: paper electrophoresis: Technique, factors affecting migration of ions, capillary and zone electrophoresis and applications. Practical applications in analytical chemistry and research

Reference Books:

1. R.D. Braun, Introduction to Instrumental Analysis.
2. D.A.Skoog, F. J. Holler, Principles of Instrumental Analysis, 6th edition.
3. Willard, Deritt, Dean and Settle, Instrumental methods of Analysis.
4. F. J. Welcher, Standard Methods of chemical Analysis Vol.3,PartA & B.
5. G.W. Ewing, Instrumental Methods of Analysis 4th and 5th editions.
6. Chatawal and Anand, Instrumental Methods of Analysis.
7. Bassett, Denney-Jeffer and Mendham, Vogel's Textbook of Quantitative Inorganic Analysis, (5th edition).
8. Electro-analytical chemistry, edited by H.W. Nurnberg.
9. Stulic, Ion selective electrodes (John Wiley).

Course Outcomes (COs):

CO1: Fundamental knowledge of electrochemistry, electrodes, types of electrodes, its construction will lay foundation for the course.

CO2: Students will gain knowledge and skill in electroanalytical techniques like cyclic voltammetry and its types, polarography, coulometry and dynamic light scattering technique for qualitative and quantitative analysis.

CO3: Students will be familiar with the advanced electrodes used for chemical analysis, liquid-liquid membrane electrodes, enzymes and gas electrodes.

CO4: Students will learn about electrophoretic techniques, advances in electrophoresis techniques and its analytical applications.

Major Electives (Choose any One)

M.Sc. II, SEM-III

Students of Organic/Analytical Chemistry shall choose any one of the following elective papers.

EO-MCTO23-304: Drug and Heterocycles

Part- A: DRUGS

UNIT-I: Drug Design and Antibiotics **15 hrs.**

A. Drug Design **(10)**

Procedures followed in drug design, **factors affecting the development of new drugs**, concepts of prodrugs and soft drugs, **Isosterism, bioisosterism,** Theories of drug activity, Quantitative structure activity relationship, QSAR theory, Concepts of drug receptors.

B. Study of Antibiotics **(5)**

(a) Classification of antibiotics, (ii) Preparation of semi synthetic penicillin, (iii) Penicillin G, (iv) Penicillin V, (v) Conversion of penicillin into cephalosporin.

UNIT-II: Study of the Following Drugs **15 hrs.**

a) Antimalerials: Trimethoprim, Amodiaquine

b) Analgesic & Antipyretics: Meperidine, Aminopyrine, Diflunisal

c) Anti- inflammatory: Oxyphenylbutazone, Indomethacin

d) Antitubercular & antileprotic: Dapsone, Pyrazinamide, Ethionamide

e) Anaesthetics: Lidocaine, Thiopental

f) Antihistamines: Cyproheptadine, Cetirizine

g) Psychoactive: Ethiosuximide, Glutethimide

h) Antiinfective: Grisefulvin, norfloxacin

i) Cardiovascular: Warfarim, Clofibrate, Quinidine, Methyldopa, Atenolol

j) Anti-neoplastic: Recent development in cancer chemotherapy. Hormones and natural products. Synthesis of (i) Mechloraethamine, (ii) Cyclophosphamide, (iii) Mephalan, (iv) Uracils, (v) Mustards.

k) Anti-AIDS: General study

Part-B: HETEROCYCLES

UNIT-III: Study of following heterocycles **15 hrs.**

A) Small ring heterocycles: **(5)**

3 and 4 membered heterocycles: Synthesis and reactions of (i) aziridines, (ii) oxiranes, (iii) thiranes, and (iv) azetidines.

B) Six membered heterocycles with one heteroatom: **(5)**

Synthesis and reactions of (i) pyrilium salts, (ii) pyrones, (iii) coumarins, (iv) chromones.

C) Six membered heterocycles with two and more heteroatoms: **(5)**

Synthesis and reactions of (i) diazines (ii) triazines

UNIT-IV: Study of following heterocycles **15 hrs.**

A) Benzofused five membered heterocycles: **(7)**

Synthesis and reactions of (i) benzopyrroles, (ii) benzofurans and (iii) benzothiophene

B) Benzofused heterocycles with two heteroatoms: **(8)**

Synthesis and reactions of

(b) benzimidazole, (ii) benzthiazole and (iii) benzoxazole

Reference Books:

1. Medicinal Chemistry. Burger
2. Medicinal Chemistry A. Kar. (Wiley East)
3. Principals of medicinal chemistry.W. O. Foye:
4. Text book of organic medical and pharmaceutical chemistry. Wilson, Gisvold & Dorque:
5. Pharmaceutical manufacturing encyclopedia.
6. D. Sriram, P. Yogeeswari: Medicinal Chemistry
7. An introduction to chemistry of heterocyclic compounds. R. M. Acheson :(Interscience).
8. Heterocyclic chemistry. Joule &Smith: (Van Nostrand).
9. Heterocyclic chemistry. R. K. Bansal: (Wiley E).
10. Principals of modern heterocyclic chemistry.L. A. Paquitte:
11. The structure and reactions of heterocyclic compounds.M. H. Palamer:
12. Advances in Heterocyclic chemistry. A. R. Katritzky: (A.P.).
13. Organic chemistry (Vol. 1& 2) Finar.
14. Outline of Biochemistry. Cohn & Stumpt
15. Introduction to the chemistry of enzyme action. Williams:

16. The Organic Chemistry of Drug design and Drug action. R. B. Silverman Academic press.
17. Strategies for Organic Drug synthesis and Design. D. Lednicer, J. Willey.
18. Heterocyclic Chemistry. Vol-1-3, R. R. Gupta, M. Kumar and V. Gupta, Springer Veriag.
19. The Chemistry of Heterocycles. T. Eicher and S. Hauptmann, Thieme
20. Heterocyclic Chemistry. J. A. Joule, K. Mills and G. F. Smith, Chapman and Hall
21. Heterocyclic Chemistry. T. L. Gilchrist, Longman Scientific Technical
22. Contemporary Heterocyclic Chemistry. G. R. Nikome and W. W. Poudler, Willey
23. An Introduction to Heterocyclic Compounds, R. M. Acheson, J. Willey
24. Comprehensive Heterocyclic Chemistry. A. R. Katritzky and C. W. Rees

Course Outcomes (COs):

CO No.	On completion of the course, students will be able to:
CO1	To know about the drug design, history, and development of quantitative structure-activity relationship (QSAR). Also, learn the concept of drug receptors and the relationship between structure and chemical reactivity. Learn about different types of antibiotics.
CO2	Study the various types of drugs like antimalarials, Anti-inflammatory, anesthetics, Antitubercular, Tranquilizers cardiovascular, and Antineoplastic drugs.
CO3	Understand synthesis and reactions of five, six-membered heterocycles.
CO4	Learn the synthesis and reactions of diazines and triazines. Synthesis of the reactions of azepines, oxepines & thiepines.

EA-MCTA23-304: Environmental Chemical Analysis and Control

UNIT-I: Sampling in analysis 15 hrs.

Definition, theory and techniques of sampling, sampling of gas, liquids and solids, Criteria of Good sampling, Minimization of Variables, transmission and storage of samples, high pressure ashing techniques (HPAT), particulate matter, its separation in gas stream, Filtering and gravity separation. Analysis of particulate matter like asbestos, mica, dust and aerosols etc

UNIT-II: Electrochemical and spectral methods Environmental analysis 15 hrs.

Introduction to instrumental techniques, principle instrumentation and applications with respect to environmental analysis of Conductometry, Potentiometry, Ion selective electrodes,

Cyclic voltammetry, Amperometry, Coulometry, Atomic absorption spectrometry, Atomic fluorescence spectrometry, Inductively coupled plasma spectrometry, Turbidimetry, Non Dispersive Infrared Analysis (NDIR).

UNIT-III: Air and Water Pollutant Analysis **15 hrs.**

Chemistry of Air pollutants, characterization. source, methods of analysis of air pollutants; CO, CO2, NOX, NH3, H2S, SO2 etc. Monitoring Instruments, Potable and Industrial water, major and minor components, dissolved oxygen (DO) Chemical oxygen demand(COD) Biochemical oxygen demand (BOD) and their measurements. Analysis of Pd, Cd, Hg, Cr, As and their physiological manifestations. Quality of industrial waste water analysis for organic and inorganic constituents. Chemistry of odour and its measurements.

UNIT-IV: Organic Pollutants and Their Analysis **15 hrs.**

Sources, disposal, treatment and analysis of phenolic residues, methods of recovery of phenols from liquid effluents, Organomercurials and its analysis, Analysis of organochlorine pesticides, volatile organic pollutants and their analysis

Reference books:

1. A.K. De: Standard Methods of Waste and Waste water analysis.
2. P. M. S. Monk Fundamentals of Electroanalytical chemistry-John Wiley & Sons (2001) 3. Instrumental methods of chemical analysis H. Kaur
3. S.M. Khopkar, Environmental Chemistry; Environmental pollution analysis
4. M.S. Creos and Morr, Environmental Chemical Analysis, American publication (1988)
5. A.K. De, Environmental Chemistry, New Age International publishers. Moghe and Ramteke, Water and waste water analysis: (NEERI)
6. A.C. Stern, Air pollution: Engineering control Vol. IV(AP)
7. P.N. Cheremisinoff and R.A. Young, Air Pollution controland Design. Hand Book Vol. I & II (Dekker)
8. R.B. Pohasek, Toxic and Hazardous waste disposal, Vol. I & II (AAS)
9. M. Sitting, Resources Recovery and Recycling, Handbook of industrial Waste.
10. B.K. Sharma, Industrial Chemistry.
11. S.P. Mahajan, Pollution Control in Process Industries.
12. R.A. Horne, Chemistry of our Environment.

Course Outcomes (COs):

CO1: Students will acquire knowledge about sampling, criteria of good sampling, handling, preservation and storage of the samples, pretreatment and post treatment of samples.

CO2: Students will acquire knowledge of conditions and strategies required during sampling and electrochemical and spectral methods for analysis of environmental samples.

CO3: Students will learn about the air and water pollution, sources of pollution, typical parameters and properties (physical, chemical and biological) to be measured in air and water pollution with relevance to specific case studies.

CO4: Students will be acquainted with organic pollutants and their analysis with special reference to pesticide analysis.

See Annexture-I for details.

RP-MCPA23-305: Research Project (4 Cr, 120 Hrs)

See Annexture-I for details. (Page No. 28)

MJ-MCPA23-306: Analytical Chemistry Practical (2 Cr) 60 hrs.

Major Experiments:

1. Estimation of Sn, Cu and Pb from Bronze/Brass alloy (volumetric, gravimetric or colorimetric techniques can be used)
2. Analysis of Galena ore
3. Analysis of Benzoic acid and salicylic acid from medicated powder
4. Estimation of Aspirin
5. Determination of pK value of an indicator.
6. Cement analysis
7. Analysis of bauxite ore to estimate the amount of silica, aluminium and iron.
8. Estimation of salicylic acid and zinc oxide from medicated powder
9. Determination of saponification value and iodine value of oil
10. To determine stability constant of Ferric ammonium sulphate and sulphosalicylic acid by Jobs variation method
11. Studies on effect of substituent at orthoposition of benzoic acid on it's equilibrium constant pH-metrically
12. Simultaneous spectrophotometric determination of Cr and Mn.
13. Analysis of milk.

Minor Experiments:

1. Analysis of plaster of Paris for calcium content.
2. Estimation of copper fungicide.
3. Analysis of sulpha drug.
4. Analysis of vitamin-C in juices and squashes.
5. Analysis of ethambutol.
6. Identification of organic compounds by their IR spectra.
7. Determination of strength of acetic acid in commercial vinegar by conductometric method.
8. Determination of chloride content from saline water by potentiometry.
9. Estimation of bicarbonate and carbonate by potentiometric method.
10. Determination of pK of given dibasic acid pH-metrically.
11. Determination of pK of given dibasic acid potentiometrically.
12. Estimation of Fe from soil sample.
13. Analysis of Na and K from soil sample.
14. To estimate the amount of barium from given water sample by nephelometry.
15. To determine the ion exchange capacity of active group of given cation exchange resin.
16. Estimation of lactose from milk sample using flame photometer.
17. To determine the amount of alkali content of antacid tablet titrimetrically.
18. Determination of pK value of tribasic acid, by potentiometry.
19. Estimation of acetyl salicylic acid in the given aspirin tablet by titrating against 0.1N alcoholic KOH potentiometrically.
20. To determine the acid base dissociation constant and isoelectric point of amino acid pH metrically

Course Outcomes (COs):

CO1: The students will acquire hands on training for conducting the representative experiments for the analysis of wide variety of samples of inorganic, organic and physical approaches by qualitative and quantitative analysis

CO2: Student would learn the sample preparation and characterization for purity and qualitative and quantitative analysis of samples.

CO3: Students will have good experimental skills for separation and estimation of amount of metal, metal ions in given samples.

CO4: Students will be acquainted with the separation and estimation of organic compounds in given samples.

NOTE: Student should perform their practical work in the laboratory minimum 15 days in one semester for 2 credits.

M. Sc. II (Sem - IV) Analytical Chemistry

MJ-MCTA23-401: Modern Separation Methods in Analysis

UNIT-I: Advanced Gas Chromatographic Techniques **15 hrs.**

Principles, Plate theory, Instrumentation and working of a Gas Chromatograph, sampling, sample pretreatment, sample injection types, columns, Detectors, programmed temperature G.C., Applications. Gas chromatography-Mass Spectrometry, interface, instrumentation and applications. Practical applications and examples in analytical chemistry and research.

UNIT-II: Advanced Liquid Chromatographic Techniques **15 hrs.**

High Performance Liquid Chromatography (HPLC) and Ultra Performance Liquid Chromatography (UPLC)-Principle, instrumentation, mobile phase, Stationary support in HPLC, detectors and applications. Super critical fluid chromatography (SCFC), characteristics, instrumentation and applications. Comparison of HPLC and GLC with SCFC. Liquid Chromatography-Mass Spectrometry interface, instrumentation, advantages and applications. Practical applications and examples in analytical chemistry and research.

UNIT-III: Ion Chromatography **15 hrs.**

Principles, structure and characteristics of resins, eluent, supressor columns and detectors used in Ion Chromatography, commercial scope, analytical applications, environmental speciation by Ion Chromatography. Practical applications and examples in analytical chemistry and research.

UNIT –IV: A) Modern extraction and separation techniques **08 hrs.**

Basic principles, classification of solvents extraction systems, extraction equilibria, factors affecting extraction process, application of β- diketones, δHydroxyquinoline, dithicarbamaes, xanthenes, Thio, separation of nonmetals and metals. Separation of transition metal ions using ion exchangers.

B) Extractive Chromatographic Separations **07 hrs.**

Introduction, Theoretical aspects of extraction chromatography, extraction chromatography with chelating ligands, extraction chromatography by ion pair formation, extraction chromatography by solvation, extraction equilibria, nature of stationary phase in extraction chromatography, inert support, techniques in extraction chromatography, extraction chromatography with tributyl phosphate and other applications. Practical applications and examples in analytical chemistry and research.

Reference Books:

1. A.I. Vogel, a text Book of Quantitative Inorganic Analysis.
2. W H Willard, L L Merritt and J A Dean, Instrumental Methods of Analysis.
3. S. M. Khopkar, Basic Concepts in Analytical Chemistry.
4. LR. Shyder and C.H. Harvath, An Introduction to separation Science. Wiley Interscience.
5. James S Fritz and George H.Schenk Jr. Quantitative Analytical Chemistry, 2nd editions Allyn and Bacon Inc. Bosten.
6. J.G.Dick, Analytical Chemistry.
7. R.L.Pescok and L.D.Shield, Modern Methods of Chemical Analysis.
8. O.Samuelson : Ion Exchange separation in analytical chemistry (Jhonwiley , 1963)
9. Y. Marcus and A. S. Kertes: Ion Exchange and solvent Extraction of metal complexes (Wiley – Interscience, 1969)
10. J. A. Marinsky and Y. Marcus: Ion exchange and solvent Extraction (Marcel Dekker, INC , New York, 1973)
11. G. H. Morrison and H, Freiser: Solvent Extraction in Analytical Chemistry (John Wiley, New York, 1958)
12. A. K. Da, S. M. Khopkar and R. A. chalmers: solvents Extraction of metals (Von Nostrant Ravinhold, 1970).

Course Outcomes (COs):

CO 1: Students will learn about modern separation and chromatographic used for analysis of different type of samples

CO 2: The student will understand instrumentation and mechanism of various separation techniques.

CO 3: Student will acquire knowledge regarding various choice of instrument and detectors to be used for analysis depending on the sample and matrix.

CO 4: Student will learn fundamentals of extractive chromatography, types of extraction techniques, advances in extractionmethods and their hyphenations with chromatography leading to addressing challenging problems in analytical chemistry.

MJ-MCTA23-402: Organic Industrial Analysis

UNIT – I: Industrial Analysis

A) Analysis of oils, fats and Soaps 08 hrs.

Introduction to natural fats and oils; isolation of oils from natural resources and their purification. Analysis of oils and fats: Softening point, Congeal point, Titre point, Cloud point, Iodine, saponification, acid, hyroxyl, R-M and Polenske value, Elaiden test, etc.

Introduction to soaps, manufacture of soaps (in brief), analysis of soaps: total anhydrous soap and combined alkali, potassium, water, free fatty acids, saponifiable and non-saponifiable matter in soaps, estimation of phenol, copper and germicidal agents in soaps, determination of inorganic fillers and soap builders, and other additives, estimation of soap in detergents (THAM method)

B) Analysis of Detergents 07 hrs.

Classification of detergents, analysis of raw materials, separation as alcohol soluble and alcohol insoluble matter, additives in detergent formulation (chlorides, sulfates, phosphates, silicates, borates, oxygen releasing substances, CMC, EDTA, etc.), their role and analysis; analysis of active ingredients in detergents (methylene blue and Hyamine-1622 method).

UNIT – II: Food and Food Additive Analysis

A) Food Analysis 08 hrs.

Food flavors, food colors, food preservatives, analysis of milk and milk products, adulterants in milk and their identification, analysis of honey, jam and their major component. Practical applications and examples in analytical chemistry and research.

B) Food Additive Analysis 07 hrs.

Additives in animal food stuff: Antibiotics: penicillin, chlorotetracyclin, oxytetracyclin in diet supplements; Identification and estimation of growth promoting drugs such as. sulfaquinoxaline, methyl benzoquate, sulfanitran, pyrimethamine, nitrovin, nitrofurazone, acinitrazole, etc

UNIT-III: Analysis of cosmetics products 15 hrs.

Introduction to cosmetics, definition, types of cosmetics, background, development in cosmetic industry, issues in cosmetic industries (contamination and adulteration), future scope and role of analytical chemistry.

A) Analysis of cream and lotions 08 hrs.

Composition of creams and lotions, determination of water, propylene glycol, non-volatile matter and ash content; estimation of borates, carbonates, sulphates, phosphates, chlorides,

ammonia, nitromethane, oxalic acid, 4- hydroxy benzoic acid, sodium iodate, free formaldehyde, H_2O_2, mercatoacetic acid, titanium and zinc oxides. Practical applications and examples in analytical chemistry and research.

B) Analysis of face powder **07 hrs.**

Composition of face powder, estimation of boric acid, Mg, Ca, Zn, Fe, Al and Ba. Analysis of deodorants and antiperspirants-composition, analysis of fats and fatty acids, boric acid, magnesium, calcium, zinc, iron, titanium, aluminium, phenol, methanamine, hexachlorophenone, sulphonates, urea, etc. Practical applications and examples in analytical chemistry and research.

C) UNIT-IV: Analysis of Paints, pigments and petroleum products

A) Analysis of Paints and pigments **08 hrs.**

Composition of paint, preliminary inspection of sample, test on the total coating, separation and estimation of pigments, binder and thinner of latex paints; modification of binder, flash point of paints. Practical applications and examples in analytical chemistry and research.

(B) Analysis of petroleum products **07 hrs.**

Introduction, constituents and petroleum fractionation, quality control; - specific gravity, viscosity, cloud point, pour point, flash point, vapor pressure, Doctor test, sulphuric acid absorption, aniline point, and colour determination. Determination of water, neutralization value (acid and base numbers), ash content, sulphur and mercaptan sulphur. Determination of lead in petroleum; Analysis of coal and coke: Types, composition, preparation of sample, proximate and ultimate analysis calorific value by Bomb Colorimetry.

Reference Books:

1. S. R. Junk and H. M. Pancoast: Hand book of sugars(AVI)
2. B. Bilot and B. V. Well: Perfumary technology (JW)
3. I. M. Kolthoff: Treatise on Analytical Chemistry Vol. I and II
4. D. Pearson: Laboratory techniques in food analysis.
5. S. Ranganna: Handbook of Analysis and Quality control for fruits and vegetable products, 2nd Ed.(Mc Graw Hill.)
6. Nicholls: Aids to the analysis of foods and drugs.
7. G. J. Mountrey: Poultry product technology (AVI)
8. Karamer Twig: Quality control for food industry (AVI)
9. G. F. Longonan: the analysis of detergents and detergent products (JW)
10. A. Davidsohn & B. M. Mlwidaky : Synthetic detergents (Book center, Mumbai)
11. M. Ash and L. Ash: A formulary of cosmetic preparations. (G. Goodwin)
12. Kurl Bauer, Dorothea Garhe, Horst Surburg: Common fregrance and flavour materials, (VCH publisher, New York)
13. F. J. Welcher: Standard Methods of Chemical analysis Vol I & II (6th Ed.)
14. S. N. Mahendru: Analysis of food products (Swan Publishers)

Course Outcomes (COs):

CO1: Acquire knowledge of handling and investigating the characteristics of the oils, fats, detergents and soap samples and analysis of the same providing opportunity in cosmetic, pharmaceuticals, dyes and polymers industries.

CO2: Student will gain knowledge and importance of food quality, probe for food adulteration and adulterants, food preservative, food flavors and analysis of their components.

CO3: Students will also gain knowledge about the animal food stuff and the additives added in the animal food stuff as antibiotics, dietary supplements and growth promoting drugs, preservatives etc. and analysis of the same.

CO4: Student will learn about the analysis of cosmetics, face powder, hair dyes and hair care products, types of cosmetics, precautionary measures and composition of the cosmetics and specific roles of the ingredients. Will acquire knowledge about the paints, pigments and petroleum products, composition and analysis of the same using conventional and instrumental techniques.

MJ-MCTA23-403: Advanced Methods in Chemical Analysis

UNIT-I: Fluorescence and Phosphorescence Spectrophotometry 15 hrs.

Fluorimetry, types of luminescence, Instrumentations, theories of fluorescence and phosphorescence, electronic transition, structural factors, solvatochromism, solvation dynamics, faith of excited molecules, solvent effect on fluorescence, effect of intermolecular process, fluorescence anisotropy and time domain fluorescence life time measurements. Relation between concentration with fluorescence and phosphorescence intensity, fluorescence quenching mechanism, resonance energy transfer. Chemiluminescence, Fluorescence sensing, Synchronous spectrum, Fluorescent nanomaterials. Practical applications, examples and problems in analytical chemistry and research.

UNIT-II: Kinetic Methods 15 hrs.

Theoretical basis of kinetic methods of analysis, methods of determining amount of the substance, Tangent Method, Fixed Time and Concentration method. Addition Method, Oxidation Reactions of H_2O_2 with thiosulphate, iodide and amino, Enzyme catalyzed reactions. Inhibitors and Activators.

UNIT – III: Photoelectron spectroscopy 15 hrs.

Basic principles, photoelectric effects, Photoionization process, Koopman's theorem, photoelectron spectra of simple molecules, ESCA, chemical shift, Auger electron spectroscopy – basic idea.

UNIT-IV: X-ray spectroscopy 15 hrs.

Introduction, X-Ray generation, Properties of X-radiation, Interaction of X-Rays with matter, Instrumentation. X-Ray Absorption, X-ray Fluorescence, X ray Diffraction methods - Instrumentation and analytical applications.

Reference Books:

1. Gary D Christian, Analytical chemistry 6th edition. John Willey and sons INC (2003)
2. Kaur, Instrumental Methods of Chemical Analysis. Pragati Prakashan, Meerut.
3. W H Willard, L L Merritt and J A Dean, Instrumental Methods of Analysis.
4. S. M.Khopkar, Basic Concepts in Analytical Chemistry.
5. D. Skoog and D. West, Principle of Instrumental Analysis. Holl Seamlers.
6. E. Berlin, Principles and Practice of X-Ray Spectrometric Analysis, Plenum, New York.
7. J. Winefordner, S. Schulman and T O Haver: Luminescence Spectrometry in Analytical Chemistry. Wiely Interscience NewYork.
8. Gary D Christian,Analytical chemistry 6th edition. John Willey and sons INC (2003)
9. Engineering chemistry, R Gopalan,G. S. Nagrajan.
10. Engineering chemistry B. K. Sharma.

Course Outcomes (COs):

CO1: Students will be skilled in the techniques like fluorescence, phosphorescence, types of quenching, FRET and applications of the same in Analytical Chemistry and for addressing research problems.

CO2: Students will gain knowledge of the kinetic methods of analysis supporting the analysis and data procured in research.

CO3: The students will acquire the knowledge of advanced method of chemical analysis XPS, XRF, fluorescence and phosphorescence spectroscopy which will be beneficial in research.

CO4: Students will acquire knowledge of identifying types of plastic and will also be able to and determination of metallic impurities in plastics.

Major Electives (Choose any One)

M.Sc. II, SEM-IV

Students of Organic and Analytical Chemistry shall choose any one of the following elective papers.

EO-MCTO23-404: Applied Organic Chemistry

UNIT-I: Study of Agrochemicals and Perfumes **15 hrs.**

A) Agrochemicals **(7)**

(i) Organochlorine pesticides: Introduction, synthesis, and mode of action of endrin, aldrin, dieldrin. (ii) Herbicides: Synthesis and mode of action of Triazines, triazoles, pyridazinones, and bipyridylium compounds: diquat, paraquat. (iii) Juvenile hormone: introduction & structures JHA importance synthesis, IPM

B) Synthesis and applications of perfumery **(8)**

2-Phenylethanol, vanillin, and other food flavors, synthetic musk, and ionones.

UNIT-II: Unit processes **15 hrs.**

Introduction to unit operation and unit processes. Nitration: Introduction, Nitrating agents, kinetics and mechanism, oxynitration, typical industrial nitration process.

Amination: Introduction, Bechamp reduction. Halogenation: Introduction, Kinetics and mechanism, catalytic chlorination, manufacturing process for chlorobenzene and monochloroacetic acid. Sulfonation- Introduction, sulphonating agents, kinetics and mechanism, manufacturing process for benzene sulphonic acid.

UNIT-III: Dyes and Intermediates **15 hrs.**

Classification and synthesis of important dye intermediates by using nitration, sulphonation, diazotization reactions. Synthesis of Nitro dyes, xanthenes, reactive dyes, fluorescent brightening agents, thermal sensitive dyes, dispersed dyes and reactive dyes.

UNIT-IV: Polymers **15 hrs.**

Mechanism of polymerization. Industrial process for synthesis of polyethylene, acrylonitrile, acrylate and methacrylate polymer, biomedical polymer, polymer processing, Plasticizers and anti -oxidants for polymers,

Reference Books:

1. Allan: Colour Chemistry
2. K. Venkataraman: Chemistry of Synthetic Dyes Vol- 1 to 7
3. G. R. Chatwal: Synthetic dyes
4. Abrahart: Dyes & their intermediates
5. N. N. Melikov: The Chemistry of Pesticides and formulations
6. K. H. Buchel: Chemistry of Pesticides.

7. R. Clemlyn: Pesticides
8. K. H. Buchel: Chemistry of Pesticides
9. H. R. Alcock and F. W. Lambe: Contemporary Polymer Chemistry
10. J. M. G. Cowie, Blackie: Physics & Chemistry of Polymers
11. I. M. Campbell: Introduction to Synthetic Polymers
12. A. L. Gupta: Polymer Chemistry
13. M. S. Bhatnagar: A textbook of Polymers
14. F. W. Billmeyer: Textbook of Polymer Science

Course Outcomes (COs):

CO No.	**On completion of the course, students will be able to:**
CO1	Learn about the synthesis and uses of different types of Agrochemicals such as Carbamates, organophosphorous insecticides, and Natural and Synthetic Pyrethroids. They will learn the synthesis of some plant growth regulators as well as applications of Juvenile hormones and Pheromones.
CO2	Learn about the perfumery compounds, commercial process, preparation and importance of essential oils. Also learn the synthesis of 2 - phenyl ethanol, yara- yara, vanillin, synthetic musk, jasmine, ionone etc. from citral, phenyl acetate ester, benzyl acetate ester.
CO3	Understand the classification, and synthesis of azo dyes, reactive dyes, optical brighteners, dispersed dyes.
CO4	Understand the mechanism of polymerization. Also, study about the manufacturing processes of synthetic rubber plasticizers, and anti-oxidents required for natural polymers like starch and cellulose. They will get the knowledge about the Oxo and Wacker process necessary for Soap and Synthetic detergents.

EA-MCTA23-404: Applied Analytical Chemistry

UNIT-I: Spectrochemical Methods of Analysis **15 hrs.**

Introduction to spectrochemical methods. Electronic spectra and molecular structure, NIR spectrometry for non-destructive testing. Solvents for spectrometry, FTIR spectrometer, fluorometry, optical sensors. Analysis of ores –bauxites, dolomites, monazites. Analysis of Portland cement.

UNIT-II: Analysis of metals and alloys **15 hrs.**

Foundry materials, ferroalloys, and special steels, slags, fluxes. Analysis of alloys, bronze, brass, Alnico and Nichrom.

UNIT-III: Analysis of soil and fertilizers **15 hrs.**

Method of soil analysis, soil fertility and its determination, determination of inorganic constituents of plant materials, Chemical analysis as measure of soil fertility, analysis of fertilizers, applications.

UNIT-IV: Analysis of Commercial materials **15 hrs.**

Analysis of explosive materials, TNT, RDX, lead azide, EDNA (ethylene dinitramine). Analysis of conducting polymer, resins and rubber. Analysis of luminescent paints, Analysis of lubricants and adhesive.

Reference Books:

1. Hillebrand Lhundel, Bright and Hoffiman, Applied Inorganic Analysis, John Wiley.
2. Snell and Biffen, Commercial Methods of Analysis.
3. P. G. Jeffery, Chemical Methods of Rock Analysis, Pergamon.
4. Buchel, Chemistry of Pesticides. J Wiley.
5. Rieche, Outlines of Industrial Organic Chemistry, Butter Worth.
6. F. A. Henglein, Chemical Technology, Pergamon.
7. Kent, Riegl's Industrial Chemistry, Rainhold.
8. Chopra and Kanwar, Analytical Agriculture Chemistry, Kalyani Publishers.
9. Aubert and Pintes, Trace Elements in Soils.
10. Bear, Chemistry of Soil.
11. Hauson, Plant Growth Regulators, Noyes.
12. P. G. Jeffery and D.J. Hatchinson, Chemical Methods of Rock Analysis.
13. F. J. Weleher, Standard Methods of Chemical Analysis, A Series of Volumes Robert and Krigeger Publishing Company.
14. I. M. Kolthoff and PJ Ewing, Treatise o Analytical Chemistry, A series of Volumes.
15. R. D. Reeves and R.R. Brooks, Trace element Analysis of Geological Materials, John Wiley & Sons New Dehli.
16. W. M. Johnson and J.A. Maxwell, Rock and Mineral Analysis, John Wiley and Sons, New York.
17. W. F. Hildebrand, GHC Landell and HA Brighot, Applied Inorganic Analysis, John Wiley 2nd Ed.
18. K. J. Das, Pesticide Analysis (MD).

Course Outcomes (COs):

CO1: The students will acquire knowledge of analysis of metals, alloys, minerals and ores commonly used in the industry.

CO2: The students will be acquainted with the analysis of real samples like cement, plaster of Paris, different commercial ores, soil composition, soil fertility, fertilizers etc using conventional and instrumental methods of analysis.

CO3: Students will also gain the knowledge of analysis of commercial materials, explosives, polymers, resins, rubber, luminescent paints, lubricants and adhesives.

CO4: These would offer opportunity to the students to get employment in industries for quality assurance and quality control (QA-QC) of the product.

RP-MCPA23-405 Research Project (6 Cr)

See Annexture-I for details.

Note: Study tour is the part of your syllabus for M.Sc. Part- II. Students shall visit Chemical Industries in India.

Annexture-I

Research Project Paper Guidelines for all specializations

(Organic and Analytical Chemistry)

Semester III

(RP-MCPO23-305, RP-MCPA23-305)

Credits= 04, 120 Hours, 100 Marks

- The students should write synopsis of proposed research work.
- The students should perform detail literature survey related to research problem.
- The students should write review article related to research problem.
- It is expected to publish the review article either in Shivaji University Journal or peer reviewed journals.
- The students should design the problem and start experimental work. The students should complete at least 25% of their experimental work during the semester III and the same work to be continued in semester IV.
- The student should submit the spiral bound copy of research work carried out during semester III including the synopsis, research proposal, review article and certified progress report.
- The Research Project will be examined jointly by internal and external examiners during the practical examination at the end of the semester.
- The students should present their work during the evaluation in the form of power point presentation (PPT) .
- Marking Scheme:

Sr. No.	Description	Marks
1	Synopsis	10
2	Research Proposal	20
3	Review article on proposed work	20
4	Daily Lab notebook record	10
5	Progress of Experimental work	20
6	Quality and effectiveness of presentation	20
	Total	**100**

Broad guidelines for preparation of synopsis

A. The proposed synopsis for research should be self-contained and should cover the rationale for carrying out research.

B. There should not be repetition of the work or topic or theme.

C. The synopsis of the proposed research shall contain the following points :

1. Title of the Research Proposal
2. Motivation with reasoning and significance of the proposed research
3. Statement of the problem
4. Review of the relevant literature
5. Objectives of the study
6. The methodology comprising

a. Methods of research

b. Sampling design and assumptions

c. Conceptual framework if any

d. Research design (explanation of how research is being conducted and the tools used for the same)

e. Methods of data collection

f. Methods of data analysis (use of parametric and non-parametric tools and techniques as the case may be)

7. Expected outcome
8. Bibliography.

Template for Research Proposal

- Title
- Introduction
- Origin of the research problem
- Interdisciplinary relevance
- Review of Research and Development in the Subject
- Significance of the study
- Objectives
- Plan of research work

M. Sc. II Semester IV

RP-MCPO23-405, RP-MCPA23-405

Credits= 06, 180 Hours, 150 Marks

- The student should submit the final bound dissertation/thesis copy of research work carried out during semester III and IV.
- It should include title page, certificate, declaration, acknowledgement, abbreviations, index, abstract, introduction, experimental section, results and discussion, conclusions, references, participation in conferences/seminars and publications if any.
- The students should present their work during the evaluation in the form of power point presentation (PPT).
- **Marking Scheme:**

Sr. No.	Description	Marks
1	Dissertation/thesis bound copy	30
2	Quality of work (Innovative concepts, social relevance, extent of work etc.)	50
3	Publications	20
4	Participation in conferences	10 maximum
	a) Oral/Poster Presentation (10 marks)	
	b) Only attended (7 marks)	
5	Final Dissertation/thesis defense	40
	Total	**150**

Note: The Project will be examined jointly by internal (Project Supervisor) and external examiners (preferably Associate professor and above with Ph. D.) at the end of the semester. The project can be given individually or a maximum group of three students is allowed. (Not more than three students allowed).