DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, CHHATRAPATI SAMBHAJINAGAR.

CIRCULAR NO.SU/M.Sc./Deptt./NEP/115/2024

It is hereby inform to all concerned that, the syllabi prepared by the Departmental Committee and recommended by the Dean, Faculty of Science & Technology, **Academic Council at its meeting held on 08 April 2024 has accepted the following Syllabi under the Faculty of Science & Technology as per National Education Policy-2020** run at the University Department, Dr.Babasaheb Ambedkar Marathwada University as appended herewith.

Sr.No.	Courses	Semester
1.	**M.Sc.Environmental Science**	**IIIrd & IVth semester**
2.	**M.Sc. Chemistry with Specialization Analytical Chemistry.**	**IIIrd & IVth semester**

This is effective from the Academic Year 2024-25 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.No.SU/2024/272-80
Date:- 04.06.2024

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Deputy Registrar,
Academic Section

Copy forwarded with complimcnts to :-

1] **Head of the Department, Department of Chemistry and Environmental Science Dr.Babasaheb Ambedkar Marathwada University,Chhatrapati Sambhajinagar.**

2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

1] **The Director, Board of Examinations & Evaluation,** Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
2] The Section Officer,[M.Sc.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
3] The Programmer [Computer Unit-1] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
4] The Programmer [Computer Unit-2] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
6] The Public Relation Officer, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
7] The Record Keeper, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,

CHHATRAPATI SAMBHAJINAGAR

NAAC Re-accredited 'A' Grade

Department of Chemistry

FACULTY OF SCIENCE & TECHNOLOGY

Two Years P.G. Programme in Chemistry

(M. Sc. Analytical Chemistry Semester III&IV)

As Per National Education Policy-2020

(To be implemented from Academic Year 2023-24)

Course structure and Curriculum

(OBE with Choice Based Credit System)

Subject : Chemistry

Specilization : Analytical Chemistry

Effective from 2024-25

PREFACE

National Education policy 2020 has been intensely debated policies come into existence. In January, 2020 UGC has given the guideline for Learning outcome based curriculum framework (LOCF) work towards more holistic experience for the students. while focussing not just on knowledge delivery in higher education but also on the application of knowledge through field and laboratory work and emphasis on application of knowledge to real life experiences, LOCF is student-centric education in the context of development of personal, social, professional and acquired knowledge requirements in their career and life building, which focuses on measuring student performance through outcomes. It includes the knowledge, skills and attitudes enhancement in the students.

The aspects of LOCF is all-round development of the students, skill acquisition outside chosen subjects and research were undetermined but NEP has changed all of these in one stroke. The prominent features of the NEP framework are:

- Student centric education
- Flexibility in postgraduate programmes
- Multiple entry and exit points
- Skill based & outcome base education
- Credit based evaluation system
- Academic bank credits

It also focuses on evaluation of outcomes of the program by considering the knowledge, skill and behaviour of a students after completion of two year program. The educational triangle of Teaching-Learning and Evaluation process is the unique features of the OBE approach. The curriculum practices such as Competency based curriculum, Tailor-made curriculum development, spades, curriculum principles, Blooms Taxonomy and further use of assessment methodologies like, Norm-reference testing and Criterion reference testing, etc is being practiced since decades. It is also interesting to know that, globally, different countries and universities adopts the curriculum development models/approaches such as, CDIO (Conceive-Design-Implement-Operate), Evidence based education systems approach, etc as the scientific and systematic approaches in curriculum design.

Maharashtra state government and the authorities of Dr. Babasaheb Ambedkar Marathwada University, Aurangabad has decided to implement National Education policies -2020 from the academic year 2023-24 for postgraduate program with outcome based education
As per guideline of OBE the department has prepared curriculum for Master of science in chemistry with specialization Inorganic chemistry, Organic Chemistry, Physical Chemistry and self-supported Analytical Chemistry. The OBE syllabus will help to improve the quality and employability of the Post-graduates of the university department.

Professor &Head
Department of Chemistry
Dr. Babasaheb Ambedkar
Marathwada University,
Chhatrapati Sambhajinagar

1. **Vision of Department :**
A respectable teaching- learning and research organization nationally and internationally in the area of chemical sciences by providing competitive trained chemists which will assist the chemical world, industries and stake holders.

2. **Mission Department :**
   - To bring sustainable progress of society by nurturing chemistry with responsibilities
   - To create and maintain programs of excellence in the areas of research , education and public outreach
   - Department will produce students who are knowledge in chemistry and can think critically.
   - To develop the researcher and scientist in chemical science through post-graduate education and research programme.
   - To develop the competent manpower with technology based experimentation methodologies and value based practices for business and industries.
   - To undertake projects to solve field base problems.
   - To provide student centric learning facilities for the development of overall personality of learner.

3. **Eligibility Criteria :**

4. **Assessment and Evaluation :**

5. **Duration of Course Programme : Two years**

6. . **Credit Allotted for two year master programme in chemistry :**88 Credit
Semester - I : 22

Semester -II : 22

Semester -III : 22

Semester -IV : 22

7. **Program Educational Objectives:**
The program educational objectives (PEO's) are the statement that describes the career and professional achievement after the program of studies (post-graduation). The PEO' s are driven form the Mission statement (What is the purpose of organization). The PEO's can be minimum three and maximum five.

PEO1: To have advanced knowledge of chemistry domain.

PEO2: To provide the professional services to industry, Research organization and institutes.

PEO3: To provide the professional consultancy and research support for therelevant organization in the domain of super specialization.

PEO4: To opt for higher education, disciplinary & multi-disciplinary research and to be a life-long learner.

PEO5: To provide, value based and ethical leadership in the professional and social

life.

8. **Program Outcomes:**
The program outcomes (PO's) are the statement of competencies/ abilities. POs are the statement that describes the knowledge and the abilities the post-graduate will have by the end of program studies.

i).In-depth and detailed functional knowledge of the fundamental theoretical concepts and experimental methods of chemistry.

ii). Apply/implement interface between on the one hand, the history of chemistry and natural science and, on the other hand, issues pertaining to the areas of modern technology, health, and environment.

iii). Skills in planning and conducting advanced chemical experiments and applying structural-chemical characterization techniques.

iv). Skill in examining specific phenomena theoretically and/or experimentally.

v). Generation of new scientific insights or to the innovation of new applications of chemical research.

9. **Course Program outcome**

Course Program Outcomes are developed through the curriculum (curricular/co-curricular-extra-curricular activities). The program outcomes are attained through the course implementation. As an educator, one must know, **"To which POs his/her course is contributing?"** So that one can design the learning experiences, select teaching method and design the tool for assessment.

M.Sc. Analytical Chemistry Semester-III Course Structure

Sr. No.	Course Code	Course Name	Teaching (Hr/W)	Credits Assigned	Conti. Inter. Assmen.	End. Sem. Exam	Total Marks
Course type : DSC-Major Mandatory:							
1.	ACHTC-600	Structural Elucidation by Spectral Methods	4	4	40	60	100
2.	ACHTC-601	Quality Assurance and Accreditation	4	4	40	60	100
3.	ACHTC-602	Advanced Analytical Techniques-I	2	2	20	30	50
4.	ACHLC-603	Analytical Chemistry Laboratory Course	4	2	20	30	50
5.	ACHLC-604	Analytical Chemistry Laboratory Course	4	2	20	30	50
Course Type : DSE (Choose any two from pool of the course):							
6.	ACHTE-605	Electroanalytical Techniques	2	2	20	30	50
7.	ACHTE -606	Advanced Analytical Techniques-II	2	2	20	30	50
8.	ACHTE -607	Polymer, Paint and Pigment Analysis	2	2	20	30	50
9.	ACHTE -608	Petrochemical Analysis	2	2	20	30	50
Course Type :Research Project:							
10.	ACHRP-649	Research Project -I	8	4	40	60	100
Total			**32**	**22**	**220**	**330**	**550**

Course code Nomenclature :

DSC-Discipline Specific Core , **DSE**- Discipline Specific Elective, **T**-Theory, **L**- Laboratory course, **ACHTC**- Analytical Chemistry Theory Core , **ACHLC**- Analytical Chemistry Laboratory Core, **ACHTE**- Analytical Chemistry Theory Elective , **ACHRP**- Analytical Chemistry Research Project

Semester : III

Course Name: Structural Elucidation by Spectral Methods	**Course Code:**ACHTC-600
Course type : DSC-15	**4 Hrs/ Week**
Total contact hours : 60 Hrs **Theory Credit:** 4	**Marks** : 100

Learning outcomes:

On completion of this course, the students will be able:

1. Students will review elementary concepts of nuclear magnetic resonance spectroscopy and delve into spin-spin couplings, factors affecting coupling constants, and spin systems like AB, AX, and ABX.
2. They'll also explore techniques such as INEPT, INADEQUATE, and the Nuclear Overhauser effect.
3. Students will grasp elementary concepts of 13C-nuclear magnetic resonance spectroscopy, including chemical shifts for various carbon types and the impact of substituents on these shifts.
4. They'll also address instrumental challenges associated with 13C-NMR spectroscopy.
5. Students will understand the fundamentals of mass spectrometry, including ion production methods, ion analysis, factors affecting fragmentation, and the interpretation of mass spectra.
6. They'll explore fragmentation patterns for various functional groups and phenomena like the molecular ion peak and McLafferty rearrangement.
7. Students will grasp the principles of Mössbauer spectroscopy, understanding factors influencing line position and shape, including the isomer effect and quadrupole splitting.
8. They'll also delve into Electron Spin Resonance spectroscopy, analyzing hyperfine splitting, zero field splitting, and instrumentation in varied applications.
9. Students will integrate UV, IR, 1H NMR, 13C NMR, and Mass Spectroscopy data to solve complex problems in structural elucidation and compound identification.

Unit-I : Nuclear Magnetic Resonance Spectroscopy (^{1}H NMR) **12Hrs**

Elementary ideas (Recapitulation); Spin-spin couplings, Different types of couplings, factors affecting on coupling constants, Karplus equation, Spin systems (AB, AX, ABX, AMX), Rate processes, spin decoupling, shift reagents, Nuclear Overhauser effect (NOE), INEPT and INADEQUATE.

Unit-II : ^{13}C-Nuclear Magnetic Resonance Spectroscopy **12Hrs**

Elementary ideas, instrumental problems, chemical shifts (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbons); Effect of substituents on chemical shifts.

Unit-III : Mass Spectroscopy **12Hrs**

Introduction, ion production (EI, CI, FD and FAB), ion analysis, ion abundance, factors affecting on fragmentation, fragmentation of different functional groups, molecular ion peak, isotopic peaks, metastable peak, Nitrogen rule, McLafferty rearrangement, Retro-Diels-Alder reaction.

Unit-IV : **12Hrs**

Problems based on joint applications of UV, IR, ^{1}H NMR, ^{13}C NMR and Mass spectroscopy.

Unit- V : Mossbauer Spectroscopy **12Hrs**

Principle, factors affecting the line position and shape, isomer effect and Quadrupole splitting iron salt like compounds, complexes, carbonyl compounds (temperature dependence of isomer shift and Quadrupole splitting in simple compound and coordination, polynuclear complexes), Numericals. **Electron Spin Resonance Spectroscopy:** Introduction, principle of ESR spectroscopy, presentation of spectrum, hyperfine splitting in various structures, hyperfine splitting diagram of representative examples, factors affecting the magnitude of 'g' values, Zero field splitting, Kramer's degeneracy, Anisotropy in the hyperfine coupling constant, electron delocalization, instrumentation and applications.

References Books

1. Introduction to Spectroscopy: D. L. Pavia, G. M. Lampman, G. S. Kriz

2. Spectrometric Identification of Organic Compounds: R. M. Silverstein & F. X. Webster
3. ^{13}C NMR Spectroscopy: G. C. Levy, R. L. Lichter, G. L. Nelson
4. Spectroscopic Methods in Organic Chemistry: D. H. Williams & I. Flemming
5. Organic Structure Analysis: Philips Crews
6. Structural Methods in Inorganic Chemistry: E. A. V. Ebsworth& D. W. H. Rankin
7. Physical Methods for Chemistry: R. S. Drago
8. Coordination Chemistry vol. I: E. Martell
9. Coordination Chemistry by Experimental Methods: K. Barger
10. Mass Spectrometry: K. G. Das & James
11. Absorption Spectroscopy of Organic Compounds: V. M. Parikh

Semester : III

Course Name: Quality Assurance and Accreditation **Course Code:**ACHTC-601

Course type : DSC-16 **4 Hrs/ Week**

Total contact hours : 60 Hrs **Theory Credit:** 4 **Marks:** 100

Learning outcomes:

On completion of this course, the students will be able:

1. Students will understand the concepts and significance of quality control and assurance, utilizing statistical techniques like quality control charts.
2. They will master calibration and maintenance of laboratory instruments.
3. They will gain proficiency in documentation for quality assurance, including handling raw data, sampling methods, and analytical reporting.
4. The course covers establishing a quality assurance program, writing standard operating procedures, and monitoring quality assurance data.
5. Students will explore laboratory accreditation, its international aspects, criteria, and benefits.
6. They will learn about ISO 9000 standards, their evolution, and implementation, including QMS documentation, quality policies, and the significance of ISO 9001, 9002, 9003, and 9004.

Unit-I :Quality Assurance: **12Hrs**

Introduction to Quality Control and quality assurance: Concepts and significance. Quality control and statistical techniques: Quality control charts, the X-quality control chart, the R-quality control chart and its interpretation, spiked sample control charts, use of blind samples in quality control, use of proficiency evaluations in quality control.

Unit-II : Calibration and maintenance of Instruments **12Hrs**

Calibration and maintenance of Instruments : Instrument calibration – linear calibration curves, equipment calibration, frequency of calibration, calibration of common laboratory instrument and equipment (Analytical balances, volumetric glassware, ovens, furnaces, UV / Visible spectrophotometer, pH meter, conductivity meter, IR spectrophotometers, AAS, GC, HPLC etc.,). Maintenance of instruments and equipment

Unit-III :Documentation for quality assurance and Raw Data: **12Hrs**

Type of notebooks, control of notebook distribution and data entry. General Reagents and volumetric reagents.

Sampling – sampling methods, sample labelling, and sample log-in/register. Sample analysis, reporting, recording and personal training. Instrument calibration and maintenance. Analytical report. Personnel, training, records - professional personnel, technician personnel. Filing quality assurance documentation. Good laboratory practices and personnel, Quality Programme, Instrument and Organisation calibration, Customer satisfaction.

Unit-IV : Computers and quality assurance **12Hrs**

Computers and quality assurance: Sample handling. Data Acquisition. Quality control data and calculations. Computer generated analytical reports. Security considerations. Hardware and software. Establishing a Quality Assurance program: Management commitment. Define the quality assurance program. Writing standard operating procedures. Topics for standard operating procedures. Consolidating the programme. Monitoring the program – monitoring quality assurance data, reporting quality assurance problems. Writing the quality assurance manuals. AC(CB1)-4: Quality Accreditation

Unit-V : Quality Accreditation: **12Hrs**

Laboratory Accreditation: Need for laboratory accreditation. International aspects of laboratory accreditation and in India. Criteria for laboratory accreditation. Benefits of laboratory accreditation, Evolution and significance of Quality Management, Background to ISO 9000, comparison between ISO-9001, ISO-9002 & ISO-9003., ISO 9000-2000 series of standards on quality management system, - evolution of series of standards, introduction to ISO organization, Registration / certification - benefits of QMS certification. Structure of ISO 9000-2000 family of standards. 124 Advantages of ISO 9000-2000. Requirements of ISO 9001-2000 QMS and applications, Steps for effective implementations. Significance of ISO - 9001, 9002, 9003& 9004. Requirements of ISO9000/IS14001. Concepts of OHSMS (BS 8800) Quality Management Principles in QMS, QMS documentation, Quality Manual, Quality policy, conformities and Non-conformities

References Books

1. Handbook of Quality Assurance for the analytical chemistry laboratory, James P. Dux, Van Nostrand Reinhold, New York, 1986.
2. Applying ISO-9000 Quality Management Systems, International Trade Centre Publishing, UNCTAD/WTO. Geneva, Switzerland, Indian Edition Printed by D.L.Shah Trust.
3. How to practice GLP, PP Sharma, Vandana Publications, 2000, New Delhi
4. Training manuals on ISO 9000 / 2000 PQM, Girdhar J Gyani, Raj Publishing House, 2001
5. Quality Assurance in Analytical Chemistry, B.W. Wenclawiak, Springer,India, 2004.

Semester : III

Course Name: Advanced Analytical Techniques-I **Course Code:**ACHTC-602

Course type : DSC-17 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1. They will understand Supercritical Fluids, hyphenated techniques like LC-MS and GC-MS, Molecular Luminescence Spectrometry, and surface characterization techniques using spectroscopy and microscopy.

2. To understand the concept of fluorescence, phosphorescence and Chemiluminescence

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Unit-I : Supercritical Fluids and Hyphenated Techniques **10Hrs**

Properties of Supercritical Fluids, Supercritical Fluid Chromatography, Supercritical Fluid Extraction.

Introduction, Need for hyphenation, possible hyphenation, Interfacing devices and applications of the following: LC-MS, GC-IR, GC-MS,ICP-MS, MS-MS.

Unit-II :Molecular Luminescence Spectrometry: **10Hrs**

Theory of fluorescence and phosphorescence, Instruments for measuring fluorescence and phosphorescence, Applications of photoluminescence methods, Chemiluminescence`

Unit-III :Surface Characterization by Spectroscopy and Microscopy **10Hrs**

Introduction to the study of surfaces, spectroscopic surface methods, Ion spectroscopic techniques, Surface photons spectroscopic methods, Electron stimulated microanalysis methods, Scanning probe microscopes.

References Books

1. Instrumental Methods of Analysis–Willard, Merritt, Dean & Settle.

2. Instrumental methods of analysis – B. K. Sharma.

3. Instrumental methods of analysis – Chatwal and Anand.

4. Fundamental of Analytical Chemistry,-D.A. Skoog, D.M.West and F.J. Holler.

5. Introduction to Instrumental Analysis-R.D. Braun, McGraw Hill.

6. Instrumental Analysis- Skoog, Holler, Crouch.6th edition

7. Analytical Chemistry – Gary D. Christian, 6th editio

8. Instrumental Methods of Chemical Analysis–Galen W. Ewing.

Semester : III

Course Name: Analytical Chemistry Laboratory Course **Course Code:** ACHLC-603

Course type : DSC-18 **4 Hrs/ Week**

Total contact hours : 60 Hrs **Lab. Work Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1. Students will develop practical skills in various analytical techniques.
2. They will determine COD, BOD, and dissolved oxygen in wastewater, separate and estimate cadmium and zinc, and estimate nitrogen in fertilizers via the Kjeldahl method.
3. They will assess saponification, acid, and iodine values of oils, determine vitamin C in samples, and measure blood glucose levels.
4. Students will estimate APIs in pharmaceuticals, phenol/aniline, chloride in food, sodium carbonate, and moisture content.

List of experiments

1. Determination of COD, BOD and dissolved oxygen from waste water sample.
2. Separate and estimate the amount of cadmium and zinc using ion exchange resin.
3. Estimation of Nitrogen from given sample of fertilizer by Kejaldal method.
4. Determination of saponification, acid and Iodine value of oil.
5. Determination Vitamin –C from given sample of Juice/ tablet using dichlorophenol indophenols by volumetric method.
6. Estimation of blood glucose by Folin Wu method.
7. Estimation of API in the pharmaceutical sample.
8. Estimation of phenol/aniline by bromination method.
9. Estimation of chloride from food sample by Volhard titration method.
10. Determination of sodium carbonate in washing soda.
11. Determination of volume strength of commercial hydrogen peroxide using

$KMnO_4$

References Books

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by A. I. Vogels.
2. Experiments in chemistry by D. V. Jahagirdar, Himalaya publication.
3. Practical Pharmaceutical Chemistry, 4th Ed. part-2, Beckette, Stenlake.
4. Indian Pharmacopeia volume –I , II III

Semester : III

Course Name: Analytical Chemistry Laboratory Course **Course Code:** ACHLC-604

Course type : DSC-19 **4 Hrs/ Week**

Total contact hours : 60 Hrs **Lab. Work Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1. Students will master the estimation of potassium, calcium, and sodium using flame photometry, and determine boric acid via conductometry.
2. They will analyze commercial vinegar by potentiometric and conductometric methods, determine high polymer molecular weight by viscosity/turbidometry, and estimate phosphate in fertilizers/detergents spectrophotometrically.
3. They will estimate Cu (II) and Fe (III) using EDTA, reducing sugar in food by spectrophotometry, and protein by the biuret method.
4. They will analyze alcohol mixtures and nitration monitoring by gas chromatography.

List of experiments

1. Estimation of potassium, calcium and sodium from given sample using flame photometric method.
2. Determination of boric acid by conductometric method.
3. Determination of commercial vinegar by potentiometric titration and its confirmation by conductometric method.
4. Determination of molecular weight of high polymer by viscosity measurement /turbidometric method
5. Determine the amount of phosphate from given sample of fertilizer/ detergent using spectrophotometric method.
6. Estimation of Cu (II) and Fe (III) by spectrophotometric method using EDTA.
7. Estimate the reducing sugar by 3, 5 dinitrosalicylic acid in the given food sample by Spectrophotometric method.
8. Determination of protein by biureate method using by Spectrophotometric method.
9. Analysis of mixture of alcohols by Gas chromatography.
10. Monitoring of nitration of organic compound by gas chromatography.
11. Determination of petroleum hydrocarbons in burn-cases by GC method.

References Books

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by A. I. Vogels.
2. Experiments in chemistry by D. V. Jahagirdar, Himalaya publication.
3. Practical Pharmaceutical Chemistry, 4th Ed. part-2, Beckette, Stenlake.
4. Indian Pharmacoepia volume –I, II& III

Semester : III

Course Name: Electroanalytical Techniques **Course Code:**ACHTE-605

Course type : DSE-9 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1. Students will comprehend electrode processes, including electrocapillary curve and exchange current, and various types of ion-selective electrodes.
2. They will explore potentiometry, its instrumentation, and different types of potentiometric titrations, understanding their variations and limitations.
3. Coulometry principles, techniques, and applications, along with high-frequency titration theory and instrumentation, will be covered.
4. Students will learn about cyclic voltammetry, its theory, instrumentation, and qualitative/quantitative analysis techniques.
5. Electrogravimetry principles, instrumentation, and applications, including constant applied voltage/current methods, will be studied.
6. Electrophoresis techniques, including paper, capillary, zone, and gel electrophoresis, will also be explored, along with their principles, experimental techniques, and applications.

Unit-I : General Introduction and Potentiometry **10Hrs**

Electrode Processes, Electrocapillary curve and electrocapillary maximum potential, exchange current, Ion selective electrodes: Types and construction of electrode, Glass electrode, Solid state electrode and precipitate electrode, Liquid-liquid membrane electrodes, Enzyme and gas electrode, Applications of ion selective electrodes, Reference electrodes, Mercury electrodes (DME, SME, HMDE).

Potentiometry: Instrumentation, Potentiometric titrations:- Types of potentiometric titrations, Variations in potentiometric titrations, Limitations.

Unit-II :Coulometry, High frequency titration and Cyclic Voltammetry **10Hrs**

Coulometry: Principle, Technique, Coulometry at constant current and coulometry at controlled potential, Coulometric titration, Flowing stream coulometry, ,Stripping analysis, Applications.

High frequency titration: Theory and instrumentation, High frequency

titrimetry, Types of cells, Advantages of high frequency methods, Applications.

Cyclic Voltammetry: Theory and origin of polarography, Interpretation of pornographic curves, Instrumentation of polarography, Differential pulse polarography, Factors affecting on polarographic wave. Introduction and beginning of cyclic voltammetry, Range of cyclic voltrametric techniques. The acceptable sweep rate range, The shape of the peak in potential sweep curves, The role of non- aqueous solution in cyclic voltammetry, Crieteria of reversibility of electrochemical reactions, Quasi reversible and irreversible processes, Qualitative and quantitative analysis by cyclic voltametric techniques, Linear sweep voltammetry for reactions that include simple adsorbed intermediates, Amperometric titrations, Chronoamperometry..

Unit-III : Electro-Gravimetry and Electrophoresis: **10Hrs**

Electro-Gravimetry: Theory of electrogravimetry, Instrumentation, Electrogravimetric determination with constant applied voltage and constant current, Applications of electrogravimetry, Problems based on effect concentration on electrode potential, Calculation of therotical potential, Effect of pH in electrolytic separation.

Electrophoresis: Paper electrophoresis Principle, Experimental techniques, Factors governing migration of ions, and Applications, Numericals. Capillary and zone electrophoresis: Electroosmotic flow, Migration in CE, Instrumentation, Control of separation, Application. Gel electrophoresis: Principle, technique, application.

References Books

1. Quantitative analysis -. Alexeyev. V
2. Instrumental methods of analysis – Chatwal and Anand.
3. Introduction to instrumental analysis – R. D. Braun.
4. Instrumental methods of analysis – Willard, Meritt, Dean and Settle.
5. Standard methods of chemical analysis – F. G. Welcher, Vol III, Part A & B.
6. Electroanalytical chemistry – H. W. Neurenberg.
7. Principles of electrochemistry – D. A. Maclines.

8. Ion selective electrodes – (John Wiley) Stulic. 126
9. Vogel's textbook of quantitative chemical analysis - Mendham, Denney,etc.
10. Modern Electrochemistry vol. I - John O'M Bockris
11. Modern Electrochemistry vol. II - John O'M Bockris
12. Analytical Chemistry – Gary D. Christian, 6th edition
13. Principles of Instrumental Analysis–Skoog, F. J. Holler & J. A. Nieman.
14. Instrumental Methods of Chemical Analysis–Galen W. Ewing. 5th edition

Semester : III

Course Name: Advanced Analytical Techniques-II **Course Code:** ACHTE-606

Course type : DSE-10 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1. Students will master Atomic Mass and X-ray Spectrometry, including mass spectrometers and various methods such as inductive coupled plasma and electron microprobe.
2. They will understand Thermal Methods, encompassing thermogravimetry, differential thermal analysis, and thermometric titrations.
3. Students will gain proficiency in Diffraction Methods, learning about X-ray and electron diffraction techniques, Bragg's law, and structure determination.
4. They will explore applications in identifying unit cells, determining crystal structures, and understanding the differences between X-ray and neutron diffraction, particularly in magnetic scattering and transition metal oxides analysis.
5. These skills prepare students for advanced analytical roles in research and industry.

Unit-I :Atomic Mass and X-ray Spectrometry **10Hrs**

Atomic Mass Spectrometry: Some general features of atomic mass spectrometry, Mass spectrometers, Inductive coupledplasma mass spectrometrySpark source mass spectrometry, Glow discharge mass spectrometry, Other mass spectrometric methods.

Atomic X-ray Spectrometry: Fundamental principles, Instrument components, X-ray fluorescence methods, X-rayabsorption methods, The electron microprobe.

Unit-II : Thermal Methods **10Hrs**

General introduction, classification of thermal methods of analysis thermogravimetry, principles, factors affecting thermal curve, thermogravimetric analysis, Derivative thermogravimetry, Differential thermal analysis - principles, factors affecting DTA curve, applications, differential scanning colorimetry - principles, instrumen- tation and applications, thermomechanical and dynamic mechanical analysis,

thermometric titrations, numericals. Microthermal analysis.

Unit-III : Diffraction Methods **10Hrs**

Generation of X-rays, interaction of X-rays with matter, scattering and diffraction, Bragg's law, Miller indices, General instrumentation, Lauc Photograph method, Bragg's method, their principle and uses, single crystal method, Debye-Scherrer method, Identification of unit cells from systematic absences, X-ray intensities and structure determination, structure factor and its relation to electron density andintensity, Phase problem. Indexing of lattice planes in a cubic system, structure of NaCl and KCl, Avogadro's number from cubic lattice dimensions, applications of X-ray diffraction.

Electron diffraction: Scattering of electrons by gases, Weirl equation, experimental methods: visual method, sector, method, radial distribution method, low energy electron diffraction, structure determination of SiF_4 and CF_3Cl, limitations. **Neutron diffraction:** Introduction, difference between neutron and X-ray diffraction measurement technique, magnetic scattering, applications, comparison of X-ray and neutron diffraction patterns for transition metal oxides.

References Books

1. Principles of Instrumental Analysis–Holler, Skoog&Crouch 6th edition
2. Instrumental Methods of Analysis–Willard, Merritt, Dean & Settle.
3. Principles of Instrumental Analysis–Skoog, F.J.Holler&J.A.Nieman
4. Instrumental Methods of Chemical Analysis–Galen W. Ewing.
5. Analytical Chemistry – Gary D. Christian, 6 th edition
6. Handbook of Instrumental Techniques for Analytical Chemistry –Frank Settle,Editor.
7. Introduction to Instrumental Analysis-R.D. Braun, McGraw Hill.
8. Fundamental of Analytical Chemistry,-D.A. Skoog, D.M.West and F.J. Holler.
9. Instrumental methods of analysis – Chatwal and Anand.
10. Instrumental methods of analysis – B. K. Sharma.
11. Wilson and Wilson Compressive Analytical Chemistry. Ed. G. Svehla, A series of volumes.

Semester : III

Course Name: Polymer ,Paint and Pigment Analysis **Course Code:** ACHTE-607

Course type : DSE-11 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1. Students will comprehend the history and classification of polymers, along with their production methods.
2. They will analyze polymers chemically using techniques such as X-ray diffraction and thermal analysis, and assess physical properties including mechanical strength, impact resistance, and thermal behavior.
3. They will evaluate thermal, optical, electrical, and chemical properties, examining factors like flammability, transparency, and resistance to solvents.
4. Molecular weight and size measurement techniques will be explored, including osmometry and light scattering methods.
5. Students will also learn about the analysis of paints and pigments, including determination of components, pigment classification, and identification of binders.
6. These skills prepare students for roles in polymer research, development, and quality control.

Unit-I :Polymer Analysis **10Hrs**

Brief history to polymer, classification of polymer,how polymer are made. Analysis and testing of polymer. Chemical analysis of polymer: X-ray diffraction analysis, thermal analysis, TGA, DTA. Physical testing of polymers: Mechanical properties, Fatigue testing, impact testing, tear resistance,hardness, abrasion resistance. Thermal properties: Softing temperature, flammability. Optical properties: Transmittance, color, gloss, haze and transparency. Electric properties: Dielectric constant and loss factor, resistively, dielectric strength, electronic properties. Chemical properties: Resistance to solvents, vapour permeability, weathering.

Unit-II :Polymer analysis-molecular weight and size measurement **10Hrs**

Kinetics of polymerization ,Molecular mass, Number and mass average molecular mass, Molecular mass determination by osmometry, Viscometry, light scattering and Sedimentation methods ,End group analysis, colligative properties measurements, solution viscosity and molecular size, Numericals

Unit-III : Analysis of Paints and Pigments **10Hrs**

Introduction, Determination of non-volatile and volatile components, Flash point, Separation of pigments and thinner of solvent type coating, Pigment type, Identification of binders , Analysis of Vehicle and drying oils,

Analysis of pigments: Classification of organic and inorganic pigments, White tinted pigments.

References Books

1. Text Book of polymer science By F.W.Billmeyer, New York: Wiley
2. Physical polymer science by L.H .Sperlingwiley –Interscience New York
3. Fundamentals of polymer science & Engineering By A Kumar &S.K.Gupta,Tatamcgraw Hill
4. Introduction to polymer science, V.R.Gowarnikar, N.V. Vishwanathan& J.
5. Industrial Chemistry, B. K. Sharma, Goel publishing House Meerut.
6. Kent, Rieg's Industrial chemistry, Rain hold.
7. Handbook of Instrumental Techniques for analytical chemistry. Frank Settle, editor
8. Polymer science by VasantGovarikar, Wiley Earstewen. New York.
9. Principle of polymer science, Behadhar and Sastri, Narosa Publishing house.

Semester : III

Course Name: Petrochemical Analysis **Course Code:** ACHTE-608

Course type : DSE-12 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1. Students will understand the concept of fuels, including calorific value determination and modern fuel classifications.
2. They will explore solid fuels, such as coal, examining their formation, properties, and classification.
3. Students will learn about petroleum, including its occurrence, mining, and distillation processes.
4. They will analyze petroleum products, determining properties like flash point and aniline point, as well as octane and cetane numbers.
5. Additionally, students will study gas fuels, including natural gases and coal gas, analyzing their calorific values.
6. Petrochemical analysis techniques for naphtha and catalyst characterization for cracking processes will also be covered.
7. These skills prepare students for roles in the petrochemical industry and fuel analysis.

Unit-I :Fuels **10Hrs**

Introduction, calorific value. Determination of calorific value. Modern concept of fuels. Classifications of fuels, criterion of selection of fuels, properties of fuels. Method of processing. Solids fuels, Natural solid fuels, Artificial solid fuels, Industrial solids fuels .Formation of coal properties of coal, Classification of coal, coking and non-coking coals. pulverised coal. Role of sulphur and ash in coal, approximate analysis, Ultimate analysis, Numerical.

Unit-II :Petroleum **10Hrs**

Occurrence, mining of petroleum. Prospecting colour and consistency. Origin composition, classification,terms related to petroleum. Distillation of crude petroleum. Treatment of the residual liquid, Determination of flash point. Determination of aniline point, Knocking and Anti-knocking compounds. Octane number,Cetane number, Numericals.

Unit-III : Gases Fuels **10Hrs**

Analysis of natural gases, liquefied petroleum gas, coal gas, water gas, producer gas, gober gas, blast furnace gas and their calorific value determination. Petrochemical analysis: Analysis of naphtha and their feed stocks, characterization of the catalyst used for cracking.

References Books:

1. Industrial Chemistry, B. K. Sharma, Goel publishing House Meerut.
2. Handbook of Instrumental Techniques for analytical chemistry. Frank Settle, editor

Semester : III

Course Name: Research project-1 **Course Code:**ACHRP-649

Course type : Research project **8 Hrs/ Week**

Total contact hours : 120 Hrs **Theory Credit:** 4 **Marks** : 100

Learning outcomes:

On completion of this course, the students will be able:

M. Sc. Analytical Chemistry Semester IV Course Structure

Sr. No.	Course Code	Course Name	Teaching (Hr/W)	Credits Assigned	Conti. Inter. Assmen.	End. Sem Exam	Total Marks
Course Type :DSC-Major Mandatory:							
1.	ACHTC-650	Pharmaceutical and Forensic Analysis	4	4	40	60	100
2.	ACHTC-651	Environmental Analysis and Monitoring	4	4	40	60	100
3.	ACHTC-652	Analytical Method Development and Validation	2	2	20	30	50
4.	ACHLC-653	Analytical Chemistry Laboratory Course	4	2	20	30	50
Course Type : DSE (Choose any two from pool of the course)							
5.	ACHTE-654	Food Analysis	2	2	20	30	50
6.	ACHTE-655	Analysis of Oils, Soaps, Fertilizers, and Pesticides	2	2	20	30	50
7.	ACHTE-656	Analysis of Ores, Alloys & Cosmetics	2	2	20	30	50
8.	ACHTE -657	Microbial and Clinical Analysis	2	2	20	30	50
Course type :Research Project:							
9.	ACHRP -699	Research Project-2	12	6	60	90	150
		Total	**32**	**22**	**220**	**330**	**550**

Course code Nomenclature :

DSC-Discipline Specific Core **DSE**- Discipline Specific Elective, **T**-Theory, **L**-Laboratory course, **ACHTC**- Analytical Chemistry Theory Core , **ACHLC**- Analytical Chemistry Laboratory Core , **ACHTE**- Analytical Chemistry Theory Elective , **ACHRP**-Analytical Chemistry Research Project

Semester : IV

Course Name: Pharmaceutical, and Forensic Analysis	**Course Code:**ACHTC-650
Course type : DSC-20	**4 Hrs/ Week**
Total contact hours : 60 Hrs **Theory Credit:** 4	**Marks** : 100

Learning outcomes:

On completion of this course, the students will be able:

1. Students will gain an understanding of pharmaceutical analysis, covering drug classification, dosage forms, formulation sources, and impurities.
2. They will learn about pharmaceutical legislation, including drug acts, standards, and intellectual property rights.
3. Assay methods for various drug classes will be explored.
4. In forensic analysis, students will study toxicology, including poison classification and extraction methods for narcotics, stimulants, depressants, and hallucinogens.
5. They will analyze biological stains and materials, and investigate explosives, including their classification, analysis methods, and thermochemistry.
6. These skills prepare students for roles in pharmaceutical quality control and forensic investigation, ensuring product safety and legality.

Unit-I :Pharmaceutical Analysis-I **12Hrs**

General idea regarding pharmaceutical industry, Definition and classification of drugs, types of dosage forms. Introduction to pharmaceutical formulations, Sources of impurities in pharmaceutical chemicals, raw materials & Products, Shelf life of pharmaceutical product and its determination, stability studies Standardization of finished products& their characteristics, Limit tests of As, Hg, Pb, Fe, Chlorides, and sulphates. Solubility tests, dissolution test, disintegration tests.

Unit-II :Pharmaceutical legislation **12Hrs**

Introduction to drug acts, drug rules, FDA ISI, Agmark and other standard for pharmaceuticals& cosmetics particularly w.r.t. the testing of drugs, and raw material concerned. Pharmaceutical standards IP/BP/USP//EP. Cosmetic standards, Documentation, Record Keeping. Contents of labels, Types of packaging materials,

Intellectual property rights: Introduction, role of patents in the pharmaceutical industry, recent changes, some case studies.

Unit-III :Pharmaceutical Analysis-II **12Hrs**

Assay of main classes of drugs as per IP with reference to Introduction, Type, Properties, Mode of action and Methods of Analysis.

Unit-IV :Forensic Analysis **12Hrs**

Introduction, Special features of forensic analysis, Sampling, Sample storage, Sample dissolution. Toxicology: Classification of poisons and poisoning, Lethal Dose, Significance of LD50 and LC50. Extraction methods in toxicology: Isolation, Identification and determinations of: Narcotics: Heroin, Morphine, Codeine. Stimulants: Caffeine, Cocaine, Amphetamines. Despressant: BenzodiazepinesDiazepam, Oxazepam, Nitrazepam. Barbiturates- Phenobarbitone, Amylobarbitone, Pentobarbitone, Thiopentone. Hallucinogens: LSC and Cannabis. Analysis of biological stains and materials including blood, semen and saliva (qualitative and quantitative). Viscera, Stomach wash, Vomit and post mortem blood for poisons like cyanides, As, Hg, Insecticides and Pesticides.

Unit- V :Explosive: **12Hrs**

Explosion, Detonation, Classification of explosives, Propellant, Fulminates, Detonators, Blasting-cap, Thermochemistry, Hygroscopicity of explosives, Moisture by KarlFisher titration, Isolation from debris, Qualitative test, Cation & anion analysis by capillary electrophoresis, EDXRF, Analysis by TLC, HPLC, IR, GC-TEA method.

References Books

1. Isolation and Identification of drug-n E. G. Clarke vol.- I
2. Laboratory procedure manual-Forensic Toxicology- Directorate of forensic science, MHA Govt. of India.
3. Analytical Biochemistry, D. J. Holme and H.Peck, Longman
4. BioanalyticalChemitry,S.R. Mikkelsen and E. Corton, John Wiley and Sons.
5. Immunoassay – a practical guide Eds,D.W.Chan and M.T.Perlstein, Academic Press.
6. Hawk's Physiological Chemistry, McGraw Hill.
7. Pharmaceutical Analysis Edited by David C. Lee, and Michael Webb.
8. Biochemical methods, S. Sadasivam, A .Manickam.
9. Standard Methods of Biochemical Analysis, S.R. Thimmaiah.

Semester : IV

Course Name: Environmental Analysis and Monitoring **Course Code:**ACHTC-651

Course type : DSC-21 **4 Hrs/ Week**

Total contact hours : 60 Hrs **Theory Credit: 4** **Marks** : 100

Learning outcomes:

On completion of this course, the students will be able:

1. Students will understand air pollution, covering pollutants like CO, NOx, hydrocarbons, and particulates, along with monitoring techniques and control measures.
2. In water pollution, they will study pollutants, water quality standards, and monitoring methods for oxygen-demanding wastes and trace metals.
3. Chemical toxicology topics include the impact of toxic chemicals on enzymes and biochemical effects of various pollutants.
4. Soil analysis techniques for determining nutrient content will be explored.
5. Industrial pollution sources and management strategies will be examined, including noise pollution.
6. Additionally, students will learn about Green Analytical Chemistry principles, focusing on sustainable development and eco-friendly analytical methods for sample treatment and instrumentation.
7. These skills prepare students for roles in environmental monitoring and sustainability efforts.

Unit-I :Air Pollution **12Hrs**

General considerations: polluted air, Types of pollution and units of measurements. Air quality standards, Sampling, Monitoring, Analysis of CO, Sources and sinks of CO pollution, Effects of CO on plants and humans, Control of CO pollution, Analysis of oxides of nitrogen, NOx sources and sinks of NOx pollution, Control of NOx pollution, Hydrocarbons and photochemical smog and its control, Analysis of hydrocarbon in exhaust gasses, Petrol and air, Sulphur di oxide sources, Analysis and control, Acid rain particulates and their effects on human and climate, Control of particulates.

Unit-II :Water Pollution **12Hrs**

Aquatic environment, Water pollutants, Sampling of water and its preservation Trace metals in water, Chemical speciation with special reference to Copper, Lead, Mercury and Arsenic. Water quality standards Water quality parameters.

Oxygen Demanding Wastes: Dissolved oxygen, Biological oxygen demand, Monitoring techniques and methodology with special reference to ammonia, Nitrates, Nitrites, Fluorides, Cyanides, Total hardness, Lead, Cadmium and Mercury. Detection and control of Detergents, oils, Pesticides, Sewage treatment.

Unit-III : Chemical toxicology and Soil Analysis: **12Hrs**

Chemical toxicology: Toxic chemicals in environment, Impact of toxic chemicals on enzymes, Biochemical effects of Arsenic, Cadmium, Lead, Mercury, Carbon monoxide, Sulphur dioxide, Pesticides and Carcinogens.

Soil analysis: Sampling of soil, Determination of water holding capacity, Determination of total nitrogen, Ammonia and nitrates. Determination of Na,Mg, Ca, K, phosphate and Sulphur in soil.

Unit-IV :Industrial pollution: **12Hrs**

Pollution due to cement industry, Distillery, Pharmaceutical (Drug) industries, Sugar industry, Paper and pulp industries, Thermal power plants. Nuclear power plants, Metallurgical industries, Polymer industries. Recycle, reuse, recovery, disposal, and management of solid industrial waste. Noise pollution- Introduction, sources, measurement of noise level, differences between sound and noise pollution, reverberating of sound, effect and control.

Unit-V :Green Analytical Chemistry: **12Hrs**

Principle and concepts of Green Chemistry: Sustainable development and green chemistry. Green analytical chemistry: Concept and trends, 'Greening'

Sample treatment: Reduced and solvent-free sample preparation methodologies, alternative solvents, energy saving procedures of analysis.

Green instrument analysis: Assessment of analytical methods for 'Greenness', greening flow injection analysis, chemical sensors, liquid green chromatography.

References Books

1. A. K. De, Environmental Chemistry, Wiley Eastern Ltd. New Delhi.
2. S. L. Chopra and J. S. kanwar, Analytical, Agricultural Chemistry, Kalyani Publishers.
3. R. K. Trivedy and P. K. God, Chemical and biological methods for water pollution studies, Environmental publications, co. New Delhi.
4. L. A. Richards, Diagnosis and improvement of saline and alkali soils. Oxford IBH publications co. New Delhi.
5. S. M. Khopkar, Environmental chemistry, Environmental pollution analysis Environmental chemistry-B.K. Sharma.Goel publishing house Meerut.
6. M. S. Creos and Morr, Environmental chemical analysis, American publications.
7. M. Sitting, Resources, Recovery and Recycling, Handbook of industrial waste.
8. Standard methods of water and waste water analysis, American public health association Washington D. C.
9. R. Gopalan and AmruthaAnand, "Environmental chemistry laboratory manual Emerald Publication.
10. Standards for water for drinking and other purposes, Beaurau of Indian Standards India.
11. Guideline for drinking water quality recommendations of world health organization, Geneva.
12. B. K. Sharma and H. Kaur, Environmental Chemistry, Goel publishing house Meerut.
13. Thomas G. Spiro and Willian M. Stigliani, Chemistry of environment.
14. New Trends in green Chemistry, V.K.Ahluwalia and M. Kidwai, Anamaya Publishers New Delhi, (2004).

Semester : IV

Course Name: Analytical Method Development and Validation

Course Code:ACHTC-652

Course type : DSC-22

2 Hrs/ Week

Total contact hours : 30 Hrs **Theory Credit:** 2

Marks : 50

Learning outcomes:

On completion of this course, the students will be able:

1. Students will grasp assay validation principles and inter-laboratory transfer methods.
2. They will learn statistical analysis techniques and validation parameters such as accuracy, precision, calibration, selectivity, and limits of detection and quantification.
3. Special emphasis will be placed on understanding linear and non-linear response functions, internal standards, and analyse the stability in sample matrices.
4. Students will gain insights into world-wide regulations governing method validation.
5. Additionally, they will explore specific applications like dissolution studies, focusing on apparatus, sampling, calibration, and regulatory compliance.
6. These skills equip students to develop and validate analytical methods with precision, ensuring reliability and compliance with regulatory standards.

Unit-I :Assay Validation and Inter Laboratory Transfer: **10Hrs**

Introduction, fundamental definitions, Essential principles of method transfer, method validation report, the inter-laboratory qualification (ILQ) process

Unit-II :Statistical Analysis and analytical Figure of Merit validation parameters: **10Hrs**

Accuracy, precision, calibration, (linear response functions (linear regression-errors in slope and the intercept, error in the estimate of concentration, standard additions), non-linear response functions and weighted regression analysis, internal standards), selectivity and specificity (chromatographic methods), limits of detections (spectrophotometric methods, chromatographic methods and related techniques, receptor binding assay), limit of quantification, sensitivity, ruggedness and robustness, analyte stability in the sample matrix, how to reduce systematic errors, mean and standard deviation, reliability of results, confidence interval, comparison of results, comparison of two means of two samples,

experimental design.

Unit-III : Overview of World Wide Regulations **10Hrs**

Specific methods and Applications: Dissolution Studies, Introduction, Dissolution test, Apparatus-USP type –I and II, Sampling and analytical instrumentation, Single point test vs. Dissolution profile, Calibration, regulatory guidelines, analytical validation, linearity, accuracy, precision, specificity.

References Books

1. Development and validation of Analytical Methods, Progress Pharmaceutical and Biomedical Analysis, Vol-3, Edited by Chitofer M. Riley and Tomas W. Rosanske (Elvier).
2. Vogel's Textbook of quantitative Chemical Analysis, sixth Ed., Mendham, Denney, Barnes, Thomas, Pub: Pearson Education.
3. Handbook of modern pharmaceutical analysis, edited by Satinder Ahuja and Stephen Scypinski, Academic Press, Separation science Series, Vol-3.
4. HPLC method Development for pharmaceuticals, Edited by Satinder Ahuja and Henrik Rasmussen, Academic Press, Separation science Series, Vol-8.
5. Practical HPLC method Development, Snyder, Kirkiand, Glajch, Wiley India Pvt. Ltd.

Semester : IV

Course Name: Analytical Chemistry Laboratory Course **Course Code:**ACHLC-653

Course type : DSC-23 **4 Hrs/ Week**

Total contact hours : 60 Hrs **Lab. Work Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1. Students will develop practical skills in various analytical techniques.
2. They will measure hydrogen peroxide strength, pesticide residues by TLC, active chlorine in bleaching powder, magnesium in talcum powder, and alcohol content.
3. These skills prepare students for roles in environmental, pharmaceutical, and food chemistry sectors.
4. They will determine mixture composition by refractometry, characterize samples by IR spectroscopy.
5. Students will determine lactose by HPLC, analyze binary mixtures, and determine Hammett constants by pH metrics.

List of Experiments:

1) Moisture content in pharmaceutical/food sample by Karl-fisher titration method.
2) Estimation of pesticide residue by TLC method.
3) Estimation of active chlorine in the given sample of bleaching powder.
4) Estimation of mg from given sample of talcum powder.
5) Estimation of alcohol in the given sample by diffusion oxidation method
6) Determine the percentage composition of the mixture by refractometer.
7) Characterization of unknown sample by IR Spectroscopy.
8) Determine the lactose sugar by HPLC method.
9) Analysis of binary mixture of simple organic compound by HPLC method.
10) Determine the Hammett constant of substituted benzoic acid by pH metric method.

References Books

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by A. I. Vogels.
2. Experiments in chemistry by D. V. Jahagirdar, Himalaya publication.
3. Practical Pharmaceutical Chemistry, 4th Ed. part-2, Beckette, Stenlake.
4. Indian Pharmacopeia volume –I, II III.

Semester : IV

Course Name: Food Analysis **Course Code:**ACHEC-654

Course type : DSE-13 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1) Students will comprehend the nutrient value, physical characteristics, and chemical constituents of food, along with proximate composition and relevant legislation.

2) They will explore food processing, preservation, contamination, spoilage, safety considerations, and adulteration types and control methods.

3) Analytical techniques for food preservatives, emulsifiers, stabilizers, and thickeners will be studied, along with standard composition and analysis of various foods like milk, tea, cereals, and beverages.

4) Students will also learn about the analysis of water and fat-soluble vitamins, including microbiological techniques, and understand human nutrition aspects such as biological values, enzyme estimation, and macronutrient analysis.

5) These skills prepare students for roles in food quality control and nutrition assessment.

Unit-I :General concepts of food analysis: **10Hrs**

Nutrient value of food. Physical characteristics & chemical constituents Proximate composition of food Legislation related to food and recent amendments, Standards and public health

a) General idea regarding food processing and preservation

b) Food contamination and spoilage

c) Food safety considerations.

d) Adulteration-Introduction, Types, Tests for adulterants, control

Unit-II :Analysis of food: **10Hrs**

a). Study of followings with their estimation methods : Food preservatives, Foodemulsifiers,Food stabilizers, Food thickener,

b). Introduction, Standard composition and Analysis of the following foods: Milk and milk products, Tea, Coffee, Cereals & Flour, Honey, Soft

drinks & Alcoholic beverages.

Unit-III : Analysis of Vitamins: **10Hrs**

Analytical techniques of determination of water and fat soluble vitamins including microbiological techniques. Human nutrition: Biological values and estimation of enzymes, Carbohydrates, essential amino acids, proteins and lipids.

References Books

1. Chemical analysis of food By Pearson.
2. Introductions to food science and technology, series by G.F.Stewart and M.A.Amerine Academic process.
3. Applied chemistry .AText book for Engineers and technologists by H.D.Gesser.
4. Food analysis by Nielson.
5. Food additives by S.N.Mahindry (APH) publication.
6. Jacob (M.B) chemical Analysis of food and food products (Van Nostrand co. New York).
7. Analytical chemistry of foods (C.S.James) Blackie Academic and professional.
8. Food Analysis principles and techniques D. W. Gruenwedel, J. R. Whitaker,
   Mercel-Dekker.
9. Food analysis Theory and practice Y. Pomeranz and C. E. Meloan, Chapman and Hill.
10. Food Analysis ,2nd edition S.S Nelsen, Aspen publishers
11. Food analysis, A. G. Woodman, McGraw Hill

Semester : IV

Course Name: Analysis of Oils, Soaps, Fertilizers, and Pesticides **Course Code:** ACHTE-655

Course type : DSE-14 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1) Students will gain proficiency in analyzing oils and fats, including determining various parameters like softening point, iodine value, and saponification value.

2) They will learn about soap analysis, including methods for assessing saponification and unsaponifiable matter.

3) Detergent analysis will cover active ingredient determination and estimation of critical micelle concentration.

4) In fertilizer analysis, students will understand fertilizer classification and assess NPK values and chemical composition.

5) Additionally, they will study pesticide legislation, chemical structures, application dosages, and specific pesticide analysis techniques.

6) These skills prepare students for roles in quality control and regulation compliance in industries related to oils, fats, detergents, fertilizers, and pesticides.

Unit-I :Analysis of Oils, Fats Soap and Detergents **10Hrs**

Introduction to natural oils and fats, Analysis of oils and fats, Softing point, Congent point, Titer point, Cloud point, Iodine, Saponification, acid, Hydroxyl, R-M and polenske values, Elaiden test. Introduction to soaps, Analysis of soaps, for saponification, Unsaponifiable and unsaponified matter in soaps, Estimation of free alkali and phenol in soap, Classification of detergents (in Brief), Analysis of active ingredients from detergents (methylene blue and hyamine 1622 method), Estimation of CMC, Chlorides, Total phosphates

Unit-II :Analysis of fertilizers **10Hrs**

Classification of fertilizer, NPK value, Chemical composition of superphosphate, Lime and Potash fertilizer, Analysis of commercially available fertilizers for N, P & K

Unit-III : Analysis of pesticides **10Hrs**

Legislation and recent amendments with respect to pesticides materials. Names of pesticides and their chemical structures. , Application dosage of different pesticides. , Analysis of specific pesticides.

References Books

1. Chemical analysis of food By Pearson.
2. Introductions to food science and technology, series by G.F.Stewart and M.A.Amerine Academic process.
3. Applied chemistry .AText book for Engineers and technologists by H.D.Gesser.
4. Food analysis by Nielson.
5. Food additives by S.N.Mahindry (APH) publication
6. Jacob (M.B) chemical Analysis of food and food products (Van Nostrand co. New York)
7. Analytical chemistry of foods (C.S.James) Blackie Academic and professional
8. Food Analysis principles and techniques D.W.Gruenwedel, J.R.Whitaker, MercelDekker
9. Food analysis Theroy and practice Y.pomeranz and C.E.Meloan,Chapman and Hill
10. Food Analysis ,2nd edition S.S Nelsen, Aspen publishers
11. Food analysis, A. G. Woodman, McGraw Hill

Semester : IV

Course Name: Analysis of Ores, Alloys & Cosmetics **Course Code:**ACHTE-656

Course type : DSE-15 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1) Students will learn to analyze various ores such as dolomite, bauxite, and zinc blend for their major constituents using standard methods.
2) They will also study the composition, properties, and analysis of alloys like brass, bronze, and stainless steel.
3) Analysis of building materials including cement and glass will be covered, focusing on major components and types.
4) In cosmetic analysis, students will evaluate raw materials, additives, and legislation related to cosmetics, and analyze physical and chemical constituents of skincare products, creams, lipsticks, and lotions.
5) Additionally, they will explore wood, pulp, and paper analysis, including methods for determining cellulose, moisture, and other key parameters.

Unit-I :Analysis of ores and Alloys: **10Hrs**

Analysis of ores: Composition and analysis of Dolomite, Bauxite, Ilminite, Zinc blend, hematite, pyrolusiteand calcite for their major constituents using one of the standard methods of analysis.

Analysis of alloys: Composition, Properties, uses and analysis of : Brass, Bronze Solder, Stainless Steel, Monel-metal, gun-metal, Silver coin for their major constituents using one of the standard methods of analysis

Analysis of Cement and building materials: Types of cement, Sampling, Analysis of- Silicon dioxide, Aluminum oxides, Ferric oxides, Calcium oxide, Magnesium oxide, Sodium and potassium oxide. Analysis of Glass: Types of glasses, Determination of lead and lead glass.

Unit-II :Cosmetic Analysis: **10Hrs**

Introduction to cosmetics. b) Evaluation of cosmetic materials-raw materials, additives, colours, perfumes. c) Legislation and recent amendments with respect to cosmetic materials. d) Analysis of Physical and chemical constituents of : Skin powder , Creams , Lipsticks , Lotions

Unit-III : Analysis of wood, pulp and paper: **10Hrs**

Wood: sampling, determination of methoxy group in wood. A brief idea of analysis of moisture in wood chips and saw dust by toluene methods, cellulose in wood. Pulp: Introduction, sampling, determination of cellulose in pulp, permanganate number of pulp, copper number of pulp. Paper: Introduction,sampling,determination of reducible Sulphur in paper and paper boards, moisture in paper, ash in paper, starch in paper, cellulose in paper, copper number of paper, acid-soluble iron in paper

References Books

1. Hillenbrand Lhundel, Bright and Hoffman, Applied inorganic analysis, John Wiley.
2. P. G. Jeffery and. J. Hatchinsion, Chemical methods of rock analysis.
3. Snell and Biffen, Commercial methods of analysis.
4. P. G. Jeffery, Chemical methods of rock analysis, pergamon.
5. Rieche, Outline of industrial organic chemistry, Butter worth.
6. Kent, Rieg's Industrial chemistry, Rain hold
7. F. J. Welcher Standard methods of chemical analysis, a series of volume Robert and Krigeger Publishing Company.
8. Metallurgical analysis by S. K. Jain and K. K. Jain.

Semester : IV

Course Name: Microbial and Clinical Analysis **Course Code:**ACHTE-657

Course type : DSE-16 **2 Hrs/ Week**

Total contact hours : 30 Hrs **Theory Credit:** 2 **Marks** : 50

Learning outcomes:

On completion of this course, the students will be able:

1) In Microbial Analysis, students will grasp microbiology fundamentals, including microorganism types and growth factors, and learn sterilization and disinfection techniques.
2) They will conduct sterility tests and learn about microbial isolation methods.
3) In Clinical Analysis, they will understand body fluid composition, collection, and preservation techniques.
4) They'll analyze constituents like pH, glucose, and urea in blood, and uric acid, albumin, and creatinine in serum.
5) Immunological methods for urine analysis will be covered.
6) Additionally, students will determine vitamin levels in body fluids, learning about vitamins' functions, deficiencies, and analytical methods, such as spectrophotometry and fluorometry.

Unit-I :Microbial Analysis **10Hrs**

a) Introduction to Microbiology, Application to pharmacy, Study of different types of micro-organisms (Bacteria, Viruses, and Fungi) w.r.t. morphology, cell characteristics, habits, nutrition, reproduction, and cultivation b) Isolation of important groups of bacteria by- Total viable count, Standard plate count. c) Microbial growth and factors affecting it: Temperature, pH, Heavy metals (media), Relative humidity, Molecular oxygen and Osmotic pressure. d) Sterilization-Principle, Methods used in general and as applied to Pharmaceutical products. e) Disinfectants-Classification, mode of action, efficiency. Antiseptic techniques: Sterility tests for typical Pharmaceutical products

Unit-II :Clinical Analysis **10Hrs**

Introduction: Body fluids: Composition, Collection and Preservation of body fluids and detection of abnormal levels of certain constituents leading

to diagnosis of diseases and disorders. Analysis of constituents of physiological fluids, 1.Blood -PH, Glucose, Urea. 2.Serum-uric acid, total protein, albumin, globulin& A/G ratio, barbiturates, alkaline phosphatase, acid phosphatase, bilurubin, cholesterol, amylase, creatinine carbohydrates.. Urine- Immunological methods: General process of immune response, Antibody-Antigen ratio, Precipitation reactions, Enzyme linked immunosorbent assays ELISA

Unit-III : Determination of vitamins in body fluid **10Hrs**

Classification of vitamins with example, Each vitamin must be explained with respect of functions, deficiency diseases, daily requirement, and analytical method i) Retinol (determination of retinol and serum carotene in serum using TFA), Vit D3 (cholecalciferol), Vitamin E (Tocopherols, Determination of serum tocopherol by spectrophotometry by dipyridyl method), Vitamin B1 (thiamine determination by flurometry), Vitamin B2 (riboflavin, Photofluorometric method), Vitamin B6 (Pyidoxine, Fluorometric determination of Xanthuric acid), Nicotinic acid and Niacin: determination by fluorometry, Ascorbic acid (vitamin –c) Volumetric method using 2,6 dichlorophenol method, colorimetric determination of leucocyte ascorbate.

References Books

1. General Microbiology- R. V. Stainer 6th edition
2. Principle of microbiology- A. J. Salle
3. Microbiology- Pleczar
4. An Introduction to Practical Biochemistry, David Plummer.
5. Biochemical methods, S. Sadasivam, A .Manickam
6. Standard Methods of Biochemical Analysis, S.R. Thimmaiah

Semester : IV

Course Name: Research project-2 **Course Code:**ACHRP-699

Course type : Research project **12 Hrs/ Week**

Total contact hours : 180Hrs **Theory Credit:** 6 **Marks** : 150

Learning outcomes:

On completion of this course, the students will be able: