

M.Sc. CHEMISTRY

**ANALYTICAL CHEMISTRY SPECIALISATION
SYLLABUS OF III & IV SEMESTERS
*REVISED AS PER NEW (CB) SYLLABUS***

**FOR STUDENTS ADMITTED FROM THE YEAR
2023-24 ONWARDS**



M.Sc. CHEMISTRY
ANALYTICAL CHEMISTRY SPECIALISATION

Syllabus for III and IV Semesters

[Under Restructured CBCS Scheme]

(for the batches admitted in academic year 2023-24 onwards under CBCS pattern)

Grand total marks and credits (all 4 semesters) 2400 marks – 80 credits

(Approved in the P.G. BOS meeting held on 27-01-2024)

Semester - III (Analytical Chemistry)

	Instruction Hrs/week	Internal assessment	Semester exam	Total marks	Credits
CH(AC)301T (Core)	3	50 marks	50 marks	100	3
CH(AC)302T (Core)	3	50 marks	50 marks	100	3
CH(AC)303T (Elective)	3	50 marks	50 marks	100	3
CH(AC)304T (Elective)	3	50 marks	50 marks	100	3
CH351P (AC LAB 1)	4		50 marks	50	2
CH352P (AC LAB 2)	4		50 marks	50	2
CH353P (AC LAB 3)	2		25 marks	25	1
CH354P (AC LAB 4)	2		25 marks	25	1
Seminar	2		50 Marks	50	2
Total	26			600	20

Semester - IV (Analytical Chemistry)

	Instruction Hrs/week	Internal assessment	Semester exam	Total marks	Credits
CH(AC)401T (Core)	3	50 marks	50 marks	100	3
CH(AC)402T (Core)	3	50 marks	50 marks	100	3
CH(AC)403T (Elective)	3	50 marks	50 marks	100	3
CH451P (AC LAB1)	4		50 marks	50	2
CH452P (AC LAB2)	4		50 marks	50	2
CH453P (AC LAB3)	2		25 marks	25	1
CH454P (Project)	12	50 marks	125 marks	175	6
Total	31			600	20

Grand total marks and credits (all 4 semesters) 2400 marks - 80 credits

N. S. R. Reddy

M.Sc. SEMESTER III ANALYTICAL CHEMISTRY SPECIALISATION
(for the batches admitted in academic year 2023-24 & later under CBCS pattern)

PAPER I CH (AC) 301T (CORE): ANALYTICAL TECHNIQUES

AC-01: Sampling & Data handling

AC-02: Thermal & Radiochemical methods of analysis

AC-03: Atomic Spectroscopy

PAPER II CH (AC) 302T (CORE): SPECTROSCOPIC METHODS OF ANALYSIS-I

AC-04: ¹³C and 2D NMR

AC-05: Electron Spin Resonance Spectroscopy

AC-06: Mossbauer and Nuclear Quadrupole Resonance Spectroscopy

PAPER III CH (AC) 303T (ELECTIVE III A): MISCELLANEOUS METHODS OF ANALYSIS

AC(CB1)-07: Surface Analysis Methods

AC(CB1)-08: Diffraction Methods, X-Ray Absorption and X-Ray Fluorescence

AC(CB1)-09: Micromeritics, Dissolution and disintegration

PAPER III CH (AC) 303T (ELECTIVE III B): CLASSICAL, ELECTROANALYTICAL AND SPECTROSCOPIC METHODS OF ANALYSIS

AC(CB1)-07: Titrimetric and Gravimetric analysis.

AC(CB1)-08: Electroanalytical Methods

AC(CB1)-09: Optical Methods

PAPER IV CH (AC) 304T (ELECTIVE IV A): APPLIED ANALYSIS

AC(CB2)-10: Industrial Analysis

AC(CB2)-11: Food and Agricultural analysis

AC(CB2)-12: Analysis of Air and Water Pollutants and Sewage water treatment

PAPER-IV CH(IC) 304T (ELECTIVE IV B): NUCLEAR CHEMISTRY, ZEOLITES & SOLID STATE CHEMISTRY

AC(CB2)-10: Nuclear Chemistry

AC(CB2)-11: Zeolites and Molecular Sieves

AC(CB2)-12: Solid State Chemistry

LABORATORY COURSE

Paper V CH (AC) 351P: Titrimetry, Solvent extraction and Chromatography

Paper VI CH (AC) 352P: Spectrophotometry –I

Paper VII CH(AC) 353P: Water analysis

Paper VIII CH(AC) 354P: Spectrophotometry II

SEMINAR

N. Kiran

M. H. M. M. M.

K. R. Reddy



M.Sc. SEMESTER IV
ANALYTICAL CHEMISTRY SPECIALISATION
(for the batches admitted in academic year 2023-24 & later under CBCS pattern)

PAPER I CH (AC) 401T (CORE): SPECTROSCOPIC METHODS OF ANALYSIS-II

AC-13: Electronic spectroscopy,

AC-14: IR & Raman spectroscopy

AC-15: Fluorimetry, Phosphorimetry, Nephelometry and Turbidimetry

PAPER II CH (AC) 402T (CORE): SEPARATION METHODS AND MASS SPECTROMETRY

AC-16: Solvent extractions & Chromatography-I

AC-17: Chromatography -II

AC-18: Advanced Mass spectrometry

PAPER III CH (AC) 403T (ELECTIVE IIIA): LABORATORY MANAGEMENT AND QUALITY ASSURANCE

AC(CB1)-19: Laboratory Automation and Management, LIMS and Computer aided Analysis

AC(CB1) -20: Quality Control and Quality Assurance

AC(CB1)-21: Quality Standards, Management and Accreditation

PAPER III CH(AC) 403T (ELECTIVE III B): APPLIED ANALYSIS AND GREEN ANALYTICAL CHEMISTRY

AC(CB1)-19: Enzyme catalysis- Analytical applications

AC(CB1)-20: Forensic Chemical Analysis

AC(CB1)-21: Green Analytical Chemistry

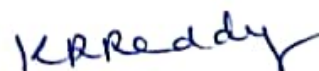
LABORATORY COURSE

Paper IV CH (AC) 451P: Electro analytical techniques - I

Paper V CH (AC) 452P: Evaluation of Physical Parameters of Tablets, Spectroscopic Techniques and problems

Paper VI CH (AC) 453P: Electro analytical techniques - II

PROJECT CH (AC) 454P



**M.Sc. ANALYTICAL CHEMISTRY SPECIALIZATION
SEMESTER-III**

PAPER I CH (AC) 301T (CORE) ANALYTICAL TECHNIQUES

AC – 01: Sampling & Data handling

AC – 02: Thermal & Radiochemical methods of analysis

AC – 03: Atomic Spectroscopy

AC – 01: Sampling & Data handling

15 Hrs

Classification of Analytical Methods. Types of samples, Preparation of sample for analysis, effect of sampling uncertainties, sample treatment, moisture in sample, decomposition of organic & inorganic compounds, procedure of sampling of solids, liquids and gases.

Errors and Evaluation:-Accuracy, precision, sensitivity, detection limits, significant figures, rounding off. Types of errors – determinate and indeterminate errors. Ways of expressing accuracy, absolute and relative errors. Significant figures and propagation of errors. Confidence limit, Test of significance – the F-test and T-test. The statistical Q-test for rejection of a result, statistics for small data sets. Linear least squares method. The correlation coefficient. Calculation for the above parameters.

AC – 02: Thermal and Radiochemical methods of Analysis

15 Hrs

Thermal methods of analysis: Thermogravimetry, Differential Thermal Analysis and Differential Scanning Calorimetry, instrumentation. Methodology of TG, DTA and DSC. Application of TG to study of oxalates and chromates. Determination of Glass transition, Heat capacity determination, Characterization of polymer blends. Problems based on decomposition path way and % composition. Evolved gas analysis.

Thermometric titrimetry – theory, instrumentation, applications.

Radiochemical methods of analysis: Radioactive tracer techniques and its applications, isotope dilution analysis, neutron activation analysis, radiometric titrations: principle, theory, applications and problems.

AC – 03: Atomic Spectroscopy

15 Hrs

Atomic Absorption Spectroscopy (AAS): Principles of AAS, Instrumentation – flame AAS and furnace AAS, resonance line sources, sensitivity and detection limits in AAS, interferences –chemical and spectral, evaluation methods in AAS and applications in qualitative and quantitative analysis.

Atomic Emission Spectroscopy (AES): Principle of AES, Instrumentation, Interferences, evaluation methods, Application in quantitative analysis.

Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES): Limitations of AES, Principles of plasma spectroscopy, plasma as an excitation source. Inductively coupled plasma source, ICP-AES – Instrumentation. Applications of ICP-AES. Comparison with AAS.

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SUGGESTED BOOKS

1. Principles of Instrumental Analysis - Skoog, Holler, Nieman, 5th ed., Harcourt College Publishers (1998).
2. Analytical Chemistry – Gary D. Christian, 6th ed., John Wiley and sons. Inc., New York (1994).
3. Instrumental methods of Analysis - Willard, Merit, Dean, 6th ed., CBS Publishers & distributors (1986).
4. Hand Book for Instrumental Techniques for Analytical Chemistry, Ed. Frank Settle, Prentice Hall, New Jersey, USA (1997).
5. Vogel's Text book of Quantitative Analysis – GJ Jeffery, J Bassett et al, 5th ed., Longmann, ELBS Publications (2000).
6. Principles and practice of Analytical Chemistry, F.W. Field & D'Kealey, 5th Ed. Blackwell Science (2000).
7. Quantitative Chemical Analysis, Daniel C. Harris, 6th Ed. WH Freeman & Co. New York (2003).
8. Analytical Chemistry An Introduction, Crouch, 7th Ed. Saunders College Publishing (2000).
9. Organic Analytical Chemistry theory and practice, Jag Mohan, Narosa Publications (2003).
10. Pharmaceutical analysis, Watson
11. Electronic Absorption Spectroscopy and related techniques, D.N. Satyanarayana, University Press (2001).

Analytical Chemistry

H. Chavaj
M. Vijaya
P. S. Reddy
M. R. Reddy

**PAPER II CH (AC) 302T (CORE):
SPECTROSCOPIC METHODS OF ANALYSIS I**

AC – 04: ^{13}C & 2D NMR Spectroscopy

AC – 05 : Electron Spin Resonance Spectroscopy

AC – 06 : Mossbauer and Nuclear Quadrupole Resonance Spectroscopy

AC – 04: ^{13}C & 2D NMR Spectroscopy

15 Hrs

^{13}C NMR spectroscopy: Introduction, Types of ^{13}C NMR spectra: undecoupled, proton decoupled and off-resonance decoupled spectra. ^{13}C chemical shifts, factors affecting the chemical shifts, chemical shifts of organic compounds. Calculation of chemical shifts of alkanes, alkenes and alkynes. Homonuclear (^{13}C , ^{13}C J) and heteronuclear (^{13}C , ^1H J and ^{13}C , ^2H J) coupling. Applications of ^{13}C -NMR spectroscopy: Structure determination, stereochemistry, reaction mechanisms and dynamic processes in organic molecules. ^{13}C NMR spectral editing techniques: principle and applications of APT, INEPT and DEPT methods.

2D-NMR spectroscopy: Principles of 2D NMR, Classification of 2D-experiments. Correlation spectroscopy (COSY) HOMOCOSY (1H-1H COSY), Hetero COSY (^1H , ^{13}C COSY, HMQC), long range ^1H , ^{13}C COSY (HMBC), Homonuclear and Heteronuclear 2D-J-resolved spectroscopy experiments and their applications.

AC – 05: Electron Spin Resonance Spectroscopy

15 Hrs

Principle; Selection Rules; Instrumentation; Application of ESR to the study of simple free radicals - methyl (CH_3^\cdot), amine (NH_2^\cdot), diphenylpicrylhydrazyl, cyclopentadienyl ($\text{C}_5\text{H}_5^\cdot$), hydroxy methyl ($\text{CH}_2\text{OH}^\cdot$) radicals; Zero-Field Splitting (ZFS) and Kramer's degeneracy; Effective Spin; ESR Spectra of d^1 - d^9 Transition metal complexes with examples; Calculation of g values with simple examples; Interpretation of g in cubic, axial and rhombohedral geometries; Intensities of g_{\parallel} and g_{\perp} peaks; Evidence for metal-Ligand bond covalency - Cu(II)-bis-salicylaldehyde, Cu(II)-diethyldithiophosphate, Vanadyl dithiophosphate, Cu(II)-tetraphenylporphyrin, Co(II)-phthalocyanine and $\text{K}_2[\text{IrCl}_6]$; Application of ESR in structure determination - $[(\text{NH}_3)_5\text{CoO}_2\text{Co}(\text{NH}_3)_5]^{5+}$; Calculation of 'g' and 'A' values from esr spectral data in i) MnF_6^{4-} , ii) CoF_6^{4-} , and CrF_6^{3-} . ESR spectra of dinuclear Cu (II) complexes.

AC – 06: Mossbauer and Nuclear Quadrupole Resonance Spectroscopy

15 Hrs

Mossbauer Spectroscopy: Principle; Experimental Considerations and Presentation of the Spectrum; Isomer Shifts; Quadrupole splitting and Magnetic hyperfine splitting; Selection Rules.

Applications:

Iron Compounds: Low-spin and High-spin Fe(II) and Fe(III) Complexes, π -bonding Effects in Iron complexes, Study of High-spin Low-spin Cross-over, Diamagnetic and Covalent Compounds, Structural aspects of Iron Carbonyls and Iron-Sulphur Proteins.

Tin Compounds: Tin Halides and Organotin Compounds.

Nuclear Quadrupole Resonance Spectroscopy: Principle, nuclear quadrupole resonance experiment, structural information from NQR spectra, Interpretation of nuclear quadrupole coupling constants.

SUGGESTED BOOKS

1. Nuclear Magnetic Resonance Basic principles, Atta-ur-Rahman, Springer-Verlog (2011)
2. Spectroscopy of organic compounds, P S Kalsi, 8th Edition, New Age International Publishers (2020)
3. Organic Spectroscopy, William Kemp, 3rd Edition, Visionias (2020)
4. Introduction to organic spectroscopy, Donald Pavia, 5th Edition, Cengage India Private Limited (2015)
5. Structural Methods in Inorganic Chemistry, E. A. V. Ebsworth, D. W. H. Rankin and S. Craddock, ELBS, Blackwell Scientific publications (1987).
6. Physical Methods in Chemistry, R. S. Drago, W.B. Saunders Co., (1977).
7. Physical Methods for Chemists, Russell S. Drago Second edition, Saunders College Publishing (1992).
8. Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NQR, D.N. Satyanarayana, Dreamtech press, Wiley (2022).
9. Magneto Chemistry, Dutta & Shyamal, Oxford Chemistry Primers, Vol 62 (1993).
10. Instrumental Methods of Chemical Analysis, Gurdeep R Chatwal, Sham K. Anand, Himalaya Publishing House, (2019)
11. Principles of Mossbauer spectroscopy, T. C. Gibb, Chapman and Hall, London, (1976).
12. Mossbauer Spectroscopy, N. N. Greenwood and T. C. Gibb, Chapman and Hall, London (1971).
13. Principles of Instrumental Analysis, Skoog, Holler and Nieman, Harcourt Asia PTE Ltd. (1998)
14. Hand book of Instrumental Techniques for Analytical Chemistry, Frank Settle, Prentice Hall (1997).
15. Physical Methods in Advanced Inorganic Chemistry, Hill and Day, Interscience publishers (1968).

**PAPER III CH (AC) 303T (ELECTIVE III A):
MISCELLANEOUS METHODS OF ANALYSIS**

AC(CB1)-07: Surface Analysis Methods

AC(CB1)-08: Diffraction Methods, X-Ray Absorption and X-Ray Fluorescence

AC(CB1)-09: Micromeritics, Dissolution and disintegration

AC(CB1)-07: Surface Analysis Methods

15 Hrs

Introduction, types of surface measurements.

Photon Probe Techniques: Photoelectron Spectroscopy: Principle and instrumentation, types of photoelectron spectroscopy – UPS & XPS. Binding energies, Koopman's theorem, Chemical shifts. Photoelectron spectra of simple molecules; N₂, O₂, and F₂. Vibrational structure of PES bands, potential energy curves, interpretation of vibrational spectral data for ionized (M⁺) species, prediction of nature of molecular orbitals. ESCA in qualitative analysis.

Electron Probe Techniques: Scanning electron microscopy (SEM) – Principle, Instrumentation, applications. Transmission Electron Microscopy (TEM) - Principle, Instrumentation, applications. Auger electron spectroscopy (AES) - Principle, Instrumentation, applications.

Ion Probe Techniques: Secondary ion mass spectrometry (SIMS) – Fundamental aspects of sputtering, Principle, Instrumentation (static & dynamic), applications

Scanning probe microscopy Techniques: Atomic Force Microscopy - Principle, Instrumentation, applications.

AC(CB1)-08: Diffraction Methods, X-Ray Absorption and X-Ray Fluorescence

15 Hrs

X – ray Diffraction: X –rays and their generation – choice of radiation ; Miller indices; Bragg's equation; Experimental methods – Powder and single crystal methods; Indexing the reflections; Systematic absences; Electron density studies by X – rays – Platinum phthalocyanine complex, Advantages and limitations of X – ray Diffraction.

Electron Diffraction by gases: Principle; Advantages; Radial distribution curves – Interpretation of results for PBrF₂S, PF₃S, PF₂HS; Limitations – HClO₄, Silylmonothioacetate and Germylmonothioacetate and HgCl₂ molecules.

Neutron Diffraction: Principle, Application in Hydrogen bonding studies, combined use of X –ray and Neutron diffraction studies, Advantages and limitations.

X-ray absorption method: Principle, radiographic non-dispersive x-ray Absorptimeters

X-ray fluorescence method: Instrumentation, qualitative and quantitative applications of XRF– advantages and limitations.

AC(CB1)-09: Micromeritics, Dissolution and disintegration**15 Hrs**

Particle size analysis- concepts of particle size, size distribution, mean size of particulate system, methods of particle size analysis (sieving, microscopic method, sedimentation methods, electrical sensing zone method, optical sensing zone and light diffraction method). Dissolution: Drug absorption, theories of drug dissolution – Diffusion layer model, Danckwert's model & interfacial barrier model. Dissolution tests for tablets and capsules (basket apparatus, paddle apparatus, flow through cell apparatus). Disintegration tests for tablets, capsules and enteric coated tablets.

SUGGESTED BOOKS

1. Structural Methods in Inorganic Chemistry: E.A.V. Ebsworth, David W.H Rankin, Stephen Cradock, Second edition, Blackwell Publishers, 1991. ©
2. Physical Methods in Chemistry - R.S. Drago, W.B. Saunders Co.(1977).
3. Instrumental Methods & Chemical Analysis – Galen Ewing, 5th ed., McGraw-Hill Publishing Company Ltd.,(1985).
4. Analytical Chemistry - Gary D. Christian, 6th ed. John Wiley and sons. Inc, New York(1994).
5. Principles of Instrumental Analysis – Skoog, Holler, Nieman, 5th ed., Harcourt College Publishers (1998)
6. Solid state Chemistry and its Applications : Anthony R.West, Second edition, Wiley Publishers (2022).
7. Introduction to Solids: Leonid V. Azaroff, McGraw-Hill Education-Europe, 2017.
8. Atkin's Physical Chemistry : Peter Atkins and Julio de Paula, Tenth edition, Oxford Publications (2019).
9. Basic Course in Crystallography: J.A.K. Tareen, T.R.N. Kutty, University Press (2001).
10. Solid State Chemistry: D.K. Chakrabarthy, 2nd Edition, New Age Science (2010).
11. Principles and practice of Analytical Chemistry, F.W.Fifield & D Kealey, 5th Ed.Blackwell Science (2000).
12. Quantitative Chemical Analysis, Daniel C. Harris, 6th Ed. WH Freeman & Co. NewYork (2003).



**PAPER III CH (AC) 303T (ELECTIVE III B):
CLASSICAL, ELECTROANALYTICAL AND SPECTROSCOPIC METHODS
OF ANALYSIS**

AC(CB1)-07: Titrimetric and Gravimetric analysis.

AC(CB1)-08: Electroanalytical Methods

AC(CB1)-09: Optical Methods

AC(CB1)-07: Titrimetric and Gravimetric analysis.

15 Hrs

Redox titrations: Formal and Standard potentials in various media, standardization, Oxidizing systems: Mn(VII), Ce(IV), Cr(VI), V(V). Reducing systems: V(II), Ti(III), Sn(II), Fe(II) in H₃PO₄. Detection of end point in redox titrations – selection of suitable indicator. **Complexometric titrations:** Introduction, stability constants of EDTA complexes, titration curves, types of EDTA titrations with examples. Standard EDTA solutions, some practical considerations during EDTA titrations. Titration of mixtures (Mg²⁺&Ca²⁺; Pb²⁺&Ca²⁺; Mn²⁺&Mg²⁺), selectivity, masking and demasking agents. Metal ion indicators: General properties, theory of the use of metal ion indicators, use of Murexide, Eriochrome black- T, Calcon, Xylenol orange, Methyl thymol blue, Fast sulphon black- F.

Gravimetric Analysis: Theory, principles, precipitation reagents (DMG, Oxine), Determination of Nickel as dimethylglyoximate, Aluminium as 8-hydroxyquinolate & Chloride as silver chloride.

AC(CB1)-08: Electroanalytical Methods

15 Hrs

pH-metry: Accuracy of direct potentiometer measurements. The Glass pH electrode – Theory, construction, standard buffers, accuracy of pH measurements, measurements with the pH – meter, pH titration of unknown soda ash.

Electrogravimetry: Basic principles of electrogravimetry, Instrumentation, electrogravimetry determination with constant applied voltage and at constant current. Applications of electrogravimetry. Problems based on effect of concentration on electrode potentials, calculation of theoretical cathode potential at the start of deposition, effect of pH in electrolytic separations.

Coulometry: Basic principles, Types of coulometers, constant current coulometric analysis, coulometric titrations – principle, circuit and cell for coulometry, Application to neutralization, Redox, precipitation, complexometric titrations, Advantages of coulometric titrations and errors. Controlled potential coulometry – Technique & applications of inorganic & organic compounds.

AC(CB1)-19: Optical Methods

15 Hrs

Refractometry: Theory, instrumentation, specific and molecular refraction, Abbe, Pulfrich and immersion types, applications

Polarimetry: Theoretical considerations – Plane polarized light, optical activity, specific and molecular rotations. Instrumentation, applications.

Handwritten signatures:
 A. K. Chavany
 J. K. Jais
 P. Jais
 P. Jais
 M. K. Jais
 M. K. Jais

Optical rotator dispersion and Circular dichorism: Optical rotation, circular birefringence, circular dichroism and Cotton effect, Octet Rule, Experimental Techniques, Applications : quantitative analysis,determination of absolute configuration, conformational studies and equilibrium studies. Use of CD in the conformational studies of metal complexes, DNA and DNA-metal complexes.

SUGGESTED BOOKS

1. Vogel's Text book of Quantitative Analysis – GJ Jeffery, J Bassett et al, 5th ed.,Longmann, ELBS Publications (2000).
2. Principles and practice of Analytical Chemistry, F.W.Fifield & D Kealey, 5th Ed.Blackwell Science (2000).
3. Quantitative Chemical Analysis, Daniel C. Harris, 6th Ed. WH Freeman & Co. NewYork (2003).
4. Instrumental Methods & Chemical Analysis – Galen Ewing, 5th ed., McGraw-HillPublishing Company Ltd.,(1985).
5. Analytical Chemistry - Gary D. Christian, 6th ed. John Wiley and sons. Inc, New York(1994).
6. Principles of Instrumental Analysis – Skoog, Holler, Nieman, 5th ed., Harcourt College Publishers (1998).
7. Instrumental methods of Analysis - Willard, 6th ed., CBS Publishers & distributors (1986).
8. Analytical Chemisstry Instrumental techniques, Maninder Singh, DominantPublishers, New Delhi (2002).

PAPER IV CH (AC) 304T (ELECTIVE IV A): APPLIED ANALYSIS

AC(CB2)-10: Industrial Analysis

AC(CB2)-11: Food and Agricultural analysis

AC(CB2)-12: Analysis of Air and Water Pollutants and Sewage water treatment

AC(CB2)-10: Industrial Analysis

15 Hrs

Analysis of Ferroalloys: Analysis of steel - Molybdenum, Phosphorous. Analysis of Ferromanganese, Ferrovandium.

Analysis of non- Ferrous alloys: Analysis of Tin, Zinc and Copper in Brass, Bronze. Analysis of Tin and lead in Solder.

Analysis of Cement: Composition of Portland cement, estimation of Aluminium oxide and Ferrous oxide. Determination of Alumina in Cement by Polarography.

Analysis of Oils & Fats: Theory, Melting point of fats, Chemical Characteristics: Saponification value, Iodine value,

Thiocyanogen value, ketone or perfume rancidity. Analysis of fatty acid composition in oil by GLC, Oxidation levels of fats by TLC.

Soaps & Detergents: Composition of Soaps. Determination of low level Surfactants, determination of Germicides in soaps and detergents by photometric method, analysis of phosphates by paper chromatography, determination of detergent alkylates by Mass Spectrometry .

Paints & Pigments: Constituents of Paints, Analysis of Tio₂ in Titanium dioxide pigments by XRD. Determination of Zn, Pb in Paint pigments by Polarographic method. Analysis of polyesters, acrylics by Gel permeation chromatography.

Analysis of Pharmaceuticals : Determination of Calcium in Vitamin D and Calcium formulations (Complexometry), Phenobarbitone in tablets (IR), pivolic acid in dipivefrin eye drops(GC), Assay of hydrocortisone cream. (HPLC). Impurity profiling of Propranolol (GC-MS), famotidine (LC-MS).

AC(CB2)-11: Food and Agricultural analysis

15 Hrs

Food Analysis: Analysis of Chemical Additives in foods: Division of colour additives, Chromatographic identification of colours, and quantitative estimation of added dyes in foods (Titanium Trichloride Method) - chemical preservatives and synthetic sweetening agents (Organic-ether extractable and Non-ether extractable) - Analysis of SO₂ & Sodium Benzoate (Chemical Methods), Sorbic Acid (Chromatography) - Types of Antioxidants used in Foods, Analysis of Butylated Hydroxy Toluene (BHT) (Spectrophotometry).

Agricultural Analysis: Analysis of soils for available Major Nutrients - Estimation of available Nitrogen (Kjeldahl Method), Phosphorus (Olsen's Method and Bray and Kurtz Method), and Exchangeable Calcium & Magnesium (by EDTA). Soil analysis for Micronutrients - Estimation of Available Zinc, Copper, Manganese and Iron (AAS) Analysis of Pesticide Residues - Determination of Methyl Parathion Residues in food grains & vegetables (Solvent Extraction and Titrimetry) - Determination of Organochlorine pesticides by Gas Chromatography (Cypermethrin) - Determination of Malathion and DDT Residues in food grains (Spectrophotometry).

AC(CB2)-12: Analysis of Air and Water Pollutants and Sewage water treatment

15 Hrs

Water Hardness: causes, measurement of hardness, units- types of hardness, estimation of temporary and permanent hardness

Treatment of Water for Municipal Supply: Characteristics of potable water/Domestic water, WHO standards and Indian Standards. Aeration, Sedimentation with coagulation, Filtration, Sterilization and Disinfection: Ozonization, Chlorination, Breakpoint chlorination and Dechlorination.

Desalination of Brackish Water: electrodialysis, and reverse osmosis (RO).

Mineral Water and Purified Water: Typical Manufacturing Process, Flow-Sheet Diagram of Mineral Water Manufacturing Process.

Sewage Water Treatment: On-Site Sewage Treatment Systems and Off-Site Sewage Treatment Systems.

Analysis of air pollutants-SO₂ and H₂S by Spectrophotometry, NO-NO_x (Colorimetric technique- Saltzman method), CO & CO₂ (IR), Aromatic hydrocarbons in automobile exhaust (GC).

Analysis of Water Pollutants- Analysis of anions (CN⁻, Cl⁻, F⁻, SO₄²⁻, PO₄²⁻.) and Toxic metals (Cd) by Spectrophotometry.

SUGGESTED BOOKS

1. Analytical Chemistry - Gary D. Christian, 6th Ed. John Wiley and sons. Inc, New York (1994).
2. Fundamentals of Analytical Chemistry, Skoog & West, 9th Ed, Cengage Learning (2022)
3. Pharmaceutical Drug Analysis, Ashtosh Kar, Second edition, New Age International Publishers (2020)
4. Vogel's Text Book of Quantitative Chemical Analysis, J Mendham, R C Denney, J D Barnes, M Thomas, B. Sivasankar, 6th Ed, Pearson Education Ltd (2009)
5. Environmental Pollution Analysis, S M Khopkar, Wiley Eastern Ltd (1995).
6. Environmental Analytical Chemistry, F W Fifield, P J Haines, 2nd Ed, Wiley-Blackwell (2000).
7. Environmental Chemistry, B K Sharma, Goel Publishing House, Meerut (2014).
8. Handbook of Analysis and quality control for fruit and vegetable products, S Ranganna, Tata-Mc Graw Hill Publishers Ltd. (1986).
9. Introduction to chemical analysis of foods, S Suzanna & Nielsen, CBS Publishers & Distributors.
10. Practical pharmaceutical Chemistry, a H Beckett and J B Stenlake, III Ed, Vol I and Vol II, CBS Publishers & Distributors (1997).
11. Pharmaceutical Analysis, David G Watson, Churchill Livingstone Harcourt Brace and Company Ltd, (1999).
12. A Textbook of Engineering Chemistry, Dr. Y. Bharathi Kumari and Dr. Jyotsna Cherukuri, VGS Publications, First Edition, India (2009).
13. Engineering Chemistry, Jain P C and Monica Jain, 15th Edition, Dhanpat Rai Publishing Company Ltd, New Delhi, India (2005).

**PAPER-IV CH(IC) 304T (ELECTIVE IV B):
NUCLEAR CHEMISTRY, ZEOLITES & SOLID STATE CHEMISTRY**

AC(CB2)-10: Nuclear Chemistry

AC(CB2)-11: Zeolites and Molecular Sieves

AC(CB2)-12: Solid State Chemistry

AC(CB2)-10: Nuclear Chemistry

15 Hrs

Nuclear Chemistry: Introduction, the atomic nucleus-elementary particles; classification of nuclides based of Z and N values; binding energy, nuclear stability-nuclear binding energy theory, meson theory of nuclear forces, nuclear shell structure theory, nuclear fluid theory; Isotopes- isotopic constitution of elements; whole number rule and packing fraction.

Radioactivity: α , β , γ rays, disintegration theory, modes of decay, group displacement law, radioactive decay kinetics, half-life period, average life period, radioactive equilibrium, radioactive disintegration series.

Nuclear transformation and artificial radioactivity-Artificial transmutation of elements, types of nuclear reactions, nuclear fission-atomic bomb, nuclear fusion – hydrogen bomb.

Applications of radio isotopes: Reaction mechanism, structure determination, surface area of a powder, isotope dilution analysis, neutron activation analysis, radiometric titrations, carbon dating. (Problems wherever necessary)

AC(CB2)-11: Zeolites and Molecular Sieves

15 Hrs

Introduction to porous materials: Classification into micro-, meso- and macro porous materials, the origin of pores and its significance, distinction from condensed materials.

Zeolites: Definition, natural and synthetic zeolite or aluminosilicates, the primary and secondary building blocks, final framework structures, Lowensteins rule, sodalite and other structures, Nomenclature: Atlas of zeolite; structural distinctions, Novel zeolites, examples of small, medium, large and extra large pore zeolites; general properties and application of molecular sieves.

Characterization of zeolite: XRD, SEM and other techniques; spectral techniques: FT-IR and solid-state NMR; sorption capacity, surface area by BET method, pore volume and pore structure, the origin of Brønsted and lewis acidity in zeolites, the number and the strength, techniques for the estimation of acidity: adsorption of bases and IR spectra, temperature programmed desorption of bases.

AC(CB2)-12: Solid State Chemistry

15 Hrs

Electronic structure of solids and band theory, Fermi level, K Space and Brillouin Zones. Structure of ionic Crystals & Compounds: Ionic Crystals with stoichiometry MX, Ionic Crystals with stoichiometry MX₂, spinel structure, perovskite structure. AB [nickel arsenide (NiAs)], AB₂ [fluorite (CaF₂) and anti-fluorite structures, rutile (TiO₂) structure and layer structure [cadmium chloride and iodide (CdCl₂, CdI₂)].

Crystal Defects and non-stoichiometry: Classification of Defects: subatomic, atomic and lattice defects in solids; Thermodynamics of vacancy in metals; Thermodynamics of Schottky defects in ionic solids ; Thermodynamics of Frenkel defects in silver halides; Calculation of number of defects and average energy required for defect, Other examples of defect structure; Non-stoichiometry and its classifications.

Preparative method of solids: Introduction, Ceramic method, microwave synthesis, Precursor method, Hydrothermal method, Chemical vapour deposition (CVD) Method, Chemical vapour Transport, Choosing a method for solids.

Crystal Growth: law governing nucleation; Growth of nuclei; Reaction between two solids; Improving the reactivity of solids; Zone refining method; Crystal growth.

SUGGESTED BOOKS

1. Essentials of nuclear chemistry, H.J.Arnikaar, 5th Edition, New Age International Publishers (2022).
2. Text book of inorganic chemistry, P.L.Soni, Mohan Katyal, 20th Revised Edition, Sultan Chand & Sons (2022)
3. Introduction to zeolite science and practice, H. Van Bekkum, E. M. Flanigen, P. A. Jacobs and J. C. Jansen ,Elsevier Pub. Amsterdam (2001).
4. Zeolites molecular sieves- Structure, chemistry and use, Breck.D.W, John Wiley & Sons N.Y. (1974).
5. Solid-State Chemistry an Introduction (2nd Edition) – Lasley Smart and Elaine Moore Chapman & Hall(1996)
6. Solid State Chemistry- D.K.Chakraborty (New Age International Pvt.Ltd. New Delhi, (2000)
7. Introduction to Solids-L.V.Azaroff, Tata McGraw Hill Publication Ltd., New York (1960)
8. Principles of the Solid State-H.V.Keer , Wiley Eastern Ltd.New Delhi (1994).
9. Solid state Chemistry –N.B.Hannay , Prentice Hall, New Jersey (1967).
10. Chemisorption, B. M. W. Trapnell, Butterworths Scientific Publications, London(1955).
11. Adsorption on solids, VladimirPonec, Zlatko Knor, Slavoj Cerny, Butterworth & Co publishers (1974).
12. Catalysis: Principle and Applications, B. Viswanathan, S. Sivasanker, A. V. Ramaswamy, Narosa Publishing House(2002).

AP

Jayanti Vijayachandran
P. S.

M.A. 27/10/24, K.R. Reddy
V. Chandra

LABORATORY COURSE

Paper V CH (AC) 351P: Titrimetry, Solvent extraction and Chromatography

4 Hrs/Week

I. Titrimetry:

1. Soil Analysis: Determination of
(i) Ca^{2+} , (ii) Mg^{2+} , (iii) CO_3^{2-} & HCO_3^- .
2. Cement Analysis:
(i) Determination of Ca in Cement
3. Oil Analysis: Determination of
(i) Saponification value and
(ii) Iodine value of an oil sample

II Solvent extraction:

1. Determination of Pb using Dithiazone
2. Determination of Fe(II) using Oxine

III. Chromatography (Demonstration):

1. Separation of Co & Ni in Cellulose column
(i) Column preparation and separation
(ii) Analysis of eluents by titrimetry
2. Separation of amino acids in a mixture by TLC using Ninhydrin
3. Separation of and identification pigments in leaves by column chromatography
4. Separation of additives in Ink by GC.
5. Separation of synthetic corticosteroids in by HPLC.

Paper VI CH (AC) 352P: Spectrophotometry –I

4 Hrs/week

I. Spectrophotometry:

1. Determination of Manganese in steel
2. Determination of Phosphorous in human serum
3. Determination of Nickel using DMG
4. Determination of pKa of an organic Indicator (Methyl Orange)
(i) Evaluation of λ_{max} for HMR (λ_A) and MR- (λ_B)
(ii) Verification of Beer's Law for HMR and MR- at both λ_{max} and determination of their relative amounts in the solution
5. Simultaneous determination of Cr and Mn in an admixture
(i) Determination of molar absorption coefficients and verification of additivity of absorbances

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(ii) Determination of Chromium and Manganese in a mixture

6. Determination of composition of Complex:

(i) Cu(II)-EDTA by Job's Method

(ii) Cu(II)-EDTA by Mole ratio Method

(iii) Fe(II)-o-Phen by Job's Method and

(iv) Fe(II)-o-Phen by Mole ratio Method

II. Atomic Absorption Spectroscopy

Determination of i) Fe, ii) Zn, iii) Cu, iv) Pb.

Paper VII CH(AC) 353P: Water analysis.

2 Hrs/week

I Water analysis:

1. Determination of residual Chlorine in water by Iodometry
2. Determination of Dissolved Oxygen.
3. Determination of COD.
4. Determination of BOD.
5. Determination of fluoride ion
6. Determination of sulphate ion
7. Determination of hardness of water

Paper VIII CH(AC) 354P: Spectrophotometry I

2 Hrs/week

I. Colorimetry:

1. Determination of blood sugar
2. Determination of blood cholesterol
3. Determination of Paracetamol
4. Determination of Creatinine
5. Estimation of Ascorbic acid
6. Determination of protein by biurette method
7. Estimation of urea by diacetyl monoxime method

SUGGESTED BOOKS

1. Chemistry Experiments for Instrumental Methods, Donald T Sawyer William R. Hememan et.al., John Wiley & Sons (1984).
2. Analytical Chemistry by Gary D. Christian 6th Edition John Wiley & Sons Inc., New York (1994).
3. A Text Book of Quantitative Inorganic Analysis by A.I. Vogel 3rd Edition Elbs Publication (1969).
4. Vogel's Text Book of Quantitative Inorganic Analysis Jeffery et al 4th edition Elbs Publications (1988).

Handwritten signatures:
A. Jaisankar, P. Jayaram, M.M. Srinivasulu, K.P. Reddy, H. Chavara, P. ...

5. Vogel's Text Book of Quantitative Chemical Analysis, 6th edition. Pearson Education Ltd (2002).
6. Analytical Chemistry Theory and Practice by R.M. Verma 3rd Edn., CBS Publishers & Distributors (1994).
7. Comprehensive Experimental Chemistry by V.K. Ahluwalia et al New Age Publications (1997).
8. Laboratory hand Book of Instrumental Drug Analysis. by B.G. Nagavi 2nd edn. (1996)
9. Practical Pharmaceutical Chemistry, A.H. Beckett and J.B. Stenlake 4th edn. CBS publishers (2001)
10. Separation methods, MN Sastri, 2nd edn, Himalaya Publishing House (1996)
11. Hand book of analysis and quality control for fruit and vegetable products. S. Ranganna, 2nd edn, Tata MCGraw-Hill Publishing Company (2002).
12. Gas Chromatography, Rajbir Singh, 1st edn, Mittal Publications (2002)

M.Sc. SEMESTER - IV
ANALYTICAL CHEMISTRY SPECIALIZATION

(For the batches admitted in academic year 2023-24 onwards under CBCS pattern)

PAPER I CH (AC) 401T (CORE):
SPECTROSCOPIC METHODS OF ANALYSIS-II

AC-13: Electronic spectroscopy,

AC-14: IR & Raman spectroscopy

AC-15: Fluorimetry, Phosphorimetry, Nephelometry and Turbidimetry

AC – 13: Electronic spectroscopy

UV and visible spectroscopy: Beer Lamberts law, Real limitations to Beer's law, instrumentation for colorimetry and spectrophotometry – Numerical problems based on Beer's law, simultaneous & differential spectrophotometry. First derivative spectrophotometry. Classification of Electronic Spectra for Metal Complexes, Selection rules: Electric dipole transitions, Magnetic dipole transitions, Orbital selection rules, Spin selection rules, Relaxation in selection rules. Nature of electronic spectral bands: band widths, band intensities. Factors influencing band shapes: Jahn-Teller effect, Spectrochemical series, Nephelauxetic effect. Orgel diagrams for d^1 - d^9 configurations in O_h and T_d geometries, Crystal field spectra of O_h and T_d metal complexes of 3d metals, Charge Transfer Spectra. Calculation of $10Dq$ values, Racah parameter (B') and Nephelauxetic ratio (β).

15 Hrs

AC – 14: IR & Raman spectroscopy

IR Spectroscopy: Principle, instrumentation, sample handling, Fourier transform infrared spectroscopy- Principle, instrumentation & its advantages. IR in quantitative analysis. Applications of IR spectroscopy: structure analysis of organic compounds, inorganic molecules-sulphato, carbonato, nitrate & metal chelates - acetylacetonato complexes. Analysis of petroleum hydrocarbons, oil and grease contents by EPA method, Quantitative analysis of multi-component mixtures.

15 Hrs

Raman Spectroscopy: Theory, Instrumentation, sample handling, Illumination diagnosis and structure analysis, polarization measurements, quantitative analysis, laser applications, Resonance Raman spectroscopy: Principle, theory and its applications.

AC – 15: Fluorimetry, Phosphorimetry, Nephelometry and Turbidimetry

Fluorimetry and Phosphorimetry: Theory of Fluorescence and Phosphorescence, Excited states producing Fluorescence and Phosphorescence. Rates of absorption and emission. Deactivation processes, Variables affecting Fluorescence and Phosphorescence. Types of photoluminescence spectra for Phenanthrene. Instrumentation: Components of fluorimeter, spectrofluorimeters and Phosphorimeters. Applications of fluorimetry- Determination of Inorganic cations, fluorimetric reagents. Fluorimetric determination of organic species – Thiamine, Aneurine Hydrochloride, Polycyclic aromatic hydrocarbons. Phosphorimetry: Determination of Aspirin in blood serum. Chemiluminescence: Origin, measurements. Analytical applications - Atmospheric pollutants (Oxides of Nitrogen and Sulphur compounds, Ozone). Detection

15 Hrs



in Gas chromatography, High performance liquid chromatography and Capillary electrophoresis. Detection of Enzyme reaction products. Immunoassay and Nucleic acid assays.

Nephelometry and Turbidimetry: Principles and instrumentation for Nephelometry and Turbidimetry, Applications

Suggested Books

1. Principles of Instrumental Analysis– Skoog, Holler, Nieman, 5th ed., Harcourt College Publishers (1998).
2. Introduction to Ligand Fields – Figgis, Wiley Eastern Ltd (1966).
3. Inorganic Electronic Spectroscopy – A.B.P. Lever, Elsevier Publishing Company, London (1968).
4. Chemical Analysis – A. K. Srivatsava & Jain, 3rd ed., S. Chand & Company Ltd. (1977).
5. Hand Book for Instrumental Techniques for Analytical Chemistry, Ed. Frank Settle. Prentice hall, New Jersey, USA (1997).
6. Analytical Chemistry – Gary D. Christian, 6th ed, John Wiley and sons. Inc., New York (1994).
7. Analytical Chemistry – Skoog & West, 6th ed, W.B. Saunders (1998).
8. Infrared and Raman Spectra of Inorganic and Coordination Compounds, Kazuo Nakamoto, 5th ed., John Wiley & Sons (1995).
9. Vogel's Text book of Quantitative Analysis – J. Mendham et al, 6th ed., Pearson Education Ltd (2002).
10. Instrumental methods of Analysis - Willard, 6th ed., CBS Publishers & distributors (1986).
11. Analytical Chemistry Instrumental techniques, Maninder Singh, Dominant Publishers, New Delhi (2002).

**PAPER II CH (AC) 402T (CORE):
SEPARATION METHODS AND MASS SPECTROMETRY**

AC-16: Solvent extractions & Chromatography-I

AC-17: Chromatography -II

AC-18: Advanced Mass spectrometry

AC-16: Solvent extractions & Chromatography-I

15 Hrs

The distribution coefficient, distribution ratio, relation between KD & D, the percent extracted.

Solvent extraction of metals – ion association complexes, metal chelates, effect of pH and reagent concentration, extraction process, separation efficiency of metal chelates, analytical separations – multiple counter current distribution, solid phase extraction, solvent extraction of flow injection analysis. Super critical fluid extraction.

Organic reagents in Inorganic analysis: Theoretical basis for the use of organic reagents in inorganic analysis. Extraction of metal ions by the use of organic reagents – acetylacetone, thionyl-trifluoroacetone. Applications to extractions of metal ions by chelating agent (Dithiazone, and cupferron) determination of alkaloids in crude drugs.

HPTLC: Principle, Technique, advantages over TLC

Gas Chromatography (GC) – Theory, Data acquisition and processing Applications, Monitoring of ethylene dibromide (EDB) residue in Indian Black pepper by GC using electron capture detector. Analysis of petroleum products. Headspace analysis of tobacco. Preparative gas chromatography

High Performance Liquid Chromatography (HPLC) – Theory, and separation modes, Applications with respect to separation of enantiomers, Organic and inorganic systems.

AC -17: Chromatography - II

15 Hrs

Supercritical fluid chromatography (SFC): Instrumentation of SFC, stationary and mobile phases used in SFC, Detectors, Advantages of SFC. Technique and applications of SFC.

Size Exclusion Chromatography: Principle of Gel Chromatography, Filtration Chromatography, Instrumentation, retention behaviour, resolution, selection of gel type, applications. Ion Exclusion: Principle and applications.

Electrophoresis: Introduction, Definition

Paper Electrophoresis: Principle, Experimental Requirements, Technique, Factors governing the migration of ions, Applications

Capillary Electrophoresis: Electro osmotic flow, migration in CE, instrumentation, control of separation, applications

Gel Electrophoresis: Principle, technique, applications

Immuno-electrophoresis: Principle, technique, applications

Ultra Performance Liquid Chromatography: Principle, Instrumentation

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AC-18: Advanced Mass spectrometry**15 Hrs****Introduction to Mass Spectrometry:** Principle and Block diagram of mass spectrometer (MS)**Mass Analyzers:** Quadruple, Ion traps, Time of flight (TOF) mass analyzers**Hyphenated Techniques:** GC-MS Principle, Instrumentation, Interfaces- Direct coupling interface and Open split interface, Applications of GC-MS. LC-MS- Principle, Instrumentation – Interfaces- Moving belt interface, Particle beam interface, Thermospray interface, Electrospray interface, Atmospheric pressure chemical ionization interface, Applications of LC-MS. ICP – MS – Principle, Instrumentation, and Applications.**Tandem Mass Spectrometry (MS/MS or MS²):** Principle, Instrumentation, Applications.**Matrix-assisted laser desorption/ionization-Time of flight Mass spectrometry (MALDI-TOF-MS):** Principle, Matrix, Sample Preparation for MALDI-MS - Dried droplet Crystallization, Thin layer method, Sandwich Crystallization, Instrumentation, Applications.**Suggested Books**

1. Separation Methods - M. N. Sastri, 1st ed., Himalaya Publishers (1991).
2. Principles of Instrumental Analysis – Skoog, Holler, Nieman, 5th ed., Harcourt College Publishers (1998).
3. Analytical Chemistry - Gary D. Christian, 6th ed, John Wiley and sons. Inc., New York, sixth edition (1994).
4. Mass spectrometry for Chemists and Biochemists, Robert A.W. Johnstone and Macolm.E. Rose, 2th ed Cambridge University Press (1996).
5. Structural methods in Inorganic chemistry - E.A.V. Ebsworth, et al ELBS Publications (1988)
6. Introduction to analytical Gas Chromatography, Raymond PW Scott, 2nd Ed. Marcel Dekker, Inc. New York (1988).
7. Techniques and practice of Chromatography, Raymond PW Scott, Marcel Dekker, Inc. New York (1995).
8. Liquid Chromatography-Mass Spectrometry Principles & Applications, WMA Neissen & JV Greef, Marcel Dekker, Inc. New York (1992).
9. Matrix-assisted laser desorption/ionization - https://en.wikipedia.org/wiki/Matrix-assisted_laser_desorption/ionization

Krishna

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**PAPER III CH (AC) 403T (ELECTIVE IIIA):
LABORATORY MANAGEMENT AND QUALITY ASSURANCE**

AC(CB1)-19: Laboratory Automation and Management, LIMS and Computer aided Analysis

AC(CB1) -20: Quality Control and Quality Assurance

AC(CB1)-21: Quality Standards, Management and Accreditation

AC(CB1)-19: Laboratory Automation and Management, LIMS and Computer aided Analysis

15 Hrs

Laboratory Automation: Introduction, classification of Analytical methods, Types of instrumental methods, Instruments for analysis. Planning for laboratory automation. An overview of automatic instruments & instrumentation. Flow Injection Analysis, Discrete Automatic systems.

Laboratory Management Introduction – Administration, Geographical location, Internal organization of the laboratory, Architectural issues, laboratory infrastructure of equipment and instrumentation. Relationship with the industrial exploratory, regulatory work and the analytical laboratory. Disciplines represented in the Laboratory. Educational requirements of the laboratory personnel. Regular academic research work, work load statistics and coordination between routine work and research cell. opportunities for training.

Good laboratory practices: Instrumental standardization, optimization of procedures. Quality Programme, Instrument and Organisation calibration, Customer Satisfaction.

Laboratory Information Management System: Laboratories as information producers, properties of good information, Laboratory information management system, conclusions.

Computer aided analysis: Computer-instrument interaction, computer organization- Hardware -Basic Digital/circuit components, Microprocessors and Microcomputers, Computer Software -Software control of the computer-instrument interfaces. Automated laboratory – Automated instruments (AAS), Applications of computers,

AC(CB1) -20: Quality Control and Quality Assurance

15 Hrs

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.

Calibration and maintenance of Instruments / Equipment: 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.,).

Documentation for quality assurance: Raw Data - Type of notebooks, control of note book distribution and data entry. General Reagents and volumetric reagents. Sampling – sampling methods, sample labeling, sample log-in/register. Sample analysis, reporting, recording and personal training. Filing quality assurance documentation. Data

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Acquisition. Quality control data and calculations. Computer generated analytical reports. Security considerations.

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)-21: Quality Standards, Management and Accreditation 15 Hrs

Analytical Methods: Choosing the methods- standard methods, official methods, literature methods. Validation of new methods - comparison of analytical methods. Characteristics of Analytical procedures – Accuracy, precision, linearity, Range specificity, Detection limit, Quantitation limit, robustness process validation, Types of process validation –prospective, concurrent and retrospective process validation.

Standard reference materials: Standards of Analysis, Analytical standards, reference materials, High purity substances, working and secondary standards.

Quality Management: Quality systems, the operational aspects required to deliver a quality system (Traceability, quality control, quality assurance, quality management and quality manual) calibration and test methods. Total Quality Management (TQM) – Essentials of TQM: Quality Planning, Quality control, Quality Audit, Quality surveillance, Quality assurance, Quality circles.

Laboratory Accreditation: International organization for standardization, National accreditation board for testing and calibration laboratories. Need for laboratory accreditation. International aspects of laboratory accreditation and in India. Criteria for laboratory accreditation. Benefits of laboratory accreditation. Introduction to ISO 9000, ISO 9000-2000 series of standards on quality management system, Introduction to ISO organization, Registration / certification, Structure of ISO 9000-2000 family of standards. Advantages of ISO 9000-2000. Requirements of ISO 9001-2000 Significance of ISO 9001, 9002, 9003 & 9004. Requirements of ISO9000/IS14001.

Suggested Books

1. Principles of Instrumental Analysis - Skoog, Holler, Nieman, 5th ed., Harcourt College Publishers (1998).
2. Model for Quality assurance in design/development production, installation and servicing, ISO 9001.
3. Journal of Validation technology, Vol.-III and IV (1997).
4. Instrumental Methods of Analysis - Willard, Merit, Dean, 6th ed., CBS Publishers & distributors (1986).
5. Hand Book for Instrumental Techniques for Analytical Chemistry, Ed. Frank Settle, Prentice Hall, New Jersey, USA (1997).
6. Handbook of Quality Assurance for the analytical chemistry laboratory, James P. Dux, Van Nostrand Reinhold, New York (1986).
7. Quality in Totality – Parag Diwan, Deep & Deep Publications, 1st ed. (2000).

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8. QA manual – DH Shah, Business Horizons, 1st ed. (2000).
9. Applying ISO-9000 Quality Management Systems, International Trade Centre Publishing, UNCTAD/WTO. Geneva, Switzerland, Indian Edition Printed by D.L.Shah Trust.
10. How to practice GLP, PP Sharma, Vandana Publications, New Delhi (2000),
11. Training manuals on ISO 9000 / 2000 PQM, Girdhar J Gyani, Raj Publishing House, (2001)
12. Quality Assurance in Analytical Chemistry, B.W. Wenclawiak, Springer India (2004).

D.L. Shah

M.B. 27/01/24

A

**PAPER III CH(AC) 403T (ELECTIVE III B):
APPLIED ANALYSIS AND GREEN ANALYTICAL CHEMISTRY**

AC(CB1)-19: Enzyme catalysis- Analytical applications

AC(CB1)-20: Forensic Chemical Analysis

AC(CB1)-21: Green Analytical Chemistry

AC(CB1)-19: Enzyme catalysis- Analytical applications

15 Hrs

Basic principles, Catalysis – measurement of catalytic reactions, Non-specificity of catalysts, types of reactions catalyzed. Enzyme catalysis, enzyme kinetics, properties of enzymes, enzyme inhibitors and activators, enzyme specificity, Determination of enzymes and enzyme substrates. Example of enzymatic analysis: Dehydrogenase reactions, Substrate determinations: Glucose, Uric acid. Immobilized enzymes. Evaluation methods.

AC(CB1)-20: Forensic Chemical Analysis

15 Hrs

Contact traces – Analysis of soil, fibre and paint evidence in forensic work.

Analysis of narcotic drugs and psychotropic substances (opiates, cannabinoids, barbiturates, benzodiazepines, amphetamines with one example each and LSD) by colour/micro crystal tests, chromatographic methods (TLC, GC, and LC) and spectroscopic methods (UV-Vis, IR, MS and GC-MS). Analysis of explosives and explosion residues (Low explosive residues – cations and anions, High explosive residues – RDX) by spot tests, chromatographic methods (TLC, GC and GCMS) and spectroscopic methods (UV-Vis, IR, MS and GC-MS).

Analytical toxicology – extraction techniques for drugs and pesticides – analytical techniques in forensic toxicology for alcohols, drugs and pesticides involving spot tests (TLC, GC & LCMS). Interpretation of analytical data – court testimony.

AC(CB1)-21: Green Analytical Chemistry

15 Hrs

Green Analytical Chemistry: Concepts and trends

“Greening” Sample Treatment: Reduced and solvent-free sample preparation methodologies, alternative solvents, energy saving procedures.

Green Instrumental Analysis: Assessment of analytical methods for “Greenness”, greening flow injection analysis, chemical sensors, liquid green chromatography.

Suggested Books

1. Analytical Chemistry - Gary D. Christian, 6th ed. John Wiley and sons. Inc, New York (1994).
2. Kinetics methods of analysis – Marck & Rekniz Vol.25
3. Practical Pharmaceutical Chemistry, A.H. Beckett et al, 3rd ed. – Vol. 1 & Vol. 2 CBS Publishers & distributors (1986).
4. Green Analytical Chemistry: Theory & Practice, Miguel De La Guardia, Sergio Armenta, Elsevier (2010)
5. Green Analytical Chemistry, Mihkel Koel, Mihkel Kaljurand, RSC Publishing (2010)

M. J. Singh *Arnt* *MM* 27/10/24

CH(IC) 454P: PROJECT

12 Hrs/Week

Marks Distribution for Project Assessment

INTERNAL ASSESSMENT

Research Design Seminar	1 credit	25 marks
Progress Seminar	1 credit	25 marks

SEMESTER END ASSESSMENT

Dissertation	1 credit	50 marks
Final presentation	2 credits	50 marks
Viva Voce during final presentation	1 credit	25 marks

