

**Swami Ramanand Teerth Marathwada University, Nanded**

**Faculty of Science**

**Syllabus of B. Sc. III (Third) Year**

**Analytical Chemistry**

<b>Paper</b>	<b>Course Code</b>	<b>COURSE</b>	<b>Periods/Week</b>	<b>Total periods</b>	<b>Marks</b>
VIII	CHAC-301	Modern Techniques of Chemical Analysis	03	90	100
IX	CHAC-302	Applied Analytical Chemistry	03	90	100
X	CHAC-303	Laboratory Course – IV	04	120	100
XI	CHAC-304	Laboratory Course – V	04	120	100

**B. Sc. Third Year**  
**Analytical Chemistry**  
**Paper – VIII**  
**Modern Techniques of Chemical Analysis**  
**Paper Code CHAC 301**

Periods : 80

Marks : 100

**Unit – I**

- 1.1 Infrared Spectroscopy : 10P**  
Range of I R radiation, Theory- Requirements for I R radiation absorption, Different normal modes of vibrations of atoms in poly atomic molecules, Factors Influencing Vibration as frequencies IR- absorption spectra, Instrumentation and Experimental Technique. Applications of IR spectroscopy.
- 1.2 <sup>1</sup>H NMR Spectroscopy: 10P**  
Theory of <sup>1</sup> H NMR Quantum description of Nuclear magnetic resonance, Resonance condition, Instrumentation, Experimental technique, NMR spectra Number of signals- equivalent and nonequivalent protons, Chemical Shift Measurement of Chemical Shift, Factors affecting chemical shift, Spin-spin coupling, Interpretation of <sup>1</sup>H NMR spectra in structure determination and identification.

**Unit – II**

- 2.1 Mass Spectrometry: 10P**  
Theory , Instrumentation, components of mass spectrometer, Recording of mass spectrum, Resolution of mass spectrometer, Types of ions produced in a mass spectrometer, General rules for interpretation of mass spectra, Applications of mass spectrometry.
- 2.2 Fluorescence Spectroscopy: 05P**  
Theory factors affecting fluorescence, Relation between fluorescence intensity and concentration, Single and Double beam filter fluorimeters, Applications.

**Unit- III**

- 3.1 Electro analytical Techniques -1 12P**  
Conductometry : Conductance , specific conductance, Equivalent conductance, molecular conductance Effect of dilution, measurement of conductance-conductivity cell, wheat stone bridge apparatus. Conduct metric Titrations, apparatus for conducto metric titrations, Types of conducto metric titrations Acid base, Precipitation and Redox titrations.  
**Potentiometry :** Electrode Potential Standard electrode potential Nernst equation, EMF of an electrolytic cell, reference indicator and 1 on selective electrodes. Theory of potentiometer titrations Types of potent ometric titrations Acid base Redox and precipitation titrations. Karl Fischer method .
- 3.2 Electro analytical Techniques -2: 13P**  
**Polarograph:** Principle of DC polarography, polaro gram, Factors affecting the limiting current Residual current , Migration current, Diffusion Current, Il Kovic equation, Kinetic Current , Decomposition potential, Half wave potential, Oxygen waves and its removal, Current maxima. Instrumentation, Dropping mercury electrode, Dissolved oxygen electrode. Analytical applications.

**Amperometry** : Theory of amperometric titrations, Typical titration curves, Apparatus with rotating Platinum microelectrode, Technique and applications.

**Unit- IV**

**4.1 Automation in Chemical Analysis**

**06P**

Introduction, Automated instruments and process control- continuous Analysers , Discrete Analyzers. Automatic instruments, Semi Automatic instruments, Auto Analyzer, Centrifugal Analyser, Flow injection analysis.

Role of computers and Microprocessors in Analytical Chemistry.

**4.2 Chromatographic Techniques :**

**14P**

Ion Exchange Chromatography : Principle, ion exchange resins & their types- cation exchange resins anion exchange resins, ion exchange reactions, ion exchange equilibria properties of ionexchange resins, ion exchange capacity, Techniques- Batch & Column method applications.

**Size Exclusion chromatography** : Principle Gel-materials, Technique, instrumentation and applications.

**Super Critical Fluid Chromatography** : Principle, instrumentation and applications :

**B. Sc Third Year  
Analytical Chemistry  
Paper IX  
Applied Analytical Chemistry  
Paper-CHAC 302**

**Periods : 80**

**Marks : 100**

**Unit – I**

**1.1 Environmental Analysis ( Air and water ) : 10P**

**Analysis of Air :** Composition of atmospheric air, sampling of air, General considerations- size, rate, duration of sampling, sample storage, sampling train and sampling, devices. Determination of i ) particulate matter suspended and settled ii ) Sulphur dioxide iii) Nitrogen dioxide iv) Carbon mono and dioxide as pollutants.

**Analysis of Water :** Introduction to potable water quality standards, objectives of water analysis. Sampling and preservation of water for analysis. Methods of measurement of water quality parameters: Physical parameters pH, conductivity, colour, turbidity total dissolved solids . Determination of chemical parameters – Temporary and Permanent Hardness, Dissolved oxygen, Chemical Oxygen Demand and Bio chemical Oxygen Demand.

**1.2 Environmental Analysis (Industrial Effluent & Soil) 10P**

**Analysis of Industrial Effluents :**

Definition of industrial effluent, Estimation of toxic metals like Hg, Zn Cd and Pb in industrial effluent.

**Analysis of Soil :**

Inorganic and organic components of Soil, methods of soil sampling, Determination of : i) Bulk density (ii) specific gravity (iii) water holding capacity (iv) moisture content (v) Loss on ignition (vi) soil pH. Chemical Analysis of Soil : Determination of i) Total nitrogen, (ii) Nitrate Nitrogen (iii) organic matter (iv) organic Carbon. Determination of major constituents by fusion analysis – Silica total combined oxides of Fe, Al and Ti. Determination of phosphorus, potassium and sodium.

**Unit – II**

**2.1 Analysis of Food and Food Products: 15P**

**Composition and Analysis of following:**

i) Milk: Determination of specific gravity, Total solids, fat, Protein, Lactose and Acidity

ii) Wheat flour: Determination of moisture, ash fat, protein, fiber, acidity, pH & starch.

iii) Fish: Assessment of raw fish for its spoilage Chemical methods for assessment of spoilage Determination of moisture, total fat ash, chloride, Nitrogen and total phosphorus

iv) Tea: Determination of moisture, ash water & ether extractives, Tannin and Caffein.

v) Fruits and Vegetables: Determination of ash, pectin, pentosans and Vitamin- C

vi) Honey: Determination of total solids, moisture , ash , free acid pH and glucose.

- 2.2 Analysis of Cosmetics: 05P**  
Introduction to cosmetics, definition, General characteristics, composition and analysis in outline of the following (i) Face Powders (ii) Hair dyes

**Unit – III**

- 3.1 Pharmaceutical Analysis: 08P**  
Definition, classification of drugs on the basis of their effects, therapeutic action and structure. Definition and analysis of followings classes of drugs with one specific example of each : (i) Narcotics (ii) Antiseptics and Disinfectants (iii) Analgesics (iv) Antipyretics (v) Antibiotics

- 3.2 Clinical & Biochemical Analysis 12P**  
Composition of Blood, Non cellular/ plasma and cellular components, Normal range of concentration of important constituents, collection and preservation of blood for plasma, serum, glucose and CO<sub>2</sub> analysis. Estimation of sodium, potassium, calcium, and bicarbonate, Blood glucose, Blood urea. Trace elements in the body.  
Proteins – Structure, separation and estimation of amino acids.  
Carbohydrates- structure of starch, cellulose and glycogen; Estimation of sugars.

**Unit – IV**

- Separation by Solvent Extraction: 10P**
- 4.1 Theoretical Principles – Nernst distribution law, Distribution constant, Distribution ratio, Efficiency of extraction, Percentage extraction, amount of solute extracted and left Unextracted, Sequence of extraction process, Extraction equilibria, factors favouring extraction, Techniques of extraction, Analytical applications.**
- 4.2 Analysis of fuels: 10P**  
Definition and classification of fuels, solid fuels, liquid fuels and gaseous fuels. Calorific value of fuels, Gross and Net calorific value, Determination of calorific value by Bomb Calorimeter, Proximate analysis of coal- moisture, volatile matter, Ash fixed carbon & their significance Ultimate analysis of coal- carbon & Hydrogen, Nitrogen, sulphur, Ash and oxygen & their significance Flash, fire and aniline points of liquid fuels, their determination and significance . Definition of octane number and cetane number.

**B. Sc Third Year**  
**ANALYTICAL CHEMISTRY**  
**CHAC-303 Paper – X**  
**LABORATORY COURSE – IV**

**Period: 120**

**Marks:100**

1. **Analysis of ores & Soil.**
  1. Estimation of Na/ K by flame photometer in a solution/ sample.
  2. Estimation of aluminium in bauxite gravimetrically.
  3. Determination of calcium in dolomite by flame photometer.
  4. Electrogravimetric determination of copper in an ore.
  5. Polarographic determination of trace quantity of lead/ Cadmium/ Zinc in sample solution.
  6. Determination of Silver in an alloy by Volhard's method
  7. Determination of Silica in soil .
  8. Determination of magnesium in soil.
  9. Determination of soil pH.
2. **Analysis of biochemicals.**
  1. Estimation of Na/ K in blood serum by flame photometer.
  2. Determine of blood sugar by Folin –Wu-Method.
  3. Mercurometric determination of blood or Urine chloride.
  4. Determination of bicarbonate in blood using back titration.
  5. Spectrophotometric determination of inorganic phosphorus in human serum or Urine.
  6. Testing for chemical toxicity using bacteria.
  7. Determination of SO<sub>2</sub> in sugar (Ref: System of Technical control for canesugar factories in India – R. M. Verma Sugar Technologists Assoc. of India, Kanpur )
  8. Spectrophotometric determination of lead on leaves using solvent extraction.
  9. Spectrophotometric determination of manganese and chromium in mixture.
3. **Chromatographic Techniques**
  1. Determination of Capacity of cation exchange resin.
  2. Determination of Capacity of anion exchange resin.
  3. Separation of cobalt and nickel on an anion exchange resin and their subsequent determination by direct back EDTA titration.
  4. Paper/Thin layer chromatography separation of metals/ amino acids / Sugars from a mixture.
  5. Chromatographic separation of plant leaf pigments.
  6. Determination of magnesium and Zinc in a mixture/ Zinc in pharmaceutical preparations by ion exchange separation and complexometric titration.
  7. Separation of cadmium and zinc on an anion exchanger and their subsequent determination by EDTA titration.
4. **Analysis of water**
  1. Potentiometric determination of fluoride in drinking water/ river water using Fluoride- ion selective electrode.
  2. Determination of available chlorine in bleaching powder volumetrically using an external Indicator.

3. Microscale quantitative Analysis of Hard water samples using An indirect potassium permanganate Redox titration.
- 5. Elemental Analysis**
1. Determination of concentration of Ferrous ion by potentiometric titration .
  2. Determination of antimony by titration with iodine.
  3. Iodometric determination of copper.
  4. Estimation of ferrous and ferric iron in a mixture.
  5. Determination of copper and Nickel in a mixture.

**B. Sc. Third Year**  
**ANALYTICAL CHEMISTRY**  
**CHAC-304 Paper – XI**  
**LABORATORY COURSE – V**

Period: 120

Marks:100

**1. Environmental Analysis.**

1. Colorimetric estimation of traces of nitrogen in the sample of water using Nessler's reagent.
2. Determination of dissolved oxygen in water by Winkler's method.
3. Determination of nitrate nitrogen/ nitrite nitrogen/ phosphate in a sample of water by colorimetry.
4. Determination of total hardness, calcium hardness and magnesium hardness of a water sample.
5. Determination of chemical oxygen demand ( C.O.D ) of a waste water sample.
6. Estimation of carbon/ organic matter in a soil sample by chromic acid digestion.

**2. Food & Food product analysis.**

1. Determination of nitrogen in wheat flour.
2. Estimation of lipids in egg yolk.
3. Estimation of protein in milk by formol titration/ casein nitrogen.
4. Analysis of milk for its lactose/ total solid/
5. Determination of ascorbic acid in fruit juices/ citrus fruits.
6. Determination of total acidity, fixed acidity and volatile acidity in pickles / titratable acidity in fruits/ fruits juices.
7. Determination of sodium bicarbonate in carbonated drinks/ soda water/ soft drinks and determination of caffeine in cola drinks/ carbonated beverages.
8. Determination of water extractives and tannin in a Tea Coffee sample.
9. Determination of ether extractives and caffeine in tea/ Coffee samples.
10. Determination of vanillin in vanilla extract/ food sample.
11. Determination of iron content in foods by spectrophotometry.
12. Isolation of piperine from black pepper and its determination as crude piperine.
13. Determination of Carbon dioxide in carbonated beverages.

**3. Pharmaceutical, Clinical & Cosmetics analysis :**

1. Determination of glucose in honey by Wilstatter's method.
2. Analysis of acetyl salicylic acid.
3. Estimation of micro nutrients Zinc/Copper/ Manganese in a soil sample.
4. Determination of acid value of rosin.
5. Determination of pH of Hair shampoos.
6. Assay of isoniazide.
7. Ultraviolet spectro photometric determination of Aspirin, Penacetin, and caffeine in APC tablets using solvent extraction.
8. Estimation of blood glucose.
9. Estimation of serum bicarbonate.
10. Estimation of blood urea.

**4. Fuel Analysis :**

1. Determination of moisture in coal
2. Determination of Ash in coal.



### Recommended Books :

1. Fundamentals of analytical Chemistry :  
7<sup>th</sup> Edition – Douglas A Skoog, Donald M West and Holler Harcourt College Pub
2. Principles of instrumental analysis:  
D.A Skoog and D. M. West sauder's college pub
3. Standard methods of chemical analysis:  
Part A & B – Editor Welcher – Van Nostrand reinhold Co.
4. Text Book of Microbiology: Freeman Burrows \_ WB saunders.
5. Text Book of Biochemistry: West and Tood/ Lehninger.
6. Practical physiological chemistry: Hawn, Oser and summerson Tata- Mograw Hill book Co.
7. A Text book of quantitative Inorganic Analysis: A. I Vogel
8. Quantitative Analysis: Cumming and Key
9. Quantitative Chemical Analysis: Kolthoff, sandell and others 4<sup>th</sup> Edition
10. Analytical chemistry: Gary D. Christain 4<sup>th</sup> Edition John Wiley and Sons New York .
11. Environmental analysis: G. R. Chatawal MC Mehra, M satake and other – Amol Publications, New Delhi
12. Analytical Aagricultural Chemistry: SL Chopra and J. S. Kanwar Kalyani Publishers, Ludhiana
13. Chemistry of the Soil: Edited by Firman E. Bear 2nd Edition Americal chem.. Soc. Monograph Series Oxfor & IBH Pub
14. A text Book of Experiments & Calculations in Engineering Chemistry  
S. S. Dara S. Chand and Co.
15. Elements of Environmental Chemistry: H. V. Jadhav, Himalaya Publishing House.
16. Methodlogy for water Analysis :  
IAAB Editional Board M. S. Kodarkar, AD Diwan and others, IAAB Publication, VV College Hyderabad .
17. Experiments in general Chemistry :  
C. N. Rao and U. C. Agrawala, 4<sup>th</sup> Edition Affilated East – West Press
18. Chemistry of air and air pollution :  
S.A. Iquabal and Y. Mido, Discovery Publishing house, New Delhi .
19. A Text Book of Environmental :  
S. S. Dare Chemistry and Pollution Control
20. Environmental Chemistry :  
K. De, Wiley Estern Pub.
21. Pearsons Chemical Analysis of Foods :  
Harold Egan, Ronald S. Kirk and Ronald sawyer, 8<sup>th</sup> Edition, Churchill Livingstone.
22. Hand Book of Analysis & Quality Control for fruit and vegetable products S.  
Ranganna, Tata Mc Graw Hill Pub. Co.
23. Chemical analysis of food and food products: M.B. Jacob
24. Food analysis – Lab Experiments: Melon and Pomerazu
25. Introduction to Chromagraphy :  
V. K. Srivastava and K Krishna S. Chand and Co.

26. Polarographic methods in Analytical Chemistry :  
M.G. Arora, Anmol Publications, New Delhi
27. Quantitative Pharmaceutical Chemistry: Jenkins and others
28. Bentley and Drivers T. B. of Pharmaceutical Chemistry :  
Rev By L. M. Atherden 8th Edition Oxford University Press, N. Delhi
29. Air Pollution : Henry C. Perkins
30. Chemical Analysis of Water: Dickinson
31. Applied Inorganic Analysis :
32. Hoffmann, Lundell & others. Commercial Method of Analysis :  
Foster D Snell and Frank M. Biffen
33. Quantitative Analysis: Day & Underwood
34. Instrumental methods Chemical analysis: Willard, Dean and Merritt
35. Instrumental methods of Analysis: Chatwal and Anand
36. Spectrometric Identification of Organic Compounds :  
Silverstein, Bessler and others
37. Spectroscopic Methods in Organic Chemistry :  
D. H. Williams and Ian Fleming
38. Spectroscopy: William Kemp
39. Biochemical Laboratory Technique: Cheykin
40. ISI Standard methods of Water and Air analysis: Blackie , USA
41. Experiments in modern Analytical Chemistry: Dkealey, Chapman & Hall.
42. Analytical Chemistry - H, Kaur, Pragati Prakashan Meerut ( for Fuel & Soil Analysis )
43. Analytical Chemistry - Dr. Alka K. Gupta , Pragati Prakashan Meerut ( for Fuel & Soil Analysis )
44. Analytical Chemistry - Gary D. Christian Wiley students Old & 6th edition ( for automation )
45. Principles and practice of Analytical Chemistry – F. W. Field & D. Kealey ( for automation )
46. Chromatography – D. R. Brown Ivy publishers, New Delhi .
47. Chemical Analysis 2<sup>nd</sup> Edition 2007 Francis & Taylor Annick Rouessac John Wiley & Sons.