Deccan Education Society's

FERGUSSON COLLEGE (Autonomous), PUNE - 411004

Two Years
M. Sc. Degree Course in Chemistry
(Analytical Chemistry)

SYLLABUS

Semester – III and IV

Second Year M. Sc.
[Analytical Chemistry]

[Academic Year : 2017-2018]

Deccan Education Society's

FERGUSSON COLLEGE (Autonomous), PUNE – 411004

Department of Chemistry

Two Years M. Sc. Degree Course in Analytical Chemistry

[Implemented from Academic Year 2017-2018]

M. Sc. Part II Analytical Chemistry Course Structure under CBCS (Autonomous)

Term / Semester	Name of the Paper	Title of Paper	Theory Credits	No. of Lectures / Practicals
Semester III	CHA5301	Electro analytical and Radio analytical Techniques	4	60
	CHA5302	Pharmaceutical Analysis	4	60
	CHA5303	Extraction and Atomic spectroscopic Techniques	4	60
	CHA5304 CHA5305 CHA5306	Elective Papers : Any Two		
		Metallurgy and Analysis of Cement	2	30
		Geochemical and Agrochemical Material Analysis	2	30
		Consumer products	2	30
	CHA5307	Analytical Chemistry Practical V (Industrial materials Analysis)	4	15 Practicals
	CHA5308	Analytical Chemistry Practical VI (Analysis of Bioanalytical fluids)	4	15 Practicals
	CHA5309	Self-Learning Course-3	1	15
Semester III : Credits			**25**	

Term / Semester	Name of the Paper	Title of Paper	Theory Credits	No. of Lectures / Practicals
Semester IV	CHA5401	Forensic science and Food Analysis	4	60
	CHA5402	Analytical spectroscopy.	4	60
	CHA5403	Polymer science	4	60
	CHA5404 CHA5405 CHA5406	Elective Papers : Any Two		
		Bioanalytical methods.	2	30
		Pollution monitoring and control	2	30
		Nanotechnology	2	30
	CHA5407	Analytical Chemistry Practical VII (Analysis of Consumer products)	4	15 Practicals
	CHA5408	Analytical Chemistry Practical VIII (Analysis of food and pharmaceutical products / Project)	4	15 Practicals
	CHA5409	Self-Learning Course-4	1	15
Semester IV : Credits			**25**	

Deccan Education Society's

Fergusson College (Autonomous), Pune – 411004

Faculty of Science

Extra Credits for Post Graduate Courses

M. Sc. Course in Analytical Chemistry

Semester	Course Code	Title of the Course	No. of Credits
III	XCS0007	Introduction to Cyber Security - III / Information Security - III	1
	XSD0008	Skill Development - III	1
IV	XCS0009	Introduction to Cyber Security - IV / Information Security - IV	1
	XSD0010	Skill Development - IV	1

Semester III

Course Code: CHA5301
Course Title: Electro Analytical and Radio Analytical Techniques
(4 Credits)

Objectives:

1. To study the basics of electrochemical reactions.
2. To understand the concept of Faraday's law.
3. To know principle, instrumentation and applications of different electroanalytical techniques.
4. To know importance of Ilkovik equation.
5. To understand the concept of Radio analytical method of Analysis.
6. To know principle, instrumentation and applications of Activation analysis.
7. To know principle, types and applications of IDA.
8. To know principle, types and applications of Radiometric Titrations.
9. To understand basic concepts of Thermal methods of Analysis.
10. To study instrumentation of Thermo gravimetric methods of analysis.
11. To understand the factors affecting Thermo gravimetric methods of analysis curve.
12. To understand application of DTA.
13. To know principle and instrumentation of DSC.
14. To understand concept of Thermometric Titrations and EGA.

Unit-I	**Coulometry:** Current voltage relationship during an electrolysis, Operating cell an at fixed applied potential, Electrolysis at constant working electrode potential, Coulometric methods of analysis, Faradays laws of electrolysis, Instrumentations-Constant current and constant voltage instruments, potentiostatic coulometry-Instrumentation and applications, Coulometric titrations (Amperostatic coulometry)-Apparatus and applications, advantages and limitations, problems. Specific Applications of Coulometry.	**6L**
Unit-II	**Voltammetry and Polarographic Methods of Analysis** **a. Polarography** (linear scan polarography): Polarographic principles, Instrumentation (different types of microelectrode such as dropping mercury electrode, the static drop mercury electrode, rotating disc and ring disc electrode, cell for polarography, reference and counter electrode and circuit diagram), polarogram and polarographic currents, charging or capacitive current, role of supporting electrolyte, factors affecting on polarographic wave, Ilkovic Equation, advantages and disadvantages of DME, polarographic maxima and maxima suppresors, interference due to dissolved oxygen, Applications (qualitative analysis, quantitative analysis by calibration curve and standard addition methods), specific examples of analysis – analysis of Cu, Cd, Zn, Pb, etc. from tap water and alloys., problems. Specific Applications of Voltametry and Polarography. **b. Hydrodynamic voltametry** and applications of hydrodynamic voltametry (volatametric detectors in chromatography and flow injection analysis, Voltametric oxygen sensors, amperometric	**18L**

	titration), Rotating Disc Voltametry, Rotating Ring Disc voltametry, Flow through Voltametry, Specific Applications. **c. Pulse Polarography:** Different types of excitation signals in pulse polarography, Differential pulse polarography, square wave polarography, Stripping method. Voltametry with ultra microelectrode, Applications of these technique Cu and Zn from tap water by differential pulse polarography and by square wave polarography, Vitamin-C by differential pulse polarography, Determination of Pb in tap water by stripping method), Specific Applications. **d. Cyclic Voltametry:** Principle of cyclic Voltammetry, cyclic voltamogram of $K_3[Fe(CN)_6]$, and parathion, criteria of reversibility of electrochemical reactions, quasi reversible and irreversible processes. . Randles Sevcik equation, Cyclic Voltametry on modified electrode, Cyclic Voltametry of aromatic compounds, Electron transfer followed by Chemical reaction (EC mechanism), specific applications. **e. Amperometry:** Principle, instrumentation, typical applications, amperometric titrations, chronoamperometry and chrono-potentiometry, specific applications. **f. Important Electrochemical Devices:** Batteries, Fuel Cells, Super capacitors, Ion Selective Electrodes.	
Unit-III	**Radioanalytical Methods of Analysis** **a. Activation analysis:** Neutron activation analysis, principle, technique, steps involved in neutron activation analysis. Radiochemical and instrumental methods of analysis, important applications of NAA. **b. Isotope Dilution Analysis:** Principle, types of isotope dilution analysis, typical applications of isotope dilution analysis. **c. Radiometric Titration:** Principle, techniques based on complex formation & precipitation, radiometric titration curves for estimation of ions from their mixture.	**20L**
Unit-IV	**Thermal Methods of Analysis** **a. Thermo gravimetric methods of analysis:** Instrumentation, thermogram and information from thermogram, factors affecting thermogram, applications TGA for quantitative analysis (TG analysis of CaC_2O_4 H2O, $CuSO_45H_2O$, dolomite ore, etc.) and problems based TGA. **b. Differential Thermal Analysis (DTA):** Instrumentation, general principles, differential thermogram, DT and TG curve together, Applications (DT analysis of mixture of polymers, DT analysis of CaC_2O_4 H_2O, DT analysis of sulfur, DT analysis of $CuSO_4$ $5H_2O$). TG and DT curve for $Mn(PH_2O_2)_2$ H_2O. **c. Differential Scanning Calorimetry (DSC):** Principle, Instrumentation, and Applications (DCS curve of polyethylene terphthalate, DSC curve for isothermal crystallization of polyethylene, DSC of phenacetein), thermometric titrations, Evolved gas analysis.	**16 L**

References:

1 Introduction to instrumental analysis by R. D. Broun, Mc Graw Hill (1987)
2 Instrumental methods of chemical analysis by H. willard, L.Merrit, J.A. Dean and F.A. settle. Sixth edition CBS (1986)
3 Fundamentals of analytical chemistry by D. A. Skoog, D. M. West and H. J. Holler sixth edition (1992) and Principles of Instrumental Analysis Skoog, West, Niemann.
4 Vogel Text Book of quantitative analysis 6th Ed.
5 J. chemical education, 60,302 to 308 (1983)
6 Thermal analysis by W.W. Wendlandt, John Wiley, (1986)
7 Cyclic Voltammetry and frontiers of electrochemistry by N.Noel and K.I. Vasu IBH, New Delhi (1990)
8 Source book of Atomic energy by Glasstone.
9 Principle of Activation Analysis- P. Kruger, John Wiley and sons, (1971).
10 Nuclear Analytical Chemistry – J. Tolgyessy and S. Verga vol. 2, university Park press,(1972)
11 Radiochemistry and Nuclear methods – W.D. Ehmann and D.E. Vance, John Wiley and Sons.
12 Modern Electrochemistry by Boekris and Reddy, 3rd volume.
13 Laboratory Techniques in Electroanalytical Chemistry, P. T. Kissinger and W. R. Heineman.
14 Electrochemical Methods: Fundamentals and Applications by Allen J. Bard and Larry R. Faulkner.

Course Code: CHA5302
Course Title: Pharmaceutical Analysis
(4 Credits)

Objectives:

1. Requirement of bioassay.
2. Standard preparation for bioassay.
3. Blood group determination.
4. Preliminary testing of test sample
5. To understand the concept and determination of Limit test for different pharmaceutical substance
6. To understand concept of Membrane filtration technique
7. Knowledge about adulteration misbranding
8. How to read labels and its importance
9. Information about IND and NDA
10. Importance of sterilization.
11. To learn different Pharmacokinetics and Pharmacodynamics effects of drugs on human body**.**
12. Precautions needed to be taken while processing pharmaceutical product.
13. Importance of pharmacopeia.
14. To formulate Karl fischer reagent and standardisation.
15. Types of aerosols.

Unit I	**Role of FDA in Pharmaceutical Industries** Definitions of Drug & Cosmetics, Sub standard Drugs, Role of FDA, Introduction to New Drug, Development of New Drugs- Selection of Area,, Phase I, Phase II, Phase III. Application to FDA for formulation and marketing for new drug. Stability studies and Self life fixation	**5L**
Unit II	**Dosage form and analysis:** Introduction to dosage, different dosage forms with the IP requirements. Tablets, different types of tablets, additives used in tablet manufacture. Analysis of aspirin tablet, Capsules, types of capsules, (Rifampicin), Powders (Sodium benzoate), Solutions (saline NaCl), Suspensions (barium sulphate – limit test for impurity), Mouthwashes, (Ointments (salicylic acid) and creams Dimethicone by IR) Injections (Mannitol), Aerosols (salbutamol), Blood products and reporting protocols.. Problems based on assay of these materials.	**15L**
Unit III	**Physical tests:** a. Disintegration and Dissolution of tablets and capsules rate of dissolution and types dissolution apparatus, b. uniformity of weight of single-dose and uniformity of content, friability c. Moisture / water content by Karl-Fischer titration- Principle, types of Karl Fischer titration, preparation and standardization of Karl Fischer reagent. d. Sterilization: Methods for Sterilization (Physical and chemical method), Applications.	**10L**

Unit IV	**Assay :** **a. Biological Assays:** Introduction to biological assay, Biological assay of Heparin sodium, Determination of Amylase activity, Test for Undue Toxicity. **b. Microbiological Tests and Assays :** Microbiological test for Antibiotics, Cylinder-plate assay receptacles, Turbidimetric or tube assay methods, Assay Designs, Cylinder plate or Cup-plate method, Pour plate method, surface spread method, Most probable number method, Two level fractional assay.	**10L**
Unit V	**Pharmacology: Pharmacokinetics and dynamics** a. Introduction and importance, dose response relationship b. Pharmacokinetics: Definition, ADME process and pharmacokinetics models **c.** Pharcodynamics: Definition, Drug **receptor** interaction, receptor binding effect	**5L**
Unit VI	**Sources of Impurities in Pharmaceutical Raw Materials & Finished Products, Shelf Life of Pharmaceutical Product:** Raw materials, Method of manufacture, Atmospheric contaminations, Cross contamination, Microbial contamination, Container contamination, Packaging errors, Chemical instability, Temperature effect and Physical changes, shelf life of Pharmaceutical product and determination of shelf life. Water for pharmaceutical use. **Limit test:** Limit tests for aluminium, arsenic, iron, lead, potassium, sulphate, chloride, heavy metals	**10L**
Unit VII	**Analysis of Vegetable Drugs :** Sampling, foreign organic matter, test for complete extraction alkaloids, ash value, acid soluble ash, acid insoluble ash, sulphated ash, Extraction of alkaloids. Loss on drying loss on ignition.	**5L**

References:

1. Indian Pharmacopeia Volume I and II.
2. Practical Pharmaceutical chemistry third edition volume 1. By A. H. Beckett & J. B. Stenlake.
3. Remington‘s Pharmaceutical sciences.
4. Ansel’s Pharmaceutical Analysis.
5. Aymanns C, Keller F, Maus S, et al. Review of pharmacokinetics and pharmaco dynamics and the aging kidney. Clin J Am Soc Nephrol.

Course Code: CHA5303
Course Title: Extraction and Atomic Spectroscopic Techniques
(4 Credits)

Objective:

1. To understand principle behind extraction techniques.
2. To understand principle of liquid-liquid extraction techniques.
3. To identify method of selection of solvents for LLE.
4. To understand principle of Solid Phase extraction.
5. To know principle of Solid phase micro-extraction.
6. To learn about Methods of analysis: SPMEGC, SPME-HPLC-MS.
7. To acquire knowledge of advance automation of SPME.
8. To know principle of microwave assisted extraction.
9. To learn about instrumentation methods of microwave assisted extraction.
10. To study application of microwave assisted extraction.
11. To understand principle of supercritical fluid extraction.
12. To understand Theory, principle, instrumentation and applications of atomic spectroscopic techniques.
13. To learn about Methods of introducing sample in atomic spectroscopic instrumentation.
14. To understand Theory of Flame atomizer
15. To understand construction and working of LASER.
16. To study application of LASER with respect to AFS analysis.
17. To know instrumentation of Resonant Ionization Spectroscopy.

Unit I	**Introduction to Extraction Techniques:** Introduction, Pre-Sampling Issues, Sampling Strategies: Solid, Aqueous and Air Samples, Quality Assurance Aspects.	**3L**
Unit II	**Classical Approach for Aqueous Extraction:** Introduction, Liquid-Liquid extraction (LLE) (Theory of LLE, selection of solvents, solvent extraction, problems with LLE process), purge and trap for volatile organics in aqueous samples.	**6L**
Unit III	**Solid Phase Extraction (SPE):** Introduction, Types of SPE media, SPE formats and apparatus, method for SPE operation, solvent selection, factors affecting SPE, selected methods of analysis for SPE, Automation and On-Line SPE. Introduction to Solid phase micro-extraction, theoretical considerations, experimental, Methods of analysis: SPMEGC, Methods of analysis: SPME-HPLC-MS, Automation of SPME, New development in micro extraction (liquid micro extraction, membrane micro extraction).	**12L**
Unit IV	**Microwave Assisted and Supercritical Fluid Extraction** Introduction to microwave assisted and its instrumentation with Applications. Supercritical fluid extraction: concept of critical state of matter and super critical state, types of super critical fluids, apparatus and applications to environmental, food, pharmaceuticals and polymeric analysis.	**9L**
Unit V	**Introduction to Optical Atomic Spectroscopic Analysis:** Theory, atomic emission spectra, atomic absorption spectra, atomic line width,	**4L**

	factors affecting spectral width, effect of temperature, sample introduction methods, introduction of solid samples.	
Unit VI	**Atomic Absorption Spectroscopy:** Flame atomizer, types of flames, flame profile, Factors affecting atomization efficiency, electro-thermal atomizers, Cold vapor technique, radiation sources-HCL, EDL and instrumentation for AAS, chemical and spectral interferences, standard addition, internal standard method of analysis, Applications of AAS.	**8L**
Unit VII	**Atomic Emission Spectrometry (AES):** Sources, inductively coupled plasma and direct current plasma, laser microprobe, wavelength selection and detection, qualitative and quantitative analysis, comparison of atomic absorption and emission methods, Applications of AES.	**6L**
Unit VIII	**Atomic Mass Spectroscopy:** Features of atomic mass spectroscopy, Atomic weight in mass spectroscopy, mass to charge ratio, Types of atomic mass spectroscopy, transducer for mass spectroscopy, qudrapole mass analyzer, time of flight mass analyzer, Inductively coupled mass spectroscopy (ICPMS), Atomic mass spectra and interferences, Applications of ICPMS.	**6L**
Unit I	**Laser Based Techniques:** Atomic Fluorescence Spectroscopy (AFS): Theory of AFS, apparatus for AFS, EMR source for AFS, LASERS, Cells for AFS, Wavelength selection for AFS, Detectors for AFS, Analysis with AFS, Interference With AFS. Resonant Ionization Spectroscopy, Laser-enhanced ionization spectroscopy.	**6L**

References:

1. Introduction to Instrumental Analysis by R. D. Braun, Mc Graw Hill (1987)
2. Instrumental methods of chemical analysis by H. willard, L.Merrit, J.A. Dean and F.A. settle. Sixth edition CBS (1986)
3. Fundamentals of Analytical Chemistry, 6th edition, D.A. Skoog, D.M. West and F. J. Holler, Saunders college publishing.
4. Principles of Instrumental Analysis, Skoog, Holler, Nieman, (Sixth Ed.)
5. Vogel's Textbook of Quantitative analysis 6th Ed.
6. Modern analytical techniques in the pharmaceutical and bio analysis **By** Dr. Istvan Bak (Book Available Online).
7. Preparative chromatography Chrome Ed. book series, Raymond P. W. Scott (free e-book available on internet)
8. Extraction technique in analytical science, John R. Dean, Wiley (2009)
9. Practical HPLC method Development, Snyder, Kirkiand, Glajch, Wiley India Pvt. Ltd.

Elective Papers (Any Two)

Course Code: CHA 5304
Course Title: Metallurgy and Analysis of Cement
(2 Credits)

Objectives:

1. To describe ores and minerals with examples.
2. To know methods of metal dressing and effect of metallurgical process on environment.
3. To study analysis of various ores and alloys by chemical methods.
4. To understand the process of metal extraction from respective ores.
5. To describe ores and minerals with examples.

Unit I	**Introduction:** Ores and minerals, dressing of ore, methods of metal dressing (hand picking, magnetic separation, centrifuge, froth flotation etc.), pollution due to metallurgical process (Metal dressing, calcinations, smelting).	**4L**
Unit II	**Analysis of Ores and Alloys:** Dolomite (For silicate, Mg and Ca content), Ilmenite (for silicate, Ti and Fe content), Monazite (for rare earth metals), Hematite (silicate and Fe content), Pyrolusite (for silicate and Mn content) and bauxite (for Al and Silicate content). Alloy: Types, composition and analysis of Copper based alloy like cupronickel (Cu, Ni), bronze (Cu, Sn) and brass (Cu, Zn), Aluminum based alloy Duralumin and Magnalium, stainless steel (Fe, Cr, Ni, Co, Cu, Mn), and Solder (Pb and Sn).	**10L**
Unit III	**Principles of Metal Extraction and Refining:** Sources of raw material. Introduction of mineral dress, Principles of pyrometallurgy – roasting, agglomeration, smelting, refining & secondary refining Principles of hydrometallurgy, electrometallurgy. Extraction of Al from bauxite, Cu from Copper pyrites, and Fe from Hematite ore.	**6L**
Unit IV	**Analysis of Cement and Building Materials:** Types of cement, sampling, Analysis of cement and building materials: Silicon dioxide, aluminium oxide, ferric oxide, calcium oxide, magnesium oxide, sulphur- trioxide, sulphide- sulphur, loss on ignition, insoluble residue, sodium and potassium oxide.	**10L**

References:

1 Standard methods of chemical analysis, Sixth Edition, F.J. Welcher.
2 Quantitative Inorganic Analysis including Elementary Instrumental analysis, By A. I. Vogel, 3ed, ELBS, 1964.
3 Chemical analysis of metals ; Sampling and analysis of metal bearing ores: American Society for Testing and Materials 1980 - Technology & Engineering
4 Manual of Procedures for Chemical and Instrumental Analysis of Ores, Minerals, and Ore Dressing Products. Government of India Ministry of Steel & Mines, Indian Bureau of Mines, 1979.

Course Code: CHA 5305
Course Title: Geochemical and Agrochemical Material Analysis
(2 Credits)

Objectives:

1. To study the determination of major soil constituents fusion analysis.
2. To understand chemical and mineralogical composition of soil.
3. To understand the process of Sampling and sample preparation.
4. To analyze nitrogen content by Kjeldahl method.
5. Determination of total nitrogen by reduced iron method.
6. To describe various methods for Potassium content.
7. To understand mechanism of action and synthesis and sampling of pesticide residue and standards.

Unit I	**Analysis of Soil:** Chemical and mineralogical composition of soil, classification of soil, macro and micronutrients (functions and deficiency) for plant growth, Sampling, determination of Moisture Content, Water Holding Capacity. Analysis of Carbonate, Organic carbon, and organic matter, Total nitrogen, ammonia and nitrates, Total determination of major soil constituents by fusion analysis, silica and total combined oxides of iron, aluminium, and titanium, Determination Ca, Mg, Na, K, phosphate, Exchangeable cations, Cation exchange capacity.	**10L**
Unit II	**Analysis of Fertilizers:** Introduction, Sampling and sample preparation, water, total nitrogen: Kjeldahl method, total nitrogen by reduced iron method, urea nitrogen, total Kjeldahl nitrogen methods and spectrophotometric method, Ammonia nitrogen. Phosphorus: total phosphorus, available and non-available, alkali metric ammonium molybdophosphate method, water soluble phosphorous, citrate insoluble phosphate, Potassium: potassium by sodium tetra phenyl borate method, flame photometric methods, environmental effect of fertilizers.	**10L**
Unit III	**Analysis of Pesticides Residue:** Introduction, Classification, mechanism of action, uses and toxici effects, sampling of pesticide residue, pesticide standards, Analysis of Pesticide residues in food samples and water- Chlorinated Pesticide, Organo-Phosphorus Pesticides.	**10L**

References:

1 Standard methods of chemical analysis, Sixth Edition, F.J. Welcher.
2 Quantitative Inorganic Analysis including Elementary Instrumental analysis, By A. I. Vogel, 3ed, ELBS, 1964.
3 Chemical analysis of metals ; Sampling and analysis of metal bearing ores: American Society for Testing and Materials 1980 - Technology & Engineering
4 Manual of Procedures for Chemical and Instrumental Analysis of Ores, Minerals, and Ore Dressing Products. Government of India Ministry of Steel & Mines, Indian Bureau of Mines, 1979.
5 Manual for analysis of pesticide residue for food by FSSAI government of India 2012.
6 Development and validation of Analytical Methods, Progress Pharmaceutical and Biomedical Analysis, Vol-3, Edited by Chitofer M. Riley and Tomas W. Rosansk (Elvier).

7 HPLC method Development for pharmaceuticals, Edited by Satinder Ahuja and Henrik Rasmussen, Academic Press, Separation science Series, Vol-8.
8 Practical HPLC method Development, Snyder, Kirkiand, Glajch, Wiley India Pvt. Ltd.
9 Hand Book of Water, Air and Soil Analysis(A Lab Manual) by Sadhana Chaurasia.

Course Code: CHA 5306
Course Title: Consumer products
(2 Credits)

Objectives:

1. To study general scheme of analysis for soap with different parameters.
2. To determine different constraints from synthetic detergent
3. To study concept of different test for paints and pigments
4. To identify plasticizers, binders and thinners.
5. To introduce types of petroleum products and identify it by different methods.

Unit I	**Analysis of Soaps and Detergents:** **a. Soaps:** General scheme of analysis, sampling, moisture and volatile matter, active ingredient and equivalent combined SO_3, other specific tests for soaps (such as total fatty acids, Free alkali or free acid, titer test, Iodine value, saponification value). **b. Tests for synthetic detergents:** Moisture, unsulfonated matter, combined alcohols, Available oxygen (perborate), alkalinity and phosphate, anionic detergent	**8L**
Unit II	**Analysis of Paints and Pigment :** Introduction, test on the total coating, water content, separation of pigment binder, and thinner of solvent type coating, Identification of the binder, Identification of polymer resins and oils, Identification of plasticizer, Analysis of the vehicle, Identification and Analysis of pigments, Titanium dioxide, antimony oxide, analysis of colored pigments.	**16L**
Unit III	**Analysis of Petroleum and Petroleum Products:** Introduction, determination of flash and fire point by Pensky Marten's apparatus, Saybolt viscometer, API gravity by hydrometer method, cloud and pour point, aniline point and mixed aniline point, doctor test for petroleum distillate, lead anti knock compounds, vapour pressure by Reid method.	**6L**

References:

1. Standard methods of chemical analysis, volume 3, Part-B, F.J. Welcher.
2. Standard methods of water and waste water analysis by A.K. De.
3. Environmental Chemistry, A. K. De

Course Code: CHA5307
Course Title : Analytical Chemistry Practical V
(Industrial Materials Analysis) (Any Fifteen)
(Credit 4)

1. Estimation of aspirin content from tablet by conductometric titration with standard solution of NaOH.
2. To determine concentration of sulphuric acid, acetic acid and copper sulphate by conductometric titration.
3. Determine ionisation constant of indicator using spectrophotometer.
4. Determination of Na from water sample by flame photometry using calibration curve and standard addition method.
5. Determination of K from water sample by flame photometry using calibration curve and standard addition method.
6. Determination of sulphate ion by turbidimetry using calibration curve method.
7. Determine chloride from water sample by Nephelometry.
8. Determine concentration of sodium and potassium from binary mixture by flame photometry.
9. Estimation of micronutrients from food by AAS (any two elements from Fe, Cu, Zn, Mn, Mo, B etc)
10. Determination of Cu and Zn in brass alloy by polarography
11. Determination of diffusion current from cyclic voltamogram of $K_3Fe(CN)_6$.
12. Analysis of Dolomite for Si, Ca and Mg
13. Analysis of Magnalium for Al and Mg
14. Analysis of bauxite for Si and Al
15. Analysis of Plaster of Paris for Ca by $KMnO_4$ method.
16. Estimation of Mg from Milk of Magnesia.
17. Estimation of Phosphorus from fertilizer.
18. Determine amount of magnesium from given talcum powder
19. Determination of Nitrogen from Fertilizer by Kjeldhal's method.
20. Determination of organic carbon in soil
21. Analysis of Iodine value from oil.
22. Analysis of pesticide residue by Gas Chromatography.

References:

1 Pharmacoepia of India
2 Biochemical methods, Sadashivam and Manickem, New Age international Publication
3 General Chemistry Experiments, by Elias, Universities Press
4 Vogel's textbook of quantitative chemical analysis, Sixth Ed.Mendham, Denny, Barnes, Thomas, Pearson education.
5 Experiments in chemistry by D. V. Jahagirdar (Himalaya publication)
6 An introduction to practical Biochemistry, Third Ed. by Plummer, Tata Mc-Grew Publishing Company.
7 Quantitative Inorganic Analysis including Elementary Instrumental Analysis by A. I. Vogel's, 3rd Ed. ELBS (1964)
8 Environmental Chemistry by A.K. De 3rd Ed. Wiley Eastern Ltd.
9 Quantitative Inorganic Analysis including Elementary Instrumental Analysis by A. I. Vogels, 3rd Ed. ELBS (1964)
10 Standard methods of chemical analysis by F. J. Welcher
11 Biochemical Methods, Sadashivam and Manickem, Narosa publicatinon
12 Indian Pharmacoepia volume –I and II
13 Experiments in chemistry by D. V. Jahagirdar, Himalaya publication
14 Practical Pharmaceutical Chemistry, 4th Ed. part-2, Beckette, Stenlake

Course Code: CHA-5308
Course Title: Analytical Chemistry Practical VI
(Analysis of Bioanalytical Fluids Practicals) (Any Fifteen)
(Credit 4)

1. Estimation of caffeine from Tea leaves.
2. Determine the Thaimine by spectroflurometry.
3. Detection of Amino acid using ninhydrin by spectrophotometry.
4. Estimation of protein from food by Lowry method.
5. Estimation of Ketone bodies from given sample.
6. Estimation of Creatinine from serum sample.
7. Estimation of reducing sugar by Folin-Wu method.
8. Determination of Glucose from blood by enzyme method.
9. Estimation of HMF from honey.
10. Estimation of Vit-C by titration method.
11. Determination of Iron from syrup by spectrophotometry.
12. Analysis of paracetamol by titration method.
13. Analysis of Cassein from milk.
14. Analysis of Qunine sulphate by spectroflurometry
15. Estimation of chlorophylls in leaf pigments.
16. Amount of carboxylic group by 2,4-DNP.
17. Assay of detergent.
18. Determination of chloride in sodium sulphate (Limit test for chloride)
19. Preparation of Aspirin from salicylic acid.
20. Estimation of fluoride in tooth paste.
21. Estimation of aldehyde in lemon oil and cinnamon oil.

Reference:

1 Organic Laboratory technique a micro scale approach by Donald L. Pavia, Gary M.Lampman, George S. Kriz, Randall G. Engel second edition.
2 Practical clinical Biochemistry, Harold Varley (4th Edition), CBS publishers and Distributers. New Delhi -110002.
3 R. Ikan; Natural products.
4 Peach and Tracy; Methods of Plant analysis Vol. VII.
5 Pavia and others; Organic Laboratory Techniques, (Second Edition,1995),Sannders Series (Harcofst Brace)
6 Analytical Chemistry by Gary Christain, 6th edition, 2008.

Course Code: CHA5309
Course Title: Self-Learning Course-3
(1 Credits)

Objectives:

1. To understand scientific methods for searching chemical literature
2. To get familiar with software tools required for such survey
3. To analyze Plagiarism
4. Introduction to chemistry research journals

Unit I	**Literature Survey in Chemistry:** Use of computer browsing for literature search and downloading –basics of internet services –various sources of abstracts ,articles and papers of browsing and downloading, Techniques of conversion from one format to another Structure drawing programs and their uses –searches through structure. Use of Literature, Knowledge of National and International Journals, Impact Factor, Citation-Index, h Index, SCI Journals, Plagiarism.	15L

Reference:

1. Pubmed
2. Scifinder
3. Sciencedirect
4. Highwire publication
5. Googlescholar
6. Reaxys
7. Scirus.com

Scheme of Analytical Chemistry Practical Examination
CHA5307: Practical Course I : Industrial Materials Analysis (Any Fifteen)
CHA-5308: Practical Course II : Analysis of Bioanalytical Fluids Practicals (Any Fifteen)

Note :

1. The practical examination in the subject will be conducted for SIX HOURS duration.
2. The practical examination in the subject will be conducted for 50 marks.
3. Certified Biochemistry Laboratory Journal is compulsory for the examination.
4. Oral/viva examination is compulsory
5. Book/s printed material, cyclostyled or typed material will be allowed during the practical examination.
6. Examiners will arrange Q1 and Q2 experiments for conducting practical examination.
7. Lucky draw system will be followed for the students for practical examination by the examiners.
8. Log table and calculators are allowed during the practical examination.
9. Mobile/s is/are strictly not allowed during the practical examination in laboratory.

The candidate has to perform the following question/s for practical examination.

Q 1	**Major Experiment (Any ONE)**	**20 Marks**
Q 2	**Minor Experiment (Any ONE)**	**20 Marks**
Q 3	**Oral /Viva**	**05 Marks**
Q 4	**Laboratory Journal**	**05 Marks**
	Total Marks	**50 Marks**

Semester IV

Course Code: CHA5401
Course Title: Forensic science and Food Analysis
(4 Credits)

Objectives:

1. To understand role of forensic science in crime investigation.
2. To know importance of toxicology and its role.
3. To know different methods of isolations of poisons from body fluid
4. To understand different terminologies in Narcotics.
5. To give an introduction to forensic analysis.
6. To study methods of DNA Profiling, alcohol in body fluids, drug identification, blood analysis, fingerprint analysis and explosives analysis.
7. To understand concept of food preservation and processing.

Unit-I	**Forensic Science:** **a. Introduction:** History, role of forensic science in crime investigation, collection and preservation of biological materials. **b. Bloodstain Pattern Analysis**: Blood and blood grouping, type of bloodstain pattern and application. **c. DNA Profiling:** Introduction, principle, DNA and its polymorphism, DNA typing procedures-RFLP, PCR, MVR-PCR, Dot-blot, AMP-FLP, STR, other methods, paternity testing, applications, interpretation and practical use**.** **d. Fingerprint Analysis:** Latent fingerprints; optical, physical, physico-chemical & chemical detection methods; fingerprints in blood, fingerprint detection sequences. **e. Explosives:** Types, analytical methods for identification of low and high explosives in post-blast debris **f. Trace evidence:** Introduction, principle, Hair and fibre analysis. **g. Document Analysis:** Principle and application.	**25L**
Unit-II	**Forensic Toxicology:** **a. Introduction**: Introduction to toxicology, role of forensic toxicology. **b. Poisons:** Type of poisons, detection of poison in biological fluid- physical and chemical method, the role of the clinical toxicology laboratory, diagnosis of acute poisoning and their treatment. **c. Drugs:** Classification of drugs, isolation, identification and determination of following, Narcotics- heroin and cocaine, Stimulants- caffeine, amphetamines, Depressants- Barbiturates, Benzodiazepines. **d. Alcohol in body fluids:** Legal background, Sampling and sample preservation, analysis-GC, IR, enzymatic and other methods.	**15L**

Unit III	**Food Analysis:** **a. Analysis of food:** Milk and milk products, tea, coffee and beverages. Flour, starch, honey, jams and edible oils. **b. Analysis of preservatives:** Inorganic and organic preservatives, coloring matter, micronutrients. **c. Food processing:** Refining milling, canning, concentration, freezing Drying, irradiation, pasteurisation, and sterilization**.**	**20L**

References:

1 Basic Analytical Toxicology Published by WHO, By R. J. Flanagan, R. A. Braithwaite, S. S. Brown Available Online

2 http://www.forensicsciencesimplified.org/

3 Textbook of Medicinal Jurisprudence, Forensic Medicine and Toxicology, 6th edition By Dr. C. K Parikh.

4 Forensic Chemistry, 1st edition, By Suzanne Bell, Person Education Ltd.

5 Shreves' Chemical Process Industries fifth edition by George Austin Mg Graw Hill Practical Pharmceutical Chemistry by Becket

6 Biochemical Methods, Third Edition, By S Sadashivan, A. Manickam; NEW AGE International (P) limited, Publication, Pearson's chemical analysis of food.

7 Practical Biochemistry in Clinical Medicine, R. L Nath, Academic Publishers 2nd Edn (1990)

Course Code: CHA5402
Course Title: Analytical Spectroscopy
(4 Credits)

Objectives:

1. To understand the concept of different spectroscopic techniques.
2. To know principle and instrumentation of electron spectroscopy, chemiluminescence, fluorescence and phosphorescence, surface characterization techniques and XRD.
3. To understand applications of spectroscopic techniques.

Unit-I	**Electron Microscopy** **a. Electron spectroscopy:** Introduction, principle of ESCA, electron spectroscopy for chemical analysis, ESCA satellite peaks, spectral splitting, ESCA chemical shifts, Instrumentation of ESCA, Chemical analysis using ESCA, Applications, Auger electron microscopy, Ultraviolet photoelectron spectroscopy. **b. Surface Characterization by spectroscopy and microscopy:** Introduction to study of surface, Electron stimulated microanalysis methods- (electron microprobe, Transmission Electron Microscope, Scanning Electron Microscope, Scanning Transmission Electron Microscope, Analytical Electron Microscopy, Scanning-Probe Microscopes) – principle, instrumentation and application.	**10L**
Unit III	**X- ray Methods of Analysis:** Principle, Theory- X-ray spectral lines, X-ray tube, X-ray emission, Absorptive apparatus, X-ray Sources, Collimation, sample handling, wavelength dispersive devices, Energy dispersive devices, detectors, readout device, Powder XRD and Single crystal XRD, Chemical analysis using X-ray absorption, X-ray Fluorescence- instrumentation and chemical analysis, X-ray Diffraction, Chemical analysis with X-ray diffraction, numerical problems.	**10L**
Unit-II	**Chemiluminescence, Fluorescence and phosphorescence:** Introduction, principle, types, measurement of chemiluminescence, instrumentation, quantitative chemiluminescence, gas phase chemiluminescence analysis, chemiluminescence titrations, electro-chemiluminescence**,** Photo luminescent theory, Electron transitions during photoluminescence, factors affecting photoluminescence, Luminescent apparatus,Optical extractive sources, wavelength selectors, detectors ad readout devices, photo luminescent spectra, photo luminescent analysis, analysis of non-photoluminating compounds specific examples of analysis using photoluminescence, application of Fluorescence- Polarization Assays in Small Molecule Screening. .	**14L**
Unit VI	**Nuclear magnetic resonance spectroscopy:** **^{1}H- NMR :** Introduction, theory, Instrumentation, Chemical Shifts, Spin-Spin splitting, protons on hetero atoms, coupling protons with other nuclei, solvents, qualitative and quantitative analysis, problems. **^{13}C NMR:** Introduction, interpretation, chemical shifts, spin coupling, quantitative analysis, problems. **2-D NMR:** Introduction, ^{1}H-^{1}H connectivity, ^{1}H-^{13}C connectivity, ^{13}C-^{13}C connectivity, Through space ^{1}H-^{1}H proximity, option and how to	**16L**

	use them, problems.	
Unit V	**Electron Paramagnetic Resonance Spectroscopy (EPR)** Theory and Instrumentation, Spin Hamiltonian, Isotropic and anisotropic EPR spectra, Magic Pentagon rule. Applications of EPR spectroscopy.	**10L**

References:

1 Introduction to instrumental analysis by R. D. Braun, MC. Graw Hill- International edition.
2 Instrumental methods of chemical analysis by Willard, Dean and Merittee- Sixth edition.
3 Analytical chemistry principles by John H. Kenedey- Second edition, Saunders college publishing.
4 Spectroscopic identification of organic compounds Fifth Ed., Silvestrine, Bassler, Morrill, John Wiley and sons.
5 Analytical Chemistry, Ed. by Kellner, Mermet, otto, Valcarcel, Widmer, Second Ed. Wiley –VCH.
6 Vogel's Textbook of quantitative Chemical Analysis, sixth Ed., Mendham, Denney, Barnes, Thomas, Pub: Pearson Education.
7 Electron microscopy in the study of material, P. J Grundy and G. A Jones, Edward Arnold.
8 Solid state chemistry by D K Chakrabarty.
9 Instrumental analysis By Skoog and Holler.

Course Code: CHA5403
Course Title: Polymer Chemistry
(4 Credits)

Objectives:

1. To understand concept and classification of polymer.
2. To learn different types of polymerization techniques.
3. To understand concept of chemical analysis of polymer based on different instrumental techniques.
4. To learn thermal behavior, electrical, optical and chemical properties of polymers.
5. To analyze average molecular weight of polymer and understand concept of molecular weight distribution curve.
6. To understand the concept of end group analysis of polymers.

Unit-I	**Introduction of Polymers:** Basic concepts, History of polymers, Classification of polymers, classification of polymers based on: Origin, structure, stereochemistry, synthesis, type of chain and mechanical properties	**5L**
Unit II	**Polymer synthesis mechanisms:** Chain polymerization (Free radical polymerisation, cationic and anionic polymerisation, co-ordination polymerisation) and step polymerization (Polycondensation, polyaddition and ring opening polymerisation). **Polymerization techniques:** bulk, solution, suspension, emulsion, melt polycondensation, interfacial condensation, solid and gas phase polymerization	**10L**
Unit III	**Molecular Weight and Size of Polymers**: Average molecular weight, Number average and weight average molecular weight, size of polymers, degree of polymerisation, polydispersity, molecular weight distribution-fractionation methods (fractionation precipitation, fractional elution, gel permeation chromatography,), determination of molecular weight by- End group analysis, colligative properties measurements, dilution solution viscosity method (Huggins and Kraemer viscosity plot), molecular weight distribution curve (simple representation of MWD), problem solving.	**10L**
Unit IV	**Properties of polymer** : **Glass Transition Temperature (Tg):** State of aggregation, state of phase, transition and associated properties, factors affecting on Tg, relation of Tg with molecular weight, Tg and copolymers, Tg and melting point, importance of Tg. **Crystallinity of Polymers:** Degree of crystallinity, Crystallisability, polymer crystallization, structural regularity, crystallites, Helix structures, spherulites, polymer single crystals, effect of crystallinity on polymer properties. **Polymer degradation:** Thermal degradation, mechanical degradation, photodegradation, degradation by ultrasonic waves, degradation by high energy radiation, oxidative degradation. **Polymer Solution**: Process of polymer dissolution, thermodynamics of polymer dissolution, effect of molecular weight, solubility of amorphous and crystalline system, The Flory-Huggins theory, nature of polymer molecules in solution.	**15L**

Unit-V	**Analysis and Testing of Polymers:** **a.** Chemical analysis of polymers: X-ray diffraction analysis, thermal analysis (TGA, DTA and DSC). **b.** Physical testing of polymers: Mechanical properties, Fatigue testing, impact testing, tear resistance, hardness, abrasion resistance. **c.** Thermal Testing: flammability, Heat deflection temperature, Vicat softening temperature, torsion pendulum test, thermal conductivity, thermal expansion. **d.** Optical properties: transmittance, color, gloss, haze and transparency. **e.** Electrical properties: dielectric constant and loss factor, resistively, dielectric strength, electronic properties. **f.** Chemical Test: Immersion test, vapor permeability, staining resistance, solvent stress cracking resistance, environmental stress cracking.	**15L**
Unit VI	**Application of polymers :** Plastics, Natural and synthetic fibers, acrylic fibers, elastomers, adhesives. Polymer additives: Fillers, plasticizers, UV stabilizers and absorbers, antioxidants, flame retardants, colourants.	**5L**

References:

1. Textbook of polymer science 3rd edition by F. W. Billmeyer (1994).
2. Principles of polymer systems by F. Rodrigue, Tata McGraw Hill, New Delhi.
3. Principles of polymer systems by P. J. Flory, Cornell University press, New York.
4. Polymer chemistry-an introduction Seymour-Carraher-Marcel Dekker. Inc. New York.
5. Polymer Science by V.R. Gowarikar, N. B. Vishvanathane, New Age International Ltd. Publisher (1998).
6. Polymer Science by Vasant Gowarikar, Wiley Easteren New York (1998).
7. Principle of polymer science, Bahadhur and sastri, Narosa publishing house.
8. Textbook of Polymer Chemistry by M.S. Bhatnagar, S. Chand publication.

Elective Papers (Any Two)

Course Code: CHA5404
Course Title: Bioanalytical Methods
(2 Credits)

Objectives:

1. To introduce sampling methods for collection of blood and urine sample.
2. To study determination of different constituents from blood sample.
3. To study determination of different constituents from urine sample.
4. To study various types of human nutrients.
5. To study determination of carbohydrates from human nutrients by different methods.
6. To study determination of vitamins from human nutrients by Kjeldhal method and Lowry method.
7. To study determination of lipids from human nutrients by different methods.

Unit-I	**Analysis of Blood and Urine**: Blood: Collection of Blood specimens, storage and preservation, Urine: Collection of Urine, physical characteristics of urea, preservation and storage, Faeces: Collection and preservation. Determination of blood and plasma glucose by glucose oxidase method, Determination of urine for glucose, Determination of ketone bodies in blood, Oral Glucose tolerance test, Determination of serum creatinin, estimation of serum bilirubin, Estimation of serum cholesterol, determination of blood haemoglobin, Urate: determination of serum urate, Determination of urea in urine by urease method and by direct colorimetry.	**10L**
Unit-II	**Human-Nutrition:** **a. Carbohydrates-** Definition, functions and Analysis of total carbohydrates by Anthrone method, starch using Anthrone reagent, pectin by gravimetric method, and crude fibres. **b. Proteins-** Definition, functions and analysis protein by Kjeldhal method and Lowry method, total free amino acids, methionine in food grain. **c. Vitamins-** Definition, functions and analysis of Retinol, Vitamin D_3,Vitamin E, Vitamin B_1, Vitamin B_2 , Vitamin B_6, Nicotinic acid, Niacin and Vitamin C. **d. Lipids-** Definition, functions and analysis of free fatty acids, saponification value, iodine value and peroxide value.	**20L**

References:

1 Practical Clinical Biochemistry, Gowenlock, CBS published, 6th Ed.
2 Chemical analysis of food by Pearson.
3 Practical Pharmaceutical Chemistry by Beckett
4 Biochemical methods of analysis S. Sadasivam and A. Manickam, Narosa Publication.

Course Code: CHA5405
Course Title: Pollution Monitoring and Control.
(2 Credits)

Objectives:

1. To study methods of removal heavy toxic elements.
2. To understand different recovery techniques of waste water.
3. To understand hazardous effects of SO2.
4. To introduce economics of SO2 control measures.
5. To study determination of nitrogen in various form of samples.
6. To understand various effluent analysis processes.
7. To introduce photochemistry of air pollutions.
8. To introduce the concept of waste water treatment and analysis.
9. To introduce sampling methods for collection of waste water sample.
10. To study determination of different properties of water from waste.
11. To estimate toxic elements from waste water

Unit I	**Removal of Heavy Toxic Metals:** Chromium, Mercury, Lead, Cadmium, Arsenic, analytical methods of determination of small amount of the metal pollutants, copper recovery, treatments of waste to remove heavy metals, recovery techniques.	**8L**
Unit II	**Removal of Sulphur Dioxide and Nitrogenous Materials** Origin of SO2 and its hazards, Analysis of SO2 control methods, desulphurization of fuels, Indian coal and Indian crude oil. Economics of SO2 control measures. NOx, dissolved NOx, nitrites, ammonia, Urea and other nitrogen compounds in the effluent fertilizers explosive, industrial effluents, effluents from nitro aromatic industries, analytical methodology, photochemistry of air pollutions.	**10L**
Unit III	**Waste Water Analysis and Treatment** Water pollutants, purpose of chemical analysis, sampling of water, pH of water, specific conductance, determination of acidity and alkalinity, Chemical oxygen demand, biological oxygen demand, dissolved oxygen, determination of aluminium, boron, calcium, carbon dioxide, chloride, residual chlorine, Chlorine demand, total hardness, nitrate, nitrite, ammonia nitrogen, sulphate, sulphide, anionic detergents, tannin and lignin.	**12L**

References:

1 Environmental pollution analysis, S.M. Khopkar
2 Environmental pollution analysis, A.K. De
3 Pollution control in processes industries, S.P. Mahajan (J.W)
4 Industrial safety handbook, W. Handley
5 Environmental Chemistry, B. K. Sharma

Course Code: CHA5406
Course Title: Nanotechnology
(2 Credits)

Objectives:

1. To study fundamental concepts and various synthesis route of Nanomaterials.
2. To understand applications of Nanomaterials in various field.
3. To give an overview of nanotechnology in biomedical application.
4. To study use of nanomaterials in drug delivery, biomedical sensors and biosensors etc.
5. To study applications of nanomaterial as a probe for bioimaging
6. To give an overview of environmental impacts of nanotechnology.
7. To study engineered nonmaterial's in the body.
8. To study toxicological health effects of nanomaterial.

Unit I	**Introduction to Nanomaterials:** Fundamental concepts of nanomaterials, Molecular Nanotechnology: A long-term view (synthesis routes): Bottom-Up Approaches, Top-Down Approaches, Nanostructured Materials with High Application Potential, nanomaterial as a renewable energy generation, approach of nanotechnology in electronics, nanotechnology in agriculture and food industry.	**10L**
Unit II	**Biomedical Applications:** Nanotechnology in biomedical application, application of micro and nano electrochemical device to drug delivery, biomedical sensors and biosensors, quantum dot technology in cancer treatment, nanoparticle probe for bioimaging	**10L**
Unit III	**Environmental Impacts of Nanotechnology:** Introduction, engineered nonmaterial's in the body, routes of entry, toxic mechanisms, environmental implications of nanoparticles, toxicological health effects, relevant parameters in nanoparticle toxicology, integrated concept of risk assessment of nanoparticles	**10L**

References:

1 An Introduction to Nanoscience and Nanotechnology by Alain Nouailhat, John Wiley & Sons, Inc.

2 Nanotechnologies: Principles, Applications, Implications and Hands-on Activities by Luisa Filipponi and Duncan Sutherland, European Union, 2012

3 Nanotechnology: Principles and Practices by Sulabha K. Kulkarni.

Course Code: CHA5407
Course Title: Analytical Chemistry Practical VII (Analysis of Consumer Products) (Any Fifteen) (4 Credits)

1. Determination of commercial vinegar by potentiometric titration and its confirmation by conductometry.
2. Determination of borax by conductometry.
3. Determination of calcium from dairy whitener by Flame photometry
4. To determine amount of p-nitrophenol from the given mixture by spectrophotometric titration using standard NaOH solution
5. To study decomposition pattern of calcium oxalate / polymer by Thermo gravimetric analysis.
6. To determine constant of ferric thiocyanate complex by Ostwald method spectrophotometrically.
7. To determine amount of chloride in water sample by turbidometric method.
8. Determine chain linkage of polymer sample by viscosity measurement.
9. Determine molecular weight of polymer sample by viscosity measurement.
10. Analysis of mixture of carbonate and bicarbonate present in water sample using pH metry.
11. To determine concentration of Pb (II) in solution by amperometric titration with potassium dichromate solution.
12. Determination of chemical oxygen demand (COD) from water sample.
13. Estimation of total hardness, temporary hardness and permanent hardness from water sample.
14. Analysis of zinchrome Pigment for Zn and Cr.
15. Analysis of Ti by Spectrophotometrically from Titanium pigment.
16. Determination of Fe from Detergent.
17. Analysis of Acid value from oil.
18. Synthesis of nanoparticles and its analysis.
19. Analysis of Saponification value from oil/Detergent.
20. Removal of toxic dyes /metals using adsorbent.
21. XRD Spectra analysis
22. Industrial Visit / Lab Visit.

References:

1 Pharmacoepia of India
2 Biochemical methods, Sadashivam and Manickem, New Age international Publication
3 General Chemistry Experiments, by Elias, Universities Press
4 Vogel's textbook of quantitative chemical analysis, Sixth Ed.Mendham, Denny, Barnes, Thomas, Pearson education.
5 Experiments in chemistry by D. V. Jahagirdar (Himalaya publication)
6 An introduction to practical Biochemistry, Third Ed. by Plummer, Tata Mc-Grew Publishing Company.
7 Quantitative Inorganic Analysis including Elementary Instrumental Analysis by A. I. Vogel's, 3rd Ed. ELBS (1964)
8 Environmental Chemistry by A.K. De 3rd Ed. Wiley Eastern Ltd.
9 Quantitative Inorganic Analysis including Elementary Instrumental Analysis by A. I. Vogels, 3rd Ed. ELBS (1964)
10 Standard methods of chemical analysis by F. J. Welcher
11 Environmental Chemistry by A. K. De

12 Biochemical Methods, Sadashivam and Manickem, Narosa publication
13 Indian Pharmacoepia volume –I and II
14 Experiments in chemistry by D. V. Jahagirdar, Himalaya publication
15 Practical Pharmaceutical Chemistry, 4th Ed. part-2, Beckette, Stenlake
16 Standard Instrumental methods of Chemical Analysis, F. J. Welcher

Course Code: CHA5408
Course Title: Analytical Chemistry Practical VIII
(Analysis of Food and Pharmaceutical Products Practicals)
(Any Fifteen) / Project (Projects minimum 30%)
(4 Credits)

1. Estimation of Urea from blood samples.
2. Determination of phosphorous content in fruit juice by spectrophotometer
3. Estimation of tannin from Tea sample.
4. Estimation of Aspirin from given tablet by Spectrophotometer
5. Isolation of lycopine from tomato
6. Estimation of cholesterol by spectrophotometry
7. Analysis of Riboflavin from sample by spectroflurometry.
8. To determine the amount of carbohydrate in potato by Anthrone method.
9. Drug action of salicylic acid by spectrophotometry.
10. Determination of moisture content using Karl-Fischer titrator.
11. Determination of equivalent weight of carboxylic acid by titration with Std. alkali solution.
12. Determination of the loss on drying of sodium chloride.
13. Separation of Amino acid by Electrophoresis.
14. Estimation of calcium from tablet by using flame photometry.
15. Limit test of Tin and Zinc from canned food.
16. Analysis of drugs by non-aqueous titration (Glycine, Sodium benzoate, Sulpha drugs)
17. Estimation of Vit-C in ascorbic acid by $KBrO_3$ method.
18. Determination of Alcohols by Gas Chromatography
19. Estimation of Fat from given food sample
20. To study loss on ignition of Zinc Oxide
21. Determination of water soluble ash in Ginger
22. To study the Limit Tests for chloride and sulphates

Reference:

1 Organic Laboratory technique a micro scale approach by Donald L. Pavia, Gary M. Lampman, George S. Kriz, Randall G. Engel second edition.
2 Practical clinical Biochemistry, Harold Varley (4th Edition), CBS publishers and Distributers. New Delhi -110002.
3 R. Ikan; Natural products.
4 Peach and Tracy; Methods of Plant analysis Vol. VII.
5 Pavia and others; Organic Laboratory Techniques, (Second Edition,1995),Sannders Series (Harcofst Brace)
6 Analytical Chemistry by Gary Christain, 6th edition, 2008

Course Code: CHA5409
Course Title: Self-Learning Course
(1 Credits)

Objectives:

1. To understand the concept of nanotechnology in biomedical application
2. Student should able to write summery on above any topic with reference to research paper.
3. Student's interest in research project should able to give seminar on their topic of interest.

Unit I	**Nanotechnology** a. Introduction to Nanomaterials, b. Classification of Nanostructured Materials, c. Properties of Nanomaterials (surface, electrical, optical, magnetic).	**15L**

References:

1 Nanobiotechnology: Subbiah Balaji, MJP publisher, Chennai, 2010.
2 An Introduction to Nanoscience and Nanotechnology by Alain Nouailhat, John Wiley & Sons, Inc.
3 Nanotechnologies: Principles, Applications, Implications and Hands-on Activities by Luisa Filipponi and Duncan Sutherland, European Union, 2012.

Scheme of Analytical Chemistry Practical Examination
CHA5407 : Practical Course III : Analysis of Consumer Products (Any Fifteen)

CHA5408: Practical Course IV : Analysis of Food and Pharmaceutical Products Practicals (Any Fifteen) / Project (Projects minimum 30%)

Note :

1. The practical examination in the subject will be conducted for SIX HOURS duration.
2. The practical examination in the subject will be conducted for 50 marks.
3. Certified Biochemistry Laboratory Journal is compulsory for the examination.
4. Oral/viva examination is compulsory
5. Book/s printed material, cyclostyled or typed material will be allowed during the practical examination.
6. Examiners will arrange Q1 and Q2 experiments for conducting practical examination.
7. Lucky draw system will be followed for the students for practical examination by the examiners.
8. Log table and calculators are allowed during the practical examination.
9. Mobile/s is/are strictly not allowed during the practical examination in laboratory.

The candidate has to perform the following question/s for practical examination.

Q 1	**Major Experiment (Any ONE)**	**20 Marks**
Q 2	**Minor Experiment (Any ONE)**	**20 Marks**
Q 3	**Oral /Viva**	**05 Marks**
Q 4	**Laboratory Journal**	**05 Marks**
	Total Marks	**50 Marks**

Research Project
Note:

1. Certified RESEARCH PROJECT THESIS is compulsory for the examination.
2. The project presentation will be conducted for SIX HOURS duration.
3. The project presentation will be conducted for 100 marks.
4. Oral/viva examination is compulsory
5. Mobile/s is/are strictly not allowed during the project presentation.

Research Project Work is assessed as follows,

1	Title of Project	5 Marks
2	Experimental Work	15 Mark
3	Characterization of product	20Marks
4	References / Reference Work	10 Marks
5	Project Thesis	5 Marks
6	Preparation slides	10 Marks
7	Overall Presentation	20 Marks
8	Defense of Project work	10 Marks
9	Purpose / Benefit of Project	5 Marks