UNIVERSITY OF PUNE

Department of Chemistry

M.Sc. Part II- Analytical Chemistry Syllabus From July 2014

Course no.	Course name	Credits
Semester III	**Compulsory courses**	
CHP 350	Principles of Analytical Chemistry	4 Credits
CHP 351	Spectroscopic methods of analysis	4 Credits
CHP 352	Modern analytical Techniques	4 Credits
CHP 353	Introduction to Biomolecules, biosensors and Analysis of Clinical and Consumer products	4 Credits
	Compulsory courses	
CHP 354	Practical I:	6 Credits
CHP 355	Practical : II	6 Credits

Semester IV	**Compulsory courses**	
CHP 450	Forensic and Industrial Products Analysis	4 Credits
CHP 451	Polymers and Agrochemicals	4 Credits
CHP 452	Electroanalytical and Chromatographic methods of analysis	4 Credits
	Optional courses **(any one from following two)**	
CHP 444	Special Topics in Nuclear and Radiation Chemistry	4 Credits
CHP 445	Principles and Applications of Nanoscience and Nanotechnology	4 Credits
	Compulsory course	
CHP 456	Project	6 credits

Semester III

Compulsory courses

CHP– 350: Principles of Analytical Chemistry (4Credits)(48L)

Section I: (24L)

a. Analytical Science – an overview: **(8L)**
History of analytical chemistry, basic concepts, classification of analytical methods, types of instrumental methods, instruments for analysis and its different domains, Chemometrics and its application in analytical sciences, automated method of analysis.

b. Sample dissolution methods for elemental analysis: **(4L)**
Dissolution of inorganic samples by using acids as solvent, fusion process, and miscellaneous procedures, Dissolution of organic samples by dry and wet ashing, methods, special methods. Use of dissolution assemblies in analysis

c. Electrical components and circuits: **(6L)**
Direct current and alternating current circuits and measurements, current and potential measuring devices, Semiconductors and semiconductor devices, Current-voltage curves for semiconductor diodes. Transistor and its types, power supplies and regulators, read out devices. Operational amplifiers and microprocessors in chemical instrumentation, Logic devices and Computers

d. Heterogenous Catalysis and its applications: **(6L)**
Basic principles of heterogenous catalysis, different types of reactions, characterization of heterogenous catalysis, catalytic converters, zeolites, photocatalysis, commercial applications of heterogeneous catalysis. Experimental techniques used in surface analysis of heterogeneous catalysis.

Text Books:

1. Principles and Practice of Analytical Chemistry, F. W. Fifield and D. Kealey, 5th edn., Blackwell Science, Chapt. 1, pp 12-13, 331- 379, 385-411, 415-458 (Chapt. 7.4) and 463-471, (2000)
2. Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West, 4th edn., CBS College Publishing, New York, Chapt. 1, pp 12-13, (1982)
3. Introduction to Instrumental Analysis, R. D. Brown, McGraw Hill, (1987).
4. Instrumental Methods of Analysis, H. H. Willard, L. L. Meritt and J. A. Dean, Affiliated East-West Press, Chapt. 1 and 2, (1977)
5. Heterogenous Catalysis: Principles and Applications by G.C. Bond, Clarendon Press-Oxford, 1974.

References:

1. Instrumental Analysis, D. A. Skoog, F. James Hollier and S. R. Crouch, 6th edn., Thomson Brooks/Cole Publishers (2007).
2. Sample Pre-treatment and Separation, R. Anderson, ACOL Series, N.B. Chapman (Ed.), John Wiley & Sons for ACOL, Chapt. 3 and 4, pp 66-118, (1991)

Section II: **(24L)**

a. Calibration methods
b. Optimization and Experimental Design
c. Process Analysis
d. Quality Assurance and Quality Control
e. Reference Materials

a. Calibration: **(4L)**
Construction of calibration curves, comparison with single standard, matrix matching, bracketing of std, standard addition and internal standard methods, calibration of glassware, buoyancy errors, numericals

b. Optimization and Experimental Design: **(10L)**
Accuracy, precision, classification of errors, minimization of errors, significant figures and computation, mean deviation and standard deviation, Detection, reduction and compensation of errors, propagation of intermediate error, confidence level, confidence limit when sigma is known and when sigma is unknown, statistical treatment of random error, properties of Gaussian distribution, Test of significance, F test, Q test, Construction and interpretation of graphs, fitting the least squares lines, correlation coefficient and coefficient of determination, detection limits, statistics of sampling, numerical

c. Process Analysis: **(2L)**
Introduction, Hazards, Safety, continuous or regular monitoring, measurement systems, process chromatograph, process sampling and sample systems, electrochemical methods, ISEs, spectroscopic methods

d. Quality Assurance and Quality Control: **(6L)**
i) Industrial Analysis: Quality characteristics of chemical analysis, errors occurring at the start, during or by the end of analysis, interpretation and presentation of results, Shewhart Chart, CUSUM chart and EWMA chart; Batch and process evaluation, QA schemes
ii) Clinical Analysis: Introduction, analytical responsibilities, Managerial responsibilities, practical approaches to QA, characterization of a method, Results and preparation of reports. Internal QC, Accuracy and external quality assessment
iii) Water Industry: Water quality field sampling, QA/QC program, QA/QC documentation, QA project plan, designing a water quality monitoring plan, Site selection, sampling frequency and sample size, training of field personnel, field trip preparations, Water quality sampling, toxic chemicals in bottom sampling and biota, bacterial sample collection, sequential triplicate sampling, sample preservation, storage and transport, chain of custody, laboratory QC procedures inter- and intra-laboratory QC

e. Reference Materials (RMs): **(2L)**
Analytical standards, primary and secondary standards, high purity substances, reference materials, use of RMs in statistical control schemes and in intercomparisons, role of certified reference materials (CRMs), production and requirements, obtaining reference value and certified value

References:

1. D. A. Skoog, D. M. West and F. J. Holler, Fundamentals of Analytical Chemistry, 2nd Ed., Saunders College Publishing, 1991
2. R. A. Day and A. L. Underwood, Quantitative Analysis, 6th Ed., Prentice-Hall of India Pvt. Ltd., 1993
3. Gas Chromatography, Open Book Learning Series
4. Larry Hargis, Analytical Chemistry. Principles and techniques
5. Encyclopedia of Analytical Chemistry, Vol.

CHP-351: Spectroscopic Methods of Analysis (4Credits)(48L)

a. UV-Visible: **(6L)**

Introduction to spectroscopy, Beer-Lambert's Law, chromophoric Groups, factors affecting wavelength and molar extinction co-efficient, application to structural problems and uses in industry instrumentation

b. IR: **(8L)**

Introduction, basic principles, factors affecting IR group frequencies, Applications to structural problems and uses in industry, instrumentation

c. Raman: **(8L)**

Raman Spectroscopy Principle instrumentation applications

d. ^{1}H NMR: **(16L)**

Recapitulation of basic principle, Fourier Transform technique, Pulse sequence, relaxation processes. Use of Integration in the quantitative determination of isomers, Factors affecting chemical shifts (inductive, resonance and anisotropic effect with examples), chemical shift of different types of protons (alkane, alkene, alkyne and allene), aromatic protons and effect of substituent, different types of spin coupling, first order analysis of spectra, Ramsay mechanism of spin coupling, roofing effect with example, different spin systems (AB, AM, AX, ABX/AMX spin systems with examples), calculations of line intensities and chemical shifts in AB spin system, factors affecting coupling constants (dihedral angle, Karplus equation-graph, electronegativity, bond order, hybridization, bond angle with examples), non equivalence due to restricted rotations, rate processes. Effect of high field NMR for simplification of spectra, Shift reagents, Spin decoupling and Nuclear Overhauser effect with examples

e. ^{13}C NMR: **(10L)**

Elementary ideas, instrumental difficulties, FT technique advantages and disadvantages, Proton Noise Decoupling technique advantages and disadvantages, off-resonance technique, Chemical shifts of solvents, factors affecting chemical shifts, analogy with ^{1}H NMR, calculations of chemical shift of hydrocarbons, effect of substituents on chemical shifts, different types of carbons (alkene, alkyne and allene), chemical shift of aromatic carbons and effect of substituent. Chemical shifts of carbonyl, nitrile, oxime carbons

References:

1 Introduction to Spectroscopy – D. L. Pavia, G.M. Lampman, G. S. Kriz, 3rd Ed. (Harcourt college publishers)
2. Spectrometric identification of organic compounds R. M. Silverstein, F. X. Webster, 6th Ed. John Wiley and Sons.
3. Spectroscopic methods in organic chemistry – D. H. Williams and I. Flemming McGraw Hill.
4. Absorption spectroscopy of organic molecules – V. M. Parikh
5. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer-Verlag (1986)
6. One and Two dimensional NMR Spectroscopy- - Atta-Ur-Rehman, Elsevier (1989)
7. Organic structure Analysis- Phillip Crews, Rodriguez, Jaspars, Oxford University Press (1998)
8. Organic structural spectroscopy- Joseph B. Lambert, Shurvell, Lightner, Cooks, Prentice-Hall (1998)
9. Organic structures from spectra- Field L. D., Kalman J.R. and Sternhell S. 4th Ed. John Wiley and sons Ltd.
10. NMR spectroscopy of Organic compounds. Jackmann and Sternhell S
11. Instrumental methods of chemical analysis- *Chatwal and Anand*
12. Introduction to Instrumental Analysis- *R. D. Braun*, Pharmamed Press, Indian Reprint (2006)
13. Principles of Instrumental Analysis, 5th edition- *D. A. Skoog, F.J. Holler, T. A. Nieman*, Philadelphia Saunders College Publishing (1988)

CHP-352 : Modern Analytical Techniques (4Credits)(48L)

a. Radioanalytical methods:
   1. Neutron Activation Analysis : Principle, Different steps involved in NAA, radiochemical and instrumental NAA, applications, advantages and disadvantages **(4L)**
   2. Radiometric titrations: Principle, Radiometric titrations based on precipitate formation, complex formation and neutralization reactions **(4L)**
   3. Isotope Dilution Analysis: Principle and types: Direct, Reverse and Double Isotope dilution analysis **(4L)**
   4. Radioimmuno assay: Principle, methodology and applications **(4L)**

b. Atomic Absorption Spectroscopy: **(4L)**
Principle, instrumentation, interference in spectral analysis, applications, advantages and disadvantages

c. Inductively coupled plasma atomic emission spectroscopy: **(4L)**
Principle, various stages involved in the analysis, instrumentation, applications, advantages and disadvantages

d. Thermal Methods of Analysis: **(6L)**
TGA, DTA, DSC and Thermometric Titration: Principle, instrumentation and applications

e. Mass spectrometry: **(6L)**
Theory, instrumentation-basic components, ionization sources, analyzers, resolution, chemical analysis, advanced techniques-GC/MS

f. X-Ray Methods: **(12L)**
X-ray methods: Generation and properties of X-rays, X-ray absorption, X-ray absorptive apparatus, radiography and radiotherapy, applications, X rays fluorescence, fundamental principles, instrumentation, quantitative analysis, X-ray emission, fundamental principles, X ray diffraction, powder diffractometer, applications in material science, electron microprobe, XPS: Principle, instrumentation and applications

CHP-353: Introduction to Biomolecules and Analysis of Clinical and Consumer products (4Credits)(48L)

a. Protein structure and analysis:
Definition of protein and peptides; structure of protein; types of protein s; Physical and chemical properties of protein; Analysis of proteins: Total protein, albumin and globulin from serum samples.
b. Hormone analysis:
Introduction; Classification and general characteristics of hormones; Determination of cortisol from blood and urine samples; determination of oestrogens from urine samples
c. An overview of Carbohydrates and Lipids.
d. Nucleic acids (DNA and RNA):
Structure, physical and chemical properties
e. Enzymatic and Immunochemical Analysis
f. Mineral metabolism, Electrolyte analysis
g. Body fluid analysis
h. Therapeutic drug monitoring
i. Scope of Clinical chemistry:
Philosophy of clinical analysis, Practical aspects of analysis: sample types, collection of specimens (samples) like blood, urine, faeces; Cleaning of glass apparatus; Storage of clinical samples.
j. General techniques for analysis:
Brief principle and applications of following techniques: colorimetric, spectrophotometric, turbidimetric, fluorimetric, flame photometry, autoanalysis, paper electrophoresis, gel-electrophoresis, chromatography; Units of expressing biochemical values

Food Product Analysis

a. Moisture content, ash, fibre, nutrients, antinutrients, toxicants, microorganism spoilage (rancid taste), colour, preservatives
b. Analysis of amino acids, proteins, carbohydrates, lipids and fats
c. Analysis of edible oils, dairy products, pickles etc., fruit and vegetable products
d. Food additives and Food colours
e. Food adutration
f. Sensory / organoleptic evaluation of food
g. ISO 9000 and Food industry

Consumer Product Analysis

a. Consumer products and their chemical speciation (as well as qualitative and quantitative analysis)
b. Cosmetics – Face powders, hair preparations, Antiperspirants and deodorants, Perfumes, Toothpastes
c. Food pigments

References:

1. B. M. Mittal and R. N. Saha, Handbook of Cosmetics,Vallabh Prakashan, New Delhi, 1st edn., 2000.
2. S. Nanda and R. K. Khar, Cosmetic Technology, Birla Publication Pvt. Ltd., 1st edn., 2006.
3. Principles of Biochemistry, Lehninger C Rs. Publ. (1982).
4. Biochemistry, L. Stryer, W.H. Freeman, San Francisco, A. Townshend, Ed., Encyclopedia in Analytical Science, Academic Press (1995)
5. R. L. Na, Academic Press, Calcutta

CHP-354: Analytical Chemistry Practicals I (6Credits)

Part A (Any 10 experiments)

1. Determination of gamma energy of a given source using scintillation counter coupled with single channel analyser.
2. Determination of Manganese content of steel sample by neutron activation analysis technique
3. Determination of half life of radioisotopes in a given mixture
4. Determination of isobestic point of a given dye molecule by spectrophotometric method.
5. Determination of Molecular weight of a given polymer by turbidimetry.
6. Determination of Molecular weight of a given polymer by end group analysis
7. Kinetics of condensation polymerization by dilatometry.
8. Estimation of Zn and Cd from their mixture by polarographic technique.
9. Determine the molecular weight of a given polymer from viscosity measurements.
10. Estimate the amount of halide from solution by differential potentiometry method.
11. Determine the critical micelle concentration of a given surfactant by conductometry.
12. Determine the concentration of Riboflavin in the given sample by spectrophotometry.
13. Determine the activity coefficient of an non-electrolyte by freezing point depression method.
14. Determine the activity coefficient of an electrolyte by freezing point depression method.
15. Determine the molality of the solution of a substance in water and hence it's molecular weight by freezing point depression method.

Part B (Any ten experiments)

1. Determination of glucose from blood serum (Enzyme method)
2. Determination of total serum cholesterol (cholesterol & HDL).
3. Estimation of urea from blood sample.

4. Determination of glucose from blood serum by Folin –Wu – method
5. Estimation of Vitamin C.
6. Assay of Thiamine
7. Estimation of amino acids by ninhydrin method.
8. Estimation of Ketone bodies
9. Estimation of Creatine / Creatimine in urine
10. Estimation of free fatty acids in oil by titration method.
11. Growth curve of E.coli.
12. Minimum inhibitory concentration (MIC) of drugs using E.coli.
13. Isolation of plasmid DNA.
14. Agarose gel electrophoresis of DNA.
15. Separation of proteins by polyacyrlamine gel electrophoresis.

CHP-355: Analytical Chemistry Practicals II (6Credits)

Part A

1. Estimation of Tannin from tea
2. Isolation of caffine from tea
3. Quantitative analysis of mixture by gas Chromatography [e. g. Chloroform and carbon tetrachloride / methanol and ethanol]
4. Preparation of sulphanilamide from acetanilide and assay its purity
5. Preparation of methyl salicylate and assay its purity
6. Isolation of Lycopene from tomato / β-Carotene from carrots and assay its purity
7. Preparation, purification and assay of aspirin.

Part B

1. Alloy [e.g. iron, chromium and nickel from Stainless steel]
2. Ore [e.g. acid-insoluble matter (combined oxides), iron and titanium from Ilmenite]
3. Cement [e.g. silicon, aluminium, iron from Portland cement]
4. Consumer products (e.g. Inorganic Pigment [e.g. chromium from Zinc chrome]; Pharmaceutical product [magnesium from tablet of "Milk of magnesia" / calcium from calcium-supplementary tablet / aluminium from alum]; Fertilizer [NPK Fertilizer for phosphorus]
5. Ion exchange chromatography [separation and estimation of mixture of zinc (II) and magnesium (II)]
6. Thermogravimetry [Determination of percentage of $MgCO_3$ in Dolomite]
7. Flame Photometry [Determination of the percentage of sodium in the sample of dairy whitener]
8. Cyclic voltametry [Study of cyclic voltammogram of $K_3[Fe(CN)_6]$]
9. Determination of moisture content in food sample using Karl-Fischer Titrator
10. Determination of Phosphate in Detergents by Spectrophotometry
11. Determination of phosphoric acid in cola beverages by pH titration.
12. Photometric Titrations: (a) Cu Vs EDTA (b) Fe Vs EDTA using salicylic acid
13. Potentiometric Titrations: (a) FAS Vs $K_2Cr_2O_7$ (b) FAS Vs. $KMnO_4$
14. Conductometric Titrations: (a) NaOH Vs. HCl (b) NaOH Vs. Boric acid
15. Synthesis of semiconducting nano oxides such as NiO,ZnO
16. Table work for IR-spectra, NMR, UV-Visible spectra

Semester IV

Compulsory courses

CHP-450: Forensic and Industrial Products Analysis (4Credits)(48L)

Section I:

Industrial Products

a. Steel and Ferrous Materials
b. Cement and Building Materials
c. Ceramic Materials
d. Surfactants and Detergents
e. Medicinal and Pharmaceutical Products

Section I (24L)

a. Analysis of steel and ferrous materials **(8L)**
Sampling, analysis of steel and ferrous alloy: carbon, silicon, manganese, phosphorous, sulphur, selenium, copper, nickel, chromium, vanadium, tungsten, molybdenum, cobalt, aluminium, titanium, nitrogen, lead, niobium, iron

b. Analysis of cement and building materials **(4L)**
Types of cement, sampling, analysis of cement and building materials: silicon dioxide and other metal oxides, sulphide- sulphur, loss on ignition, insoluble residue

c. Analysis of ceramic materials **(4L)**
Analysis of quartz, analysis of clays and feldspar, analysis of glasses and ceramics, volatile residue and their various metal oxides

d. Surfactants and detergents **(4L)**
Soaps: General scheme of analysis, alcohol soluble and insoluble material, moisture, active ingredients, total fatty acids, fatty anhydride, combined alkali, unsaponifiable and unsaponified matter, iodine value, free glycerol.
Detergents: Unsulfonated or unsulfated material, Ester SO_3, combined alcohols, total combined SO_3, organic builders, alkalinity, silicates.
Fertilizers: Analysis of total nitrogen content in urea ammonium nitrate (UAN)

e. Medicinal and pharmaceutical products **(4L)**
General physical methods, Chromatographic methods and spectroscopic methods for the analysis of drugs, quantitative analysis of drugs in formulations using various techniques

Books:

1. "Standard methods of Chemical Analysis", Vol. 2, (Part A & B), F. J. Welcher, 5th edn., Von Nostrand & Robert E. Krieger Publishing Co. New York, (1975 and 2000)
2. "Quantitative Inorganic Analysis" A. I. Vogel, English Language Book Society, London, (1975)

Reference Book:

1. "Materials Science & Engineering, William D. Callister Jr., John Wiley and Sons, Inc. New York.,(1991).
2. "Encyclopaedia of Analytical Science", A. Townshend (Ed.), Academic Press (1995).
3. "Practical Pharmaceutical Chemistry, A. H. Beckett and J. B. Stenlake, CBS Publishers, New Delhi, 1st Indian edn., pp 16-76 and 309-348, (1986).

Section II: **(24L)**

a. Forensic analysis: **(3L)**
Overview, Destructive and Nondestructive techniques, Data interpretation

b. Blood Analysis: **(2L)**
Blood preservation and ageing effects, Analysis of blood components and exogenic substances, blood stain analysis

c. DNA Profiling: **(3L)**
DNA and its polymorphism, DNA typing procedures-RFLP, PCR, MVR-PCR, Dot-blot, AMP-FLP, STR methods, applications, interpretation and practical use

d. Determination of alcohol in body fluids: **(2L)**
Legal background, sampling and sample preservation, alcohol content analysis by GC, IR and enzymatic methods

e. Fingerprint analysis: **(3L)**
Latent fingerprints; optical, physical, physico-chemical & chemical detection methods; fingerprints in blood, fingerprint detection sequences

f. Hair analysis: **(2L)**
Structure and composition of hair, morphological examination, Chemical analysis of hair components and components remaining on or in hair

g. Systematic Drug Identification: **(2L)**
Classification and categories of compounds involved, analytical strategy-TLC, LC, GC-MS, etc., requirements for identification, possibilities & limitations of selected techniques

h. Materials of interest for Forensic studies: **(7L)**
Explosives: Types, analytical methods for identification of low and high explosives in post-blast debris.
Fibres: Fibres encountered at crime scene, identification of types, dye extraction and analysis, colour matching, analysis for metals, additives and contaminants-SEM-EDX, XRD, XRF.
Paints, Varnishes and Lacquers: Formulation of paints, types of sample, Sample pre-treatment prior to analysis, colour measurements, Analysis by SEM, TEM, TLC/HPTLC, PyrGC, IR, Raman, UV-Vis-Flu, XRF, AES, TG-DTA. Glass: As forensic evidence, measurement of physical properties, elemental analysis-XRD, NAA, etc., interpretation of results, casework examples.

Arson Residues : nature of arson evidence, chemical evidence, properties of liquid accelerants, sampling and sample pre-treatment, laboratory examination of suspect arson evidence, evidential value.
Gunshot Residues: Composition of sources, detection on hands & its limitations, determination of muzzle-to-target distance, elemental & inorganic analysis, numericals on estimation of energy released by combustion reactions, etc.

References:

1. 'Forensic Chemistry' by Suzanne Bell, Pearson Prentice Hall Publishers, 2006
2. Encyclopaedia of Analytical Chemistry, Volume 3, Academic Press, 1995

CHP-451: Polymers and Agrochemicals (4Credits)(48L)

1. Brief history of macromolecular sciences: **(4L)**
   Basic concepts of polymer science, classification of polymers, Chemical Bonding in polymers, stereochemistry of polymers

2. Kinetics of polymerization:
   Addition and condensation polymerization with specific examples
   Copolymerization: Classification of copolymers, Kinetics and mechanism of copolymerization and determination of its composition **(6L)**

3. Structure and Properties: **(6L)**
   Crystalline melting point, The glass transition temperature (Tg), States of aggregation, states of phase, Factors influencing Tg. Determination of Tg by dilatometry, calorimetry. Heat distortion temperature, Properties involving large deformations, melt viscosity, tensile strength, stress, strain, crazing, shear banding, solubility and related properties, electrical and related properties.

4. Molecular weight of polymer: **(5L)**
   Number average and weight average molecular weight and degree of polymerization,
   Measurement of molecular weight of polymers: End group analysis, Colligative property measurement, Light scattering, Solution viscosity and molecular size and GPC.

5. Characterization of polymers: **(4L)**
   Chemical analysis of polymers, IR and Raman spectroscopy, X-ray diffraction analysis, Thermal analysis TG-DSC, Thermomechanical analysis

References:

1. Text book of Polymer Science, Fred W. Billmeyer Jr., Third edition, 2000.
2. Polymer Science, V. R. Gowarikar, N. V. Vishwanathan and Jaydev Sreedha,r Reprint edition, 2002.
3. Introduction to Polymer Science and Chemistry by Manas Chanda, Taylor and Francis Pub.
4. Chemistry of Pesticides, N. M. Melnikov, Residue Reviews, Vol. 36, Springer Verlag, New York, 1971.

Analysis of Agrochemicals:

a. Introduction, Classification, mechanism of action and synthesis.
b. Insecticides: DDT, BHC,Aldrin, Endosulfon, Malathion, Parathion.
c. Herbicides: 2,4-dichloro phenoxy acetic acid, dalapon, paraquat, Banalin, Butacarb
d. Fungicides: Boardeaux mixture, Copper oxychloride, Zineb,, Benomyl(Benlte)
e. Analysis of pesticide residue and toxicological effects.

Books:

1. Text Book of Polymer Science by F. W. Bilmayer
2. Polymer Science by Gowarikar
3. Introduction to polymer science and chemistry by Manas Chanda, Taylor and Francis Pub.
4. Chemistry of pesticides, N.M. Melnikov, Residue Reviews, Vol.36, Springer Verlag, New York, 1971.
5. Future for insecticides, R. C. Netealr, J. J. Mckalvery, Jr. John Wiley &Sons, New York, 1976.
6. Pesticide processes Encyclopedia, Marshal Sitting Hoyes Data Corporation, U.S.A., 1977.

CHP-452: Electrochemistry and Chromatographic methods of analysis

(4 Credits)(48L)

a. Electrochemistry **(24L)**

Conductometry, Potentiometry, Polarography, amperometry, pH metry, Cyclic Voltammetry, Chronopotentiometry

b. Chromatographic methods of analysis **(24L)**

Chromatography: Gas solid Chromatography, Gas liquid Chromatography, High performance liquid chromatography, ion exchange chromatography, paper chromatography, thin layer chromatography, HPTLC

Reference Books:

1. Instrumental methods of chemical analysis- *Chatwal and Anand*
2. Introduction to Instrumental Analysis- *R. D. Braun*, Pharmamed Press, Indian Reprint (2006)
3. Principles of Instrumental Analysis, 5th edition- *D. A. Skoog, F. J. Holler, T. A. Nieman*, Philadelphia Saunders College Publishing (1988)

<u>Optional courses (any one from following two)</u>

CHP-444: Special Topics in Nuclear and Radiation Chemistry (4Credits)

a. Radiation hazards and safety: **(4L)**

Natural and manmade sources of radiations, internal and external radiation hazards, safe handling methods, personal dosimetry, reactor safety, the effects of Three miles and Chernobyl accidents, radiation protecting materials

b. Biological effects of radiations: **(4L)**
The interaction of radiations with biological cells, somatic and genetic effects, maximum permissible dose-ICRP recommendations, Biological effects of various doses

c. Applications of radioisotopes in nuclear medicine and pharmaceuticals: **(8L)**
General applications of radiopharmaceuticals use of nuclear properties of indicator nuclides, In-vivo diagnostic procedures: Positron Emission Tomography and Thyroiditis, In-vitro diagnostic testing: Radio Immuno Assay, Therapeutic use of radiations, Use of radiations for food preservation and sterilization

d. The origin of chemical elements: **(4L)**
Cosmology and cosmochemistry premordial nucleosynthesis, stellar nucleosynthesis, various burning processes

e. Radiation Waste Management: **(4L)**
Generation of radioactive waste from various sources, Classification of radioactive waste as per AERB guidelines, Treatment of radioactive waste: Solid waste and liquid waste

f. Accelerators: **(4L)**
Basic components, Cockroft-Walton accelerator, Van de Graaff accelerator, Linear accelerators, cyclotrons, synchrotrons

g. Ion beam analysis techniques: **(4L)**
Particle induced X-ray emissions- projectile accelerator and target preparation, ionization and X-ray emission detection,analysis and applications. Rutherford back scattering – scattering reaction,surface analysis,depth profiling, chanelling effects and applications

h. Radiolysis of aqueous solutions: **(5L)**
Radiolysis of water, Basic units, ferric sulphate,ceric sulphate, cupric sulphate solutions , effect of solute concentrations on the molecular yields from water, radical scavenging, LET, Effect of LET on molecular yields ,chain reactions

i. Radiolysis of organic systems: **(3L)**
Alkanes, aromatic hydrocarbons, alcohols

j. Radiolysis kinetics: **(8L)**
Emperical rate studies, pulse radiolysis, molecular kinetics, non-homogeneous kinetics

References:

1. Radiation Chemistry: Principles and Applications, *Farhataziz and M. A. J. Rodgers (Eds.)*, VCH Publishers, New York (1987).
2. Essentials of Nuclear Chemistry, *H. J Arnikar*, Wiley Eastern Limited, 4th Edition.(1995)
3. Nuclear and Radiochemistry, *G. Friedlander, J. W. Kennedy and J. M. Miller*, John Wiley (1981)

4. Radiochemistry and Nuclear methods of analysis-*W. D. Ehman and D. E. Vance*, John Wiley (1991)
5. Fundamental of Radiochemistry, D.D.Sood, A.V.R.Reddy, N.Ramamoorthy, IANCAS, Mumbai, 4th Edition

CHP-445- Principles and Applications of Nanoscience and Nanotechnology

(4Credits)

a. Introduction to Nanotechnology: **(2L)**
Introduction to the nanoworld, A new realm of matter that lies between chemistery and solid state physics, historical perspective of nanomaterials, classification of nanomaterials

b. Metals: **(4L)**
Structure and bonding, Properties, Reduction of Size, Size dependent properties, Applications, Synthesis of metal nanoparticles and structures

c. Chemical and catalytic aspects of nanocrystals: **(2L)**
Nanomaterials in catalysis, recent progress-Metals

d. Self Assembly and Self Organization: **(2L)**
The advantages of self assembly, Intermolecular interactions and Molecular recognition, Self assembly monolayers (SAMs)

e. Energy and Power: **(5L)**
Energy needs for future mobile devices, Basics of Battery and Power source Technology, Energy harvesting-Nanotechnology in portable systems

f. Flat Panel displays: **(3L)**
The emergence of flat panel displays, New technologies for flat panel displays, Dispalys as an Intuitive human interface

g. Memory technologies for the future: **(1L)**
Flash memory, Future options of memory technologies and their comparisons

h. Seeing beyond the hype: **(1L)**
What the internet teaches us about the development of nanotechnology

i. Size and shape effect on biomedical applications of nanomaterials: **(4L)**
Role of size and shape of nanomaterials in biomedical applications, Nanoparticles selection based on size, shape and surface,Targeted drug delivery by nanoparticles,The role of blood vessel,The significance of size, shape and surface characteristics of nanoparticles in biomedical applications, Comparison between nanorods and nanospheres, Thermotherapy or hyperthermia of tumors, Biomedical applications of Quantum dots, Carbon nanotubes and Silver nanoparticles

j. The optical and electron microscopy, Elementary principles of phase contrast microscopy, Fundamental properties of different types of electron microscopy **(3L)**

k. SEM and TEM: **(3L)**

Importance of use of electrons, Electron sources: Electron Gun, Characteristics of Electron beam, Measurement of gun characteristics Scattering and diffraction, Elastic and inelastic scattering, Diffraction in TEM, Diffraction from crystals and small

l. Lasers, apertures and resolution: **(3L)**
Electron lenses, Apertures and diaphragms, The resolution of electron lenses, Lens Defects: Aberration: Spherical and chromatic astigmatism

m. Pumps and Holders: **(3L)**
The vacuum, Diffusion, Turbomolecular ion and cryogenic pumps, Leak detection, contamination, Hydrocarbon and water, plasma cleaner, Different types of holders

n. Specimen preparation: SEM and TEM **(2L)**

o. Imaging: **(4L)**
Amplitude contrast, mass thickness contrast, z-contrast, Phase contrast images, Bright and Dark field surface imaging, Secondary electron and back scattered electron imaging, Detectors: Electron detection and displays, Semiconductor detectors, scintillator,- PMT, TV cameras, CCD detectors, Faraday cup, Everhart-Thornley detector, SE and BSE detectors

p. Analysis of Samples: **(2L)**
Qualitative and quantitative analysis using SEM and TEM

q. Other Techniques: **(4L)**
X-ray spectrometry, EELS, EDX, X-ray emission spectroscopy, AFM

References:

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Compulsory course

CHP-456: Project **(6Credits)**