

P.G. 4th SEMESTER SYLLABUS
DEPARTMENT OF CHEMISTRY
COTTON UNIVERSITY

PAPER : CHM1001C

ANALYTICAL METHODS IN CHEMISTRY

(Credits: 3+1+0=4)

Theory: 60 Lectures

Unit 1: Electrochemical, Thermal and X-ray Diffraction Methods (16 lectures)

- (a) Electrochemical methods: Principles, instrumentation and applications of cyclic voltammetry. Anodic stripping voltammetry.
- (b) Thermal methods: Principles, instrumentation and applications of TG, DTG, DTA and DSC in analysis of chemical compounds.
- (c) X-ray diffraction: Principles, instrumentation and application of Powder XRD and Single crystal XRD. Indexing reflection patterns, Scherrer equation.

Unit 2: Electron Microscopy and Scanning Probe Microscopy (8 lectures)

- (a) Scanning electron microscopy/Energy Dispersive X-ray (SEM/ EDX) and Transmission electron microscopy/ Selected Area Electron Diffraction (TEM/SAED): principle, instrumentation, applications.
- (b) Surface Tunnelling Microscopy (STM) and Atomic Force Microscopy (AFM): principle, Instrumentation and Applications.

Unit 3: Chromatographic Techniques (12 lectures)

Gas Chromatography (GC), Gas Chromatography- Mass Spectrometry (GCMS), Liquid Chromatography- Mass Spectrometry (LCMS), High Performance Liquid Chromatography (HPLC), Gel permeation chromatography (GPC): Techniques, Instrumentation and Applications.

Unit4: Electron Spectroscopy (14 lectures)

Photoelectron Spectroscopy: Basic principles and applications of XPES (O₂, N₂ and N₃), Koopman's Theorem, Chemical information from ESCA.

Chiroptical properties: Introduction to CD (Circular Dichroism), ORD (Optical Rotatory Dispersion) and Magnetic Circular Dichroism (MCD) - Octant rule.

Unit 5: Structure Elucidation using various Spectroscopy (10 lectures)

Determination of chemical structure of organic/inorganic compounds by analysing UV-Vis, IR, NMR and Mass Spectrometry data.

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Semester IV: Special Papers

PAPER : CHM1002SP1

ADVANCED BIOINORGANIC CHEMISTRY

(Credits: 4+1+0=5)

Theory: 75 Lectures

Unit 1: Supramolecular Chemistry and Ion Transport (20 Lectures)

Definition and examples of Supramolecules, Self assembly and membranes, Molecular receptors: Cryptands, Valinomycin, Spherands, Molecular recognition, interaction of metal ions and metal complexes with DNA.

Supramolecular Transport: Active transport of ions across cell membranes, selectivity of Na and K with crown ethers, cryptands and ionophores, Na/K pump, transport of Ca^{2+} , Biominerals containing Ca and Fe, Storage and Transport of Fe: Ferritin, Transferrin, Siderophores.

Unit 2: Carrier, Transport, Storage and Activation of Dioxygen (15 Lectures)

Structure of active site and functions of oxygen carrying proteins: Haemoglobin, Myoglobin, Haemerythrin and Haemocyanin, Model O_2 carriers. Mechanism of cooperativity in Haemoglobin, Dioxygen toxicity. Detoxification enzymes – Catalases, Peroxidases, Superoxide dismutases.

Unit 3: Electron Transfer Proteins (10 Lectures)

Mechanism of electron transfer reactions in: Blue Copper Proteins, Iron Sulphur Proteins: Rubredoxin, Ferridoxin and HiPIP, Cytochromes (a, b and c types).

Unit 4: Metalloenzymes (15 Lectures)

Structure of active sites and functions of Zn containing enzymes: carboxypeptidase, carbonic anhydrase, Effect of Co (II) substitution in Zn enzymes, Cytochrome P-450, Coenzyme B₁₂, Nitrogen fixation: Nitrogenase – structure, N_2 activation and fixation. Role of Ni, Cr and Vanadium in enzymes.

Unit 5: Metals in Medicine (15 Lectures)

Metal deficiency and disease, toxic effects of metals: Fe and Cu overload, Thalassemia, toxicity due to Hg, As, Cd, and Pd. Chelation Therapy: EDTA, BAL and Penicillamine. Gold compounds in Rheumatic Arthritis, Cisplatin and related anticancer drugs.

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PAPER : CHM 1002SP2

NATURAL PRODUCTS AND MEDICINAL CHEMISTRY

(Credits: 4+1+0=5)

Theory: 75 Lectures

Unit 1: Introduction to natural products (2 Lectures)

Natural products chemistry: a general treatment. Classification: Primary and secondary metabolites.

Unit 2: Carbohydrates (14 Lectures)

Open chain and ring structure of monosaccharides, reactions of the anomeric centre, reactions of hydroxyl groups, Cyclic acetals, Glycosyl activation.

Disaccharides- Ring structure of sucrose, maltose, lactose and their hydrolysis.

Introduction to deoxysugars, glycosides, glycals, glycosamines and glycosans.

Polysaccharides- Representative structure of starch, glycogen and cellulose.

Chemical disaccharide formation, Enzymatic disaccharide formation, Introduction to chemical glycobiology.

Unit 3: Terpenoids, Steroids and Alkaloids (16 Lectures)

Terpenoids: Chemistry of - Caryophyllene, α -santonin (with structure determination), biogenetic pathway of mono- and sesquiterpenes.

Introduction to carotenoids, Discussion on β -carotene and lycopene, vitamin-A. Singlet oxygen quenching and food coloring properties of carotenoids.

Steroids: Introduction to steroids: cholesterol, sex hormones, cardiac glycosides and corticosteroids.

Alkaloids: Chemistry of reserpine, and morphine including structural determinations.

Industrial and medicinal uses of Terpenoids, Steroids and Alkaloids.

Unit 4: Chemistry of vitamins (8 Lectures)

Classification and functional role in biological systems; chemistry of thiamine, riboflavin, retinol, tocopherols, vitamin C and pyridoxine.

Unit 5: Drug action and drug development (14 Lectures)

Definition and classification of drugs, prodrugs, need of new drugs, history of drug development: Aspirin, paracetamol, sulpha drugs.

Receptors, drug-receptor interaction and Clark's Occupancy Theory, physiological response, drug agonist, antagonist, inverse agonist.

Need of quantification of drug action, definition of chemotherapeutic index & therapeutic index, factors affecting bioactivity of drugs, pharmacokinetics, pharmacodynamics,

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Quantitative structure activity relationships (QSAR).

Lead compound, importance of SAR & molecular modification, combinatorial library and molecular modeling in drug discovery, introduction to gene therapy.

Phases in drug development.

Unit 6: Antibiotics (12 Lectures)

Definition of antibiotics, their sources, classification (based on structure and biological activity) and basic structures, causes & concerns of bacterial resistance to antibiotics, Definition and need of broad spectrum antibiotics.

β-lactam antibiotics: Classification, History leading to the discovery of penicillins (β-lactam antibiotics) – natural & semi-synthetic penicillins, structure activity relationship & chemical modification, bacterial resistance to penicillins - causes and inhibitors, mode of action of β-lactam antibiotics, origin of high reactivity of penicillins and related consequences.

Tetracyclines: uses and structure activity relationship, mode of action.

Macrolide antibiotics: structure activity relationship, mode of action.

Unit 7: Antimalarials (4 Lectures)

Discovery of quinine and its SAR, importance of quinine as a lead to discovery of other low cost antimalarials, artemisinin and its derivatives, their SAR and importance in dealing with CQ resistant malaria, mode of action.

Unit 8. Antiviral and Anticancer drugs (5 Lectures)

Difficulty in developing clinical solution to viral diseases, introduction to antiviral agents.

Cancer and its causes, difficulty in developing clinical solution, chemotherapy of cancer – uses of vinca alkaloids, taxol and its derivatives.

PAPER : CHM1002SP3

HETEROGENEOUS CATALYSIS

(Credits: 4+1+0=5)

Theory: 75 Lectures

Unit 1: Introduction to Heterogeneous Catalysis (25 Lectures)

Surface area determination from adsorption isotherms and point-B methods, porosity determination by volumetric and gravimetric methods. Chemisorption on metals, semi-conducting oxides and insulator oxides.

Effect of temperature on rates of catalysed reactions, mass transport limitation of catalysed reactions. Surface dependence of reaction rates, volcano principles.

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Characteristics of a good catalyst. Catalyst design methods, catalyst support and preparation of industrial catalyst, supported and unsupported metal catalysts, bimetallic catalysts.

Unit 2: Zeolites and Clays **(20 Lectures)**

Zeolites (natural and synthetic), shape selectivity properties, solid acids, acidity of zeolites and clays. Mesoporous materials, poorly crystalline silicates and aluminosilicates.

Applications of zeolites and clays as heterogeneous catalysts in cracking, reforming and olefin reactions. Zeolites as catalyst supports.

Unit 3: Catalysis in Petroleum Industry **(20 Lectures)**

Synthesis gas and production of chemicals from it. Hydrodesulphurization process and catalysts involved. Lewis acid catalysts, hydrogenation catalysts and bi-functional catalysts. Selective oxidation of hydrocarbon compounds – production of various petrochemicals. Manufacture and transformation of hydrocarbons – hydrogenation and isomerisation. Catalytic deactivation and reactivation.

Unit 4: Catalysis in Environmental Roles **(10 Lectures)**

Control of pollution from automobile exhaust, catalytic converters – use of non-selective oxidation. Abatement of nitrogen oxides and industrial odours, cleaning of industrial effluents.

Semester IV: Open Elective

PAPER : CHM1004OP1

CHEMISTRY IN HUMAN LIFE

(Credits: 3+1+0=4)

Theory: 60 Lectures

Unit 1: Chemistry of Drugs and Medicines **(15 Lectures)**

Definition of Drugs, narcotic and non narcotic drugs, stages involved in drug development, determination of LD₅₀ and ED₅₀, therapeutic index, over the counter and prescription drugs, drug regulatory agencies, side effects of drugs, drugs for metabolic and infectious diseases, Probiotics and antibiotics, antacids, anti inflammatory drugs, antidepressants, anti-viral and anti-fertility drugs. Drug tolerance and drug resistance. Harmful effects of nicotine consumption.

Unit 2: Chemistry of Food and Nutrition **(12 Lectures)**

Macro and micro nutrients in food, basics of nutrition, calorie values of food, fats and oils, Unsaturated versus saturated fat, PUFA, MUFA, trans fat. Cholesterol, uric acid, and blood sugar. Role of minerals in metabolism. Dietary fibres.

Food colours and preservatives, MSG, Artificial sweeteners.

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Unit 3: Cosmetics and Personal Hygiene

(10 Lectures)

A general study of the following: Hair oils, shampoo, sunscreen lotions, face powder, lipsticks, talcum powder, nail enamel, creams and moisturizers, toothpaste, antiperspirants and perfumes. Detergents and hair dye, hair curlers and straighteners.

Unit 4: Petroleum and Non-Petroleum Fuels

(15 Lectures)

Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional distillation (principle and process), Cracking (thermal and catalytic cracking), Reforming. Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals.

Biomass energy and biodiesel.

Unit 5: Polymers and Industrial Chemicals

(8 Lectures)

Biopolymers and man-made polymers, biodegradable and non biodegradable plastics. Fibres and fabrics. Cellulose and pulp. Pesticides and fertilizers.

Suggested Books in Chemistry for M.Sc. Course:

01. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson, P.L. Gaus (John Wiley and Sons Ltd., Indian Edition)
02. Concise Inorganic Chemistry by J.D. Lee (John Wiley and Sons Ltd., Indian Edition)
03. Inorganic Chemistry by G.L. Meissler and D.A. Tarr (Pearson)
04. Shriver and Atkins's Inorganic Chemistry by P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong (Oxford University Press, Indian Edition)
05. Inorganic Chemistry Principles of Structure and Reactivity by J. E. Huheey, E.A. Keiter, R.L. Keiter and O.K. Medhi (Pearson Education)
06. Oxford Chemistry Primer: Magnetochemistry by A.F. Orchard (Oxford University Press)
07. Oxford Chemistry Primer: Supramolecular Chemistry by P.D. Beer, P.A. Gale and D.K. Smith (Oxford University Press)
08. Fundamental Concepts of Inorganic Chemistry (Part I, II & III) by Ashim K. Das (CBS Publishers and Distributors)
09. Advanced Inorganic Chemistry (Volume I & II) by Satya Prakash, G.D. Tuli, S.K. Basu and R.D. Madan (S. Chand)

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10. Principles of Inorganic Chemistry by B. R. Puri, L. K. Sharma and K. C. Kalia (Milestone)
11. Organic Chemistry by J. Clayden, N. Greevs and S. Warren (Oxford University Press)
12. Organic Chemistry by S.H. Pine (McGraw Hill)
13. Organic Chemistry (Volume I & II) by I.L. Finar (Pearson)
14. Advanced General Organic Chemistry by S.K. Ghosh (NCBA)
15. Organic Chemistry by S.M. Mukherji, S.P. Singh and R.P. Kapoor (Wiley)
16. Reaction Mechanism in Organic Chemistry by S.M. Mukherjee and S.P. Singh (Macmillan)
17. Basic Organic Stereochemistry by E.L. Eliel (Wiley)
18. Stereochemistry of Organic Compounds by D. Nasipuri (New Age International)
19. Polymer Science by V.R. Gowariker, N.V. Viswanathan and J. Sreedhar (New Age International)
20. Atkins's Physical Chemistry by P. Atkins and J.D. Paula (Oxford University Press)
21. A Textbook of Physical Chemistry (Volume 1, 2, 3, 4 & 5) by K.L. Kapoor (MacMillan)
22. Physical Chemistry by G.W. Castellan (Addison-Wesley)
23. A Textbook of Physical Chemistry by A.S. Negi and S.C. Anand (New Age International)
24. Quantum Chemistry by I.N. Levine (Prentice Hall)
25. Quantum Chemistry and Spectroscopy by B.K. Sen (Kalyani Publishers)
26. Fundamentals of Molecular Spectroscopy by C.N. Banwell and E.M. McCash (Tata McGraw Hill)
27. Organic Spectroscopy by W. Kemp (McMillan)
28. Introductory Organic Spectroscopy by B.K. Sen and Mousumi Ganguly (Kalyani)
29. An Advanced Course in Practical Chemistry by A.K. Nad, Ghosal and Mahapatra (New Central Book Agency)
30. Chemical Kinetics by K. J. Laidler (Pearson)
31. Principles of Polymerisation by G. Odian (Wiley)
32. Textbook of Polymer Science by F. W. Billmeyer (Wiley)
33. Analytical Chemistry by G. D. Christian (Wiley)
34. Practical Organic Chemistry by A. I. Vogel (Longman)
35. Quantitative Chemical Analysis by A. I. Vogel (Longman)

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36. Vogel's Textbook of Qualitative Inorganic Analysis by G. Svehla (Longman)
37. Modern Chemical Analysis by D. Harvey (Mc Graw Hill)
38. Catalytic Chemistry by B. C. Gates (Wiley)
39. Heterogeneous Catalysis by G. C. Bond (Oxford)
40. Principles and Practice of Heterogeneous Catalysis by J. M. Thomas and W. J. Thomas (VCH)
41. Modern Electrochemistry Vol. 1 by J. O. Bockris and A. K. N. Reddy (Kluwer)
42. Modern Electrochemistry Vol. 2A by J. O. Bockris and A. K. N. Reddy (Kluwer)
43. Professional Programmer's Guide to Fortran-77 by C.G. Page (University of Leicester)
44. Computers in Chemistry by K. V. Raman (Tata McGraw Hill)
