

DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH

B.Sc. (HONS.) I Semester (C.B.C.S)
General Chemistry (CHB 151)
(W.E.F. 2017 - 2018)

M.M.: 100 (30+70)
4 Periods/week
4 Credits

Inorganic Chemistry

I (a) Atomic Structure

Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of Ψ and Ψ^2 , quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements.

(b) Periodic Properties

Atomic and ionic radii, ionization energy, electron affinity and electronegativity definition, effective nuclear charge, methods of determination or evaluation, trends in periodic table and applications in predicting and explaining the chemical behaviour.

(c) Lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule. Metallic bond-free electron, valence bond and band theories.

Organic Chemistry

II (a) Structure Bonding

Hybridization and its effect on bond length and bond angles, bond energy, localized and delocalized chemical bond, inductive, resonance, hyperconjugation, hydrogen bonding, van der Waals interactions

(b) Mechanism of Organic reactions

Homolytic and heterolytic bond breaking. Types of reagents-electrophiles and nucleophiles, Types of organic reactions. Energy considerations. Reactive intermediates-carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). Assigning formal charges in intermediates and other ionic species.

Physical Chemistry

III (a) Gaseous State

Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waals equation of state. *Critical Phenomena*: PV isotherms of real gases, continuity of states, the isotherms of van der Waals equation, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of state. Problems

Molecular velocities: Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. liquification of gases (based on Joule-Thomson effect). Problems

(b) Solid State

Definition of space lattice, unit cell.

Laws of crystallography - (i) Law of constancy of interfacial angles (ii) Laws of rationality of indices (iii) Law of symmetry. Symmetry elements in crystals.

X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CsCl.

IV (a) Chemistry of Noble Gases

Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds

(b) Introduction to Stereochemistry of organic Compounds

Concept of isomerism. Optical isomers, enantiomers and diastereomers, chiral and achiral molecules with two stereogenic centres, absolute configuration, sequences rules, D & L and R & S systems of nomenclature. Geometrical isomerism - E & Z system of nomenclature, in alkenes oximes and cyclopropane derivative compounds.

(c) Colloidal State

Definition of colloids, classification of colloids.

Sols: properties -kinetic, optical and electrical; stability of colloids, protective colloids, Hardy-Schulze rule, gold number. Emulsions: types of emulsions, preparation.

Gels: classification, preparation and properties,

Books Recommended:

1. New Concise Inorganic Chemistry by J.D. Lee Edition III Compton Printing Ltd London.
2. Principles of Inorganic Chemistry by HR Puri, R. Sharma & S.P. Jauhar, Vishal Publications Jalandhar.
3. Organic Chemistry, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
4. Modern Organic Chemistry, M. K. Jain and S.C. Sharma, Vishal Publications Jalandhar.
5. Physical Chemistry, P.W. Atkins, Oxford University Press.
6. Principles of Physical Chemistry, B.R. Puri & L.R. Sharma, Shoban Lal Nagin Chand & Co.

DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH

B.Sc. (HONS.) II Semester (C.B.C.S)
Inorganic Chemistry (CHB 252)
(W.E.F. 2017 - 2018)

M.M.: 100 (30+70)
2 Periods/week
2 Credits

- Unit I** Covalent Bond: Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence shell electron pair repulsion (VSEPR) theory to NH_3 , H_3O^+ , SF_4 , ClF_3 , ICl_2 , SO_4^{2-} , CO_3^{2-} , NO_3 and H_2O .
- Unit II** Molecular Orbital (MO) theory and applications for homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules. Weak Interactions - Hydrogen bonding, van der Waals forces.
- Unit III** Chemistry of Elements of First Transition Series, Characteristic properties of d-block elements. Properties of the elements of the first transition series, their complexes illustrating relative stability of their oxidation states, coordination number and geometry.
- Chemistry of Elements of Second and Third Transition Series, General characteristics, comparative treatment with their 3d-analogues in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.
- Unit IV** Werner's coordination theory, IUPAC nomenclature of coordination compounds, Classification of ligands, Chelates, isomerism in coordination compounds; Effective atomic number (EAN) concept of valence bond theory of transition metal complexes.

Books Recommended:

1. New Concise Inorganic Chemistry by J.D. Lee Edition III Compton Printing Ltd London.
2. Principles of Inorganic Chemistry by HR Puri, R. Sharma & S.P. Jauhar, Vishal Publications Jalandhar.
3. Basic Inorganic Chemistry F.A. Cotton and G. Willkinson III Edition.

**DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH**

**B.Sc. (HONS.) II Semester (C.B.C.S)
Physical Chemistry (CHB 253)
(W.E.F. 2017 - 2018)**

**M.M.: 100 (30+70)
2 Periods/week
2 Credits**

Unit I Chemical Kinetics:

Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction - concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates, mathematical characteristics of simple chemical reactions - zero order, first order, second order, pseudo order, half life and mean life. Determination of the order of reaction - differential method, method of integration, method of half life period and isolation method.

Problems

Radioactive decay as a first order phenomenon. Problems

Experimental methods of chemical kinetics: conductometric, optical methods, polarimetry and spectrophotometry (problems only).

Unit II Catalysis:

Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Homogeneous Catalysis, characteristics of catalysed reactions, classification of catalysis, miscellaneous examples. Enzyme Catalysis.

Unit III Thermodynamics

First law of thermodynamics: statement, definition of internal energy and enthalpy, Heat capacity. Heat capacities at constant volume and pressure and their relationship. Joule-Thomson coefficient and inversion temperature. Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

Problems

Thermochemistry: Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchhoff's equation. Problems

Unit IV Second law of thermodynamics:

Different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature. Problems

Concept of entropy: entropy as a state function, entropy as a function of V & T , entropy as a function of P & T , entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz functions: Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P, V and T . Problems

Books Recommended:

1. Physical Chemistry, G.M. Barrow, Int. Students Edition, McGraw Hill
2. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
3. Physical Chemistry, P.W. Atkins, Oxford University Press.
4. Principles of Physical Chemistry, B.R. Puri & L.R. Sharma, Shoban Lal Nagin Chand & Co.

**DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH**

**B.Sc. (HONS.) III Semester (C.B.C.S)
Physical Chemistry (CHB 353)
(W.E.F. 2018 - 2019)**

**M.M.: 100 (30+70)
2 Periods/week
2 Credits**

Unit - I Solutions and Colligative Properties

Thermodynamics of ideal solution and Raoult's law, deviations from Raoult's law – non-ideal solutions.

Partial miscibility of liquids: Critical solution temperature; Nernst distribution law and its applications, Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient, Problems.

Dilute solution, Colligative properties, relative lowering of vapour pressure, law of osmotic pressure and its measurement, Elevation of boiling point and depression of freezing point.

Unit - II Phase Equilibrium

Phases, components and degrees of freedom of system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, Cd-Mg)

Unit- III Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions.

Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Unit- IV Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG , ΔH and ΔS from EMF data.

Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge.

pH determination using hydrogen electrode and quinhydrone electrode.

Books Recommended:

1. Physical Chemistry, G.M. Barrow, Int. Students Edition, McGraw Hill
2. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
3. Physical Chemistry, P.W. Atkins, Oxford University Press.
4. Principles of Physical Chemistry, B.R. Puri & L.R. Sharma, Shoban Lal Nagin Chand & Co.

**DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH**

**B.Sc. (HONS.) III Semester (C.B.C.S)
Organic Chemistry (CHB 352)
(W.E.F. 2018 - 2019)**

**M.M.: 100 (30+70)
2 Periods/week
2 Credits**

Unit I (a) Aliphatic Hydrocarbons

Alkanes: Methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), Mechanism of free radical halogenation of alkanes- orientation, reactivity and selectivity.

(b) **Alkenes:** Methods of formation, dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rule, Hofmann elimination, Relative stabilities of alkenes. Chemical reactions-mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule. Hydroboration-oxidation, oxymercuration-demercuration, epoxidation, ozonolysis, hydration, hydroxylation with KMnO_4 .

Unit II (a) Alkynes: Methods of formation, chemical reactions and acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reaction.

(b) **Dienes:** classification- isolated, conjugated and cumulated dienes. Structure, method of formation and reactions (1, 2- and 1,4-additions, Diels-Alder reaction) of butadiene.

Unit III Alcohols: Methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Grignard synthesis: Grignard reagent and its use for synthesis of alcohol. Reactions of alcohols. Distinction between Primary, Secondary and Tertiary alcohols., Oxidative cleavage [$[\text{Pb}(\text{OAc})_4$ and (HIO_4)] and Pinacol- Pinacolone rearrangement.

Unit IV Arenes and Aromaticity:

Structure of benzene-molecular formula and Kekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture. Aromaticity- the Huckel rule, aromatic ions. Aromatic electrophilic substitution-general pattern of the mechanism, role of σ - and π - complexes. Mechanism of nitration, halogenation, sulphonation and Friedel-Craft reactions. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio, electrophilic aromatic substitution of toluene & nitrobenzene. Side chain reactions of benzene derivatives. The addition-elimination and elimination-addition mechanism of nucleophilic aromatic substitution reactions. Fries rearrangement, Claisen rearrangement and Reimer-Tiemann reaction.

Books Recommended:

1. Organic Chemistry by Morrison & Boyd, Printice-Hall.
2. Organic Chemistry, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
3. Organic Chemistry, G.M. Loudon, Oxford Press.

**DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH**

**B.Sc. (HONS) Semester IV (CBCS)
Inorganic Chemistry (CHB 452)
(w.e.f. 2018 - 2019)**

**M.M.: 100 (30+70)
2 Periods/week
2 Credits**

Unit - I Chemistry of Lanthanides and Actinides

Electronic structure, oxidation states, ionic radii of Lanthanides & Actinides. Complex formation. Occurrence and Isolation of lanthanide compounds. Lanthanide contraction and its causes. Comparative study of properties of Lanthanide & Actinides.

Unit - II Acids and Bases: Arrhenius, Bronsted-Lowry, the Lux-Flood, solvent system and Lewis concepts of acids and bases, A Generalized Acid Base Concept.

Unit - III Hard and Soft Acids and Bases (HSAB): Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid-base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness.

Unit - IV Non-aqueous Solvents: Physical properties of a solvent, types of solvents and their general characteristics, reaction in non-aqueous solvents with reference to liquid NH₃ and liquid SO₂.

Books Recommended:

1. New Concise Inorganic Chemistry by J.D. Lee Edition III Compton Printing Ltd London.
2. Principles of Inorganic Chemistry by HR Puri, R. Sharma & S.P. Jauhar, Vishal Publications Jalandhar.
3. Modern Aspects of Inorganic Chemistry by H.J. Emelens and Sharpe A.G., The English Language Book Society and Roulledge & Kegan Paul.
4. Inorganic Chemistry, Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Edition IV, Pearson Education Press.

**DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH**

**B.Sc. (HONS) Semester IV (CBCS)
Organic Chemistry (CHB 453)
(w.e.f. 2018 - 2019)**

**M.M.: 100 (30+70)
2 Periods/week
2 Credits**

- Unit I Carbonyl Compounds-I:** Synthesis of aldehydes and ketones by oxidation of alcohols, reduction of acid chloride (Friedel-Craft acylation) and by reaction of acid chloride with organo copper compounds Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction.
- Unit II (a) Carbonyl Compounds-II:** Baeyer-Villiger oxidation of ketones, Cannizzaro reaction. Clemmensen, Wolff-Kishner, LiAlH_4 and NaBH_4 reductions. Halogenation of enolizable ketones.
- (b) Active methylene compounds:** Properties and uses of malonic ester and acetoacetic ester.
- Unit III Carboxylic acids:** Structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Reduction and decarboxylation. Carboxylic Acid Derivatives: Structure and Preparation of acid chlorides, ester, amides and acid anhydrides. Relative stabilities, interconversion of acid derivatives. Mechanism of esterification and hydrolysis (acidic and basic).
- Unit IV Amines:** Preparation of amines (alkyl & aryl). Structural features affecting basicity of amines. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformation of aryl diazonium salts, azo coupling.

Books Recommended:

1. Organic Chemistry by Morrison & Boyd, Printice-Hall.
2. Organic Chemistry, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
3. Organic Chemistry, Graham Solomons, T.W. John Wiley & Sons. INC.

**DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH**

**B.Sc. (HONS.) IV Semester (C.B.C.S)
Open Elective Course
Pharmaceutical Chemistry (CHB 491)
(W.E.F. 2017 - 2018)**

**M.M.: 100 (30+70)
2 Periods/week
2 Credits**

- Unit – I **Pharmaceutical Analysis**
Introduction to Pharmacopoeia, Phases of drug development, analyst role in new drug product/ formulation development, impurities and its requirement of analysis during drug development, stability study of bulk drug/ formulation, bioavailability, equivalence, chemical equivalence and bioequivalence of drugs.
- Unit – II **Pharmaceutical Inorganic Chemistry**
Definition, classification and uses of inorganic pharmaceuticals. Pharmaceutical chemistry of sodium aurothiomalate, zinc undecylenate, calcium phosphate, sodium antimony gluconate, calamine.
- Unit – III **Synthesis of Drugs**
Sulphonamides, properties of sulphonamides. Synthesis of sulphadiazine, sulphapyridine, sulphafurazole. Synthesis of paracetamol, analgesic, classification of analgesic, Penicillin, Penicillin G.
- Unit – IV **Kinetics of Drug Action**
Introduction, Pharmacokinetic processes, parameters affecting absorption, distribution, metabolism, excretion. Rates and Orders of pharmacokinetic processes, Pharmacokinetic models, Pharmacokinetic parameters, Pharmacokinetic applications, Pharmacodynamics, theories of Drug-receptor interaction, Agonist, Antagonist, Equation for drug-receptor interaction.

Books Recommended

1. Analytical Chemistry in GMP Environment – A Practical Guide, J.M. Miller and Crowther (Ed.), Jhon Wiley & Sons Inc., New York 2000
2. Indian Pharmacopoeia, Indian Pharmacopoeial Commission, Ghaziabad (U.P.), India, 2010.
3. A Text Book of Inorganic Pharmaceutical Chemistry, C. H. Rogers, T. O. Soine and C.O. Wilson, fourth edition, Lea & Febiger, Philadelphia, 1949

**DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH**

**B.Sc. (HONS.) V Semester (C.B.C.S)
Physical Chemistry (CHB 551)
(W.E.F. 2017 - 2018)**

**M.M.: 100 (30+70)
4 Periods/week
4 Credits**

- Unit I Quantum Mechanics**
Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect. De Broglie hypothesis, the Heisenberg's uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box.
Schrodinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave functions, angular wave functions.
- Unit II** Molecular orbital theory, basic ideas -criteria for forming M.O. from A.O., construction of M.O's by LCAO- H_2^+ ion, calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions, concept of σ , σ^* , π , π^* orbitals and their characteristics. Hybrid orbitals- sp , sp^2 , sp^3 ; calculation of coefficients of A.O.'s used in these hybrid orbitals.
Introduction to valence bond model of H_2 , comparison of M.O. and V.B. models.
- Unit III Spectroscopy**
Introduction: electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom.
Rotational Spectrum
Diatomic molecules, Energy of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution), determination of bond length, qualitative description of non-rigid rotor, isotope effect.
Vibrational Spectrum
Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups.
Raman Spectrum: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.
Electronic Spectrum
Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck-Condon principle.
Qualitative description of σ , π - and n M.O., their energy levels and the respective transitions.
- Unit IV Photochemistry**
Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus -Draper law, Stark -Einstein law. Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions - energy transfer processes (simple examples).

Books Suggested:

1. Physical Chemistry, G.M. Barrow, Int. Students Edition, McGraw Hill.
2. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
3. Physical Chemistry, P.W. Atkins, Oxford University Press.
4. Principles of Physical Chemistry, B.R. Puri & L.R. Sharma, Shoban Lal Nagin Chand & Co.
5. Physical Chemistry, Maron & Lando.
6. Quantum Chemistry, R.K. Prasad, New Age.
7. Physical Chemistry, Vol. 04, K.L. Kapoor, Macmillan
8. Fundamentals of Molecular Spectroscopy, Colin N Banwell, McGraw Hill.

**DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH**

**B.Sc. (HONS.) V Semester (C.B.C.S)
Organic Chemistry (CHB 552)
(W.E.F. 2017 - 2018)**

**M.M.: 100 (30+70)
4 Periods/week
4 Credits**

- Unit I (a) **Organometallic compounds**
Organomagnesium compounds: the Grignard reagents-formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions.
- (b) **Polynuclear aromatic hydrocarbon:**
Polynuclear aromatic hydrocarbons Structure, synthesis and reaction of naphthalene and anthracene.
- (c) **Organosulphur compounds.**
Nomenclature and structural features. Methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides and sulphaguanidine.
- Unit II **Heterocyclic Compounds**
Introduction: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.
Introduction to condensed five and six- membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.
- Unit III **Carbohydrates.**
Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threodiastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose. Mechanism of mutarotation.
Structure of ribose and deoxyribose. An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.
- Unit IV **Spectroscopy**
- (a) Basic concepts of IR, UV, NMR spectroscopy & Mass spectrometry.
- (b) Nuclear magnetic resonance (NMR) spectroscopy: ¹H-NMR spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of ¹H-NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone. Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and PMR spectroscopic techniques.

Books Recommended:

1. Organic Chemistry by L.G. Wade Jr. Prentice-Hall.
2. Organic Chemistry by Fessenden & Fessenden, Brooks/Cole Publishing Company.
3. Organic Chemistry by Morrison & Boyd, Prentice-Hall
4. Fundamentals of Organic Chemistry, Solomons, John Wiley.
5. Organic Chemistry, Vol. II, III, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
6. Organic Chemistry, F.A. Carey, McGraw-Hill, Inc.

DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH

B.Sc. (HONS.) V Semester (C.B.C.S)
Inorganic Chemistry (CHB 553)
(W.E.F. 2017-2018)

M.M.: 100 (30+70)
4 Periods/week
4 Credits

- Unit I **Metal-ligand Bonding in Transition Metal Complexes**
Bonding in transition metal compounds, Valence Bond Theory, An elementary idea of crystal-field theory. Crystal field splitting in octahedral, tetrahedral and square planar complexes.
- Unit II **Magnetic Properties of Transition Metal Complexes**
Types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moment.
- Unit III **Electron Spectra of Transition Metal Complexes**
Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series. Orgel-energy level diagram for d^1 and d^9 states, discussion of the electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex ion.
- Unit IV **Organometallic Chemistry**
Definition, nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyls and aryls of Al, metal ethylenic complexes.

Books recommended:

1. Advance Inorganic Chemistry, Cotton and Willkinson.
2. Organometallic Chemistry, H. Zeiss.
3. New Conise Inorganic Chemistry, Fifth Edition, J.D. Lee.
4. Principles and Structure and Reactivity, James, E. Huheey.
5. Modern Coordination Chemistry, Lewis and Wilkins.

DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH

B.Sc. (HONS.) V Semester (C.B.C.S)
Analytical Chemistry – I (CHB 554)
(W.E.F. 2017 – 2018)

M.M.: 100 (30+70)
4 Periods/week
4 Credits

- Unit I **Errors and the treatment of the analytical data**
Accuracy and precision, Errors- determinate errors, constant errors, proportional errors, indeterminate errors, frequency distributions, the normal error curve, measurement of central tendency and variability, Students *t*-test, confidence interval of the mean, Test for significance – Comparison of two means, F-test, rejection of an observation – 4d rule and Q-test, propagation of errors, significant figures, Method of least squares, Problems.
- Unit II **Separation by solvent extraction**
Theory – distribution law, distribution coefficient, distribution ratio, percent extracted, multiple extraction. Extraction equilibria – distribution of weak acids. Extraction of metal as chelate compounds. Extraction system involving ion pair and solvates. Problems.
- Unit III **Chromatography**
Introduction, general description of chromatography, Classification of chromatographic methods – based on type of stationary and liquid phases, elution in column chromatography. Migration rate of solutes – partition coefficient, retention time and volume, Migration rates and distribution constants, retention factor, selectivity factor. Band broadening and column efficiency – plate and rate theory. The Van Deemter equation, column resolution, column optimization techniques.
- Unit IV **Spectrophotometry**
The electromagnetic spectrum, interaction of radiant energy with molecules, absorption of UV and visible radiation, Beer-Lambert's Law. Terms employed in absorption spectrometry, derivation of Beer's law. Additivity of absorbance's, deviation from Beer's law. Instrumentation of UV-VIS spectrometers – Sources, Wavelength selectors (Filters, monochromators), sample cell, Detectors (Photovoltaic cells, phototubes, Diode-array & others), single and double beam spectrophotometers, Problems.

Books Suggested:

1. Quantitative Analysis, 6th Ed. R.A. Day Jr. and A.L. Underwood. Printice Hall India Ltd. 1991.
2. Analytical Chemistry, 6th Ed. G.D. Christian, Jhon Wiley & Sons (Asia) Pvt. Ltd., New Delhi, 2004
3. Vogel's Text Book of Quantitatvive Chemical Analysis, 6th Ed. J. Mendham, R.C. Denney, J.D. Barnes, M.J.K. Thomas, Pearson Education Ltd. 2000
4. Fundamental of Analytical Chemistry, 9th Ed. D.A. Skoog, D.M. west, F.J. Holler, S.R. Crouch, Brooks Cole – Cengage Learning 2014
5. Chemical Analysis, Modern Instrumental Methods and Techniques, 2nd Ed. Francis Rouessac, Annick Rouessac, Wiley 2007.
6. G.W. Ewing, Instrumental Methods of Chemical Analysis, 5th Ed. 1985.

DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH
B.Sc. (HONS.) VI Semester (C.B.C.S)
Physical/Organic Chemistry (CHB 651)
(W.E.F. 2017 - 2018)

M.M.: 100 (30+70)
2 Periods/week
2 Credits

Unit I Amino Acids

Classification, structure and stereochemistry of amino acids, Acid-base behaviour, isoelectric point and electrophoresis. Preparation using Hell-Volhard-Zelinsky reaction, Strecker synthesis, amidomalonate synthesis, biosynthesis. Resolution of R and S amino acids, Reactions of α -amino acids.

Unit II Peptides, Proteins and Nucleic Acids

Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Levels of protein structure. Protein denaturation/renaturation. Nucleic acids: Introduction. Constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.

Unit III Dielectric Properties

Polarization – (Clausius – Mossotti equation), orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment temperature method and refractivity method, dipole moment and structure of molecules.

Unit IV Magnetic Properties

Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Introduction of paramagnetism diamagnetism and ferromagnetism.

Books recommended:

1. Organic Chemistry by L.G. Wade Jr. Prentice-Hall.
2. Organic Chemistry, by Morrison & Boyd, Printice Hall
3. Organic Chemistry, Vol. III, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
4. Organic Chemistry by Fessenden and Fessenden, Brooks/Cole Publishing Company.
5. Physical Chemistry, G.M. Barrow, Int. Students Edition, McGraw Hill.
6. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
7. Physical Chemistry, P.W. Atkins, Oxford University Press.
8. Principles of Physical Chemistry, B.R. Puri & L.R. Sharma, Shoban Lal Nagin Chand & Co.
9. Physical Chemistry, Maron & Lando.

DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH

B.Sc. (HONS.) VI Semester (C.B.C.S)
Inorganic/ Analytical Chemistry (CHB 652)
(W.E.F. 2017 – 2018)

M.M.: 100 (30+70)
2 Periods/week
2 Credits

- Unit I **Complexometric titrations - I**
Introduction, chelating agents, formation of complexes, stability of complexes, EDTA: acidic properties, complexes of EDTA and metal ions, Equilibria involved in EDTA titrations, problems.
- Unit II **Complexometric titrations – II**
EDTA titration curves, indicators for EDTA titrations: Erichrome Black – T, Calmagite, Application of EDTA titrations – direct titration, back titration, replacement titration, problems.
- Unit III Essential and Trace elements in biological systems, Na⁺/ K⁺ ion pump, metalloporphyrins with reference to Haemoglobin and myoglobin.
- Unit IV Silicones and phosphazenes as inorganic polymers: structure and bonding of triphosphazene, Silicones and their uses.

Books Suggested:

1. Quantitative Analysis, 6th Ed. R.A. Day Jr. and A.L. Underwood. Printice Hall India Ltd. 1991.
2. Analytical Chemistry, 6th Ed. G.D. Christian, Jhon Wiley & Sons (Asia) Pvt. Ltd., New Delhi, 2004
3. Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed. J. Mendham, R.C. Denney, J.D. Barnes, M.J.K. Thomas, Pearson Education Ltd. 2000
4. Fundamental of Analytical Chemistry, 9th Ed. D.A. Skoog, D.M. west, F.J. Holler, S.R. Crouch, Brooks Cole – Cengage Learning 2014
5. Chemical Analysis, Modern Instrumental Methods and Techniques, 2nd Ed. Francis Rouessac, Annick Rouessac, Wiley 2007.
6. G.W. Ewing, Instrumental Methods of Chemical Analysis, 5th Ed. 1985.
7. Advanced Inorganic Chemistry, Cotton and willkinson.
8. Organometallic Chemistry, H.Zeiss.
9. New Concise Inorganic Chemistry, J.D. Lee.

**DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH**

**B.Sc. (HONS.) VI Semester (C.B.C.S)
Physical Chemistry - DC (CHB 661)
(W.E.F. 2017 - 2018)**

**M.M.: 100 (30+70)
2 Periods/week
2 Credits**

- Unit I **Thermodynamics-I**
Reversible and irreversible processes; first law and its application to non-ideal gases. Problems.
Gibbs and Helmholtz functions: Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P, V and T. Problems.
- Unit II **Thermodynamics-II**
Third law of thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Problems.
- Unit III **Application of Thermodynamics in Chemical Equilibria:**
Law of mass action; K_p , K_c , K_x and K_n ; effect of temperature on K; ionic equilibria in solutions; pH and buffer solutions-mechanism of buffer action, Henderson-Hasselbalch equation, hydrolysis of salts, solubility product Problem.
- Unit IV **Chemical Kinetics and Adsorption:**
Theories of reaction rates (qualitative description): Collision theory; transition state theory; Kinetics of complex reaction: chain, consecutive, branched reactions, photochemical processes. Problems.
Gibbs adsorption equation; adsorption isotherm; types of adsorption; surface area of adsorbents; surface films on liquids. Problems.
Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Le Chatelier principle.
Reaction isotherm and reaction isochore-Clapeyron equation and Clausius-Clapeyron equation, applications.

Books Recommended:

DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH

B.Sc. (HONS.) VI Semester (C.B.C.S)
Organic Chemistry – DC (CHB 662)
(W.E.F. 2017 – 2018)

M.M.: 100 (30+70)
2 Periods/week
2 Credits

Unit I **Ethers and Epoxides**

- (a) **Ethers**: Nomenclature of ethers and methods of formation, physical properties. Chemical reactions - cleavage and autoxidation, Ziesel's method.
- (b) **Epoxides**: Synthesis of epoxides. acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

Unit II **Nitro compounds**

Nomenclature, Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitrocompounds. Mechanism of nucleophilic substitution in nitroarenes and their reductions in acidic neutral and alkaline media. Picric acid and halonitroarenes.

Unit III **Stereochemistry of organic Compounds – I**

Types of isomerism. Optical isomers-elements of symmetry, optical activity, properties of enantiomers, molecules with more than two chirality centres. Conformational isomerism-conformational analysis of ethane and n-butane.

Unit IV **Stereochemistry of organic Compounds – II**

Conformations of cyclohexane, axial and equatorial bonds, conformation of monosubstituted cyclohexane derivatives. Newman projection and Sawhorse formulae, Fischer and flying wedge formulae. Difference between configuration and conformation.

Books Recommended:

1. Organic Chemistry by Morrison & Boyd, Printice-Hall.
2. Organic Chemistry by L.G. Wade Jr. Prentice-Hall.
3. Organic Chemistry by Fessenden & Fessenden, Brooks/Cole Publishing Company.
4. Organic Reaction Mechanism by V.K. Ahluwalia and R.K. Parashar, Narosa Publishing House, New Delhi.
5. Fundamentals of Organic Chemistry, Solomons, John Wiley.
6. Organic Chemistry, Vol. III, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
7. Organic Chemistry, F.A. Carey, McGraw-Hill, Inc.

**DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH**

**B.Sc. (HONS.) VI Semester (C.B.C.S)
Inorganic Chemistry-DC (CHB 663)
(W.E.F. 2017-2018)**

**M.M.: 100 (30+70)
2 Periods/week
2 Credits**

- Unit I Discovery of radioactivity, types and properties, Nuclear reactions, radioactive disintegration, nuclear fission and fusion.
- Unit II Mass defect, packing fraction and binding energy, applications of radioactive isotopes. Determination of the age of the recent objects by radio-carbon dating method.
- Unit III Inorganic nomenclature, multiplying affixes, structural affixes, naming of ions like homo and hetero poly cation anion, naming of radicals, isopoly anions and acids.
- Unit IV Mixed metal oxides, spinel and inverse spinel structures, structure determination of oxides by CFSE.

Books recommended:

1. Principles of Inorganic Chemistry, Puri and Sharma, 2013.
2. Inorganic Chemistry, Principle, structure and reactivity, 4th edition, J. E. Huheey
3. Advanced Inorganic Chemistry, Cotton & Willkinson 5th Edition

DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH

B.Sc. (HONS.) VI Semester (C.B.C.S)
Analytical Chemistry – DC (CHB 664)
(W.E.F. 2017 – 2018)

M.M.: 100 (30+70)
2 Periods/week
2 Credits

- Unit I **Neutralization titration – I**
Bronsted theory, levelling effect, buffer solutions, behaviour of buffer solutions: Henderson-HasselBalch equation, buffer capacity, preparation of buffer solutions, titration curves: strong acid-strong base titration, weak acid – strong base titration, problems.
- Unit II **Neutralization titration – II**
Acid base indicators, theory of indicator behaviour, determining colour change range of an indicator, selection of proper indicator, indicator error, feasibility of acid base titrations.
- Unit III **Precipitation titration**
Precipitation titration curves, feasibility of precipitation titrations, indicators for precipitation titrations, The Mohr's method, The Volhard method, use of adsorption indicators – Fajan's method, factors affecting solubility, problems.
- Unit IV **Titration of polyprotic acids**
Polyprotic acids, solution of H_2B , solution of Na_2B , solution of $NaBH$, titration curves for polyprotic acids, titration of carbonates, titration of mixtures of two acids, problems.

Books Suggested:

1. Quantitative Analysis, 6th Ed. R.A. Day Jr. and A.L. Underwood. Printice Hall India Ltd. 1991.
2. Analytical Chemistry, 6th Ed. G.D. Christian, Jhon Wiley & Sons (Asia) Pvt. Ltd., New Delhi, 2004
3. Vogel's Text Book of Quantitatvive Chemical Analysis, 6th Ed. J. Mendham, R.C. Denney, J.D. Barnes, M.J.K. Thomas, Pearson Education Ltd. 2000
4. Fundamental of Analytical Chemistry, 9th Ed. D.A. Skoog, D.M. west, F.J. Holler, S.R. Crouch, Brooks Cole – Cengage Learning 2014
5. Chemical Analysis, Modern Instrumental Methods and Techniques, 2nd Ed. Francis Rouessac, Annick Rouessac, Wiley 2007.
6. G.W. Ewing, Instrumental Methods of Chemical Analysis, 5th Ed. 1985.

**DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH**

**B.Sc. (HONS.) VI Semester (C.B.C.S)
Physical Chemistry – AE (CHB 671)
(W.E.F. 2017 – 2018)**

**M.M.: 100 (30+70)
4 Periods/week
4 Credits**

Unit I Mathematics – I

Functions of one and many variables, Different Types of Functions and their graphs. Real and Complex Numbers and their Quadratic Equations. Infinite Series: Binomial Series, Exponential Series Logarithmic Series. Matrices and Determinants: Types of Matrices, Operation on Matrices (Addition and Multiplication; inverse, adjoint and transpose of matrices). Basic Idea about Scalars and Vectors: Vectors, dot, cross and triple products etc., gradient. Problems related to Physical Chemistry.

Unit II Mathematics – II

Differential Calculus: continuity and differentiability, Basic rules for differentiation, First Derivatives, Second Derivatives, Partial Derivatives, Exact and inexact differentials. Applications of differential Calculus in Physical Chemistry including maxima and minima. Integral Calculus: Basic rules for integration, Methods of Integration-Substitution, Partial Fractions and by parts. Applications of integral calculus in Physical Chemistry. Elementary Differential equations: First-order and second order differential equations and their applications in Physical Chemistry.

Unit III Biology – I

Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman Method) and C-terminal amino acid (by thiohydantion and with carboxypeptidase enzyme). Overview of carbohydrate and protein metabolism.

Unit IV Biology – II

Components of nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides (Nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

Books Recommended:

1. Biochemistry, Lubert Stryer; W.H. Freeman
2. Principles of Biochemistry, G.L. Zubay; McGraw-Hill

DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH
B.Sc. (HONS.) VI Semester (C.B.C.S)
Organic Chemistry – AE (CHB 672)
(W.E.F. 2017 – 2018)

M.M.: 100 (30+70)
4 Periods/week
4 Credits

Unit I Fats, Oils and Detergents

Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils. Saponification value, iodine value, and acid value. Soaps, synthetic detergents, alkyl and aryl sulphonates. Phospholipids and essential oils.

Unit II Synthetic Polymers

Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step growth polymerization. Copolymers, polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubbers. Biodegradable polymers.

Unit III Synthetic Dyes

Relationship between colour and constitution (electronic concept), Classification of dyes, Chemistry and synthesis of representative dyes:

- (i) Azo dyes: Methyl orange, Congo red.
- (ii) Triphenylmethane dyes: Malachite green, Crystal violet
- (iii) Phenolphthalein and xanthene dyes: Phenolphthalein, Fluorescein
- (iv) Nitro and nitroso dyes: Martius yellow, Fast green O
- (v) Anthraquinone dye: Alizarin
- (vi) Indigo dye: Indigo
- (vii) Fluorescent brightening agents: Synthesis of Blankophor-R and Blankophor-WT

Unit IV Drug & Pharmaceuticals

Historical background of pharmaceutical sciences and classification of drugs. Antipyretics and analgesic agents-Asprin, paracetamol, ibuprofen, salol, morphine, analgin etc. Antidiabetic drugs-Introduction to diabetes, control of diabetes, chemical structure of insulin. Antibiotic-Synthesis of Penicillin, Chloramphenicol, Tetracycline, Rifamicin etc.

Books recommended:

1. Modern Organic Chemistry, M. K. Jain and S. C. Sharma; Vishal Publishing Co.
2. Synthetic drugs by Gurdeep R Chatwal; Himalya Publishing House
3. Organic Chemistry by Morrison & Boyd, Printice Hall

DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH

B.Sc. (HONS.) VI Semester (C.B.C.S)
Inorganic Chemistry – AE (CHB 673)
(W.E.F. 2017-2018)

M.M.: 100 (30+70)
4 Periods/week
4 Credits

- Unit I Distortions in molecules:** Tetragonal distortion, compression and elongation in ML_6 type complexes with examples, vibronic coupling in octahedral complexes, centre of symmetry and colour of the complexes
- Unit II Symmetry and Symmetry operation:** Basic Concept of symmetry and symmetry operations; Elements of symmetry *viz.*, n-fold axis of rotation C_n , Plane of symmetry σ_n , Improper axis of symmetry S_n , Center of symmetry; The identity E. Applications on small inorganic molecules.
- Unit III Concepts of Fluorescence:** Chromophore molecules and their applications as luminescent agents, charge transfer transition, auxochrome, fluorescence and time resolved fluorescence, decay time, colours in dyes and pigments
- Unit IV Inorganic Chemistry in Biological System:** Photosynthesis, photo system I and II, chlorophyll and photosynthetic reaction centre, ferredoxins and ; rubredoxins, blue copper proteins.

Books recommended:

1. Inorganic Chemistry, Principle, structure and reactivity, 4th edition, J. E. Huheey
2. Advanced Inorganic Chemistry, Cotton & Wilkinson 5th Edition.
3. Elementary Organic Spectroscopy: Principles and Chemical Applications, Y. R. Sharma, S. Chand publications.

DEPARTMENT OF CHEMISTRY
A.M.U., ALIGARH

B.Sc. (HONS.) VI Semester (C.B.C.S)
Analytical Chemistry – AE (CHB 674)
(W.E.F. 2017 – 2018)

M.M.: 100 (30+70)
4 Periods/week
4 Credits

Unit I **Drugs in the Environment**

Introduction, exposure, fate and effects of drugs for human and veterinary treatment in the environment, analysis of drugs in the environment: analgesic, anti-inflammatory, beta-blockers and antibiotics.

Unit II **Pesticides and their Degradation Products**

Introduction, pesticides and transformation products in soil, Analytical procedures for determination – matrix preparation and quality control, extraction, clean-up, determination – gas chromatographic and liquid chromatographic methods, comparison of different analytical techniques.

Unit III **Air Pollutants**

Sampling – particulates (air-born solids), gases and vapours, sulphur oxides – sources, analysis and control measures. Carbon monoxide – sources, analysis and control measures.

Unit IV **Water Pollution**

Water quality parameters and their determination, steps in water treatment, determination of metal and metalloids, qualitative and quantitative analysis of ingredients of detergents.

Books Suggested:

1. An Introduction to Pollution science, R.M. Harrision [Ed.], Royal Society of Chemistry, United Kingdom, 2006.
2. Fundamental Concepts of Environmental Chemistry, G.S. Sodhi, 3rd Ed., Narosa Publishing House, New Delhi, 2013.
3. Environmental Chemistry, A.K. De, 6th Ed., Wiley Eastern Limited Publishers, New Delhi, 2006.
4. Chemosphere, Volume 40, Jorgensen & Sorensen, Pergamon Press, Denmark, 2000.
5. Trends in Analytical Chemistry, Volume 23, V. Andreu, Y. Pico, Elsevier Sciences, Spain, 2004.