

FIRST SEMESTER

ORGANIC CHEMISTRY-I

Subject Code	CH-HCT 1.1	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I: Stereochemistry I:

13Hrs

Stereochemistry, isomerism, stereoisomerism, interconversions of projection and perspective formulae, elements of symmetry, nomenclature, molecules with one & more than one chiral centers, prostereoisomerism, resolution of racemic mixtures, racemization, stereospecific & stereoselective reaction, absolute asymmetric synthesis, optical activity in the absence of a chiral carbon & presence of chiral plane, geometrical isomerism (cis-trans), conformational analysis.

UNIT-II: Stereo Chemistry II:

13Hrs

Prochirality: Prostereoisomerism & Asymmetric synthesis Introduction, nomenclature, homotopic and heterotopic ligands and faces, Conformations and stereoisomerism of acyclic and cyclic system, conformations of cyclohexane, equatorial & axial bonds in chair form of cyclohexane, conformations of substituted cyclohexane, conformational analysis of mono & disubstituted cyclohexane, stereoisomerism of disubstituted cyclohexane, equilibria of disubstituted cyclohexane and related systems, conformations of heterocycles, polycyclic compounds, cyclohexene and cyclohexanones.

UNIT-III: Reaction Mechanism (structure & reactivity):

13Hrs

Elementary & simple reactions, transition state structure, molecularity reaction profile diagram, thermodynamics of the reaction, kinetics of the reaction, thermodynamics versus kinetic control of reactions, kinetic isotope effects, methods of determining reaction mechanisms, hard & soft acids & bases (HSAB) electrophiles & nucleophiles, reaction intermediates (carbanions, carbocations, carbon radicals, carbenes, nitrenes & benzyne)

UNIT-IV:

Common name reactions:

13Hrs

Michael addition, Mannich reaction, Barton reaction, Shapiro reaction, Baeyer Villiger reaction, Chichibabin reaction, Reformsky reaction, Aldol condensation reaction, Reimer Tiemann reaction, Dieckmann condensation reaction, Hofmann reaction, Schmidt reaction, S tobbe reaction, Wittig reaction, Claisen condensation reaction.

BOOKS RECOMMENDED:

1. Text book of physical chemistry by N.K. Vishnoi, R.J. Shukla Ane's books Pvt.Ltd. Vol I.
2. Advanced organic chemistry by Dr. Jagdamba Singh & Dr. L.D.S. Yadav, A pragati edition.
3. Stereochemistry conformation & mechanism by P.S. Kalsi.

PHYSICAL CHEMISTRY-I

Subject Code	CH-HCT 1.2	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I: Solid state:

Types of crystalline solids, space lattice(crystal lattice and unit cell), Polymorphism and isomorphism, Number of atoms/molecules/ions per unit cell, crystallography, X-ray Diffraction by crystals structure and Bragg's law, determination of crystal structure experimentally, calculations involving unit cell dimensions, structure of crystals(structure of NaCl, KCl, CsCl crystal), Imperfection in crystals (scotty defect, Frenkel defect & impurity defect).

UNIT-II: Liquid State:

13Hrs

Introduction, Intermolecular forces, Structure of liquids, differences between Solid, Liquid and Gases. Liquid crystals, differences between liquid crystal, solid and liquid (Phases of matter namely liquid crystal, solid and liquid), classification of liquid crystals, Structure of Nematic and cholesteric phases, Thermography, seven segment cell (Seven-segment display layout, schematic diagram).

UNIT-III: Gaseous State:

13Hrs

Postulates of the Kinetic theory of gases, Pressure of an Ideal gas, Gas constant (R) (Deviation from Ideal behavior of gases, causes of deviation of real gases from ideal behavior), The Van Der Waals equation of state, critical phenomenon, Continuity of states, Isotherms based on Van Der Waals equation, relation between Critical constants and Van Der Waals constants(determination of critical constants , measurements of TC , PC and critical volume VC),

Colloidal state:

Classifications of colloids, preparation of colloidal sols(dispersion methods, condensation methods), purification of colloidal sols, properties of colloidal sols, origin of change on colloidal sols, coagulation of colloids, protection of colloidal sols, emulsions, gels, micelle formation, CMC determination, effects of CMC, thermodynamics of CMC.

UNIT-IV: CHEMICAL KINETICS

13Hrs

Introduction to basic concepts, Experimental methods of following kinetics of a reaction, chemical and physical (measurement of pressure, volume, EMF, conductance, diffusion current and absorbance) methods and examples. Steady state approximation and study of reaction between NO₂ and F₂, Kinetics of formation of HBr, HCl, decomposition of ozone, and nitrogen pentoxide. Ionic reaction: Primary and secondary salt effect.

BOOKS RECOMMENDED:

1. Text book of Physical chemistry – By: N.K.Vishnoi, R.T.Shukla, Ane's Book Pvt Ltd Vol I
2. Principles of Physical Chemistry- By: Puri, Sharma and Pathiana, VPC (Vishal Publishing Co.)
3. Introduction to solids – I.V.Azarrof
4. Solid state chemistry-A.R.West
5. Modern aspects of solid state chemistry – ed by C.N.Rao
6. New direction in solids state chemistry-C.N.Rao and gopal Krishanan
7. An Introduction to Electrochemistry by S. Glasstone
8. 14. Modern Electrochemistry Vol. I & II by J. O. M. Bockris and A.K.N. Reddy.
9. 15. Electrolytic Solutions by R. A. Robinson and R. H. Strokes, 1959
10. 16. Chemical Kinetics-K. J. Laidler, Pearson Education,2004
11. 17. Kinetics and Mechanism - A. A. Frost and R. G. Pearson.
12. 18. Electrochemistry- S. Glasstone, D. Van Nostrand , 1965.

INORGANIC CHEMISTRY-I

Subject Code	CH-HCT 1.3	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I:

The Ionic bonding:

13Hrs

Structure of ionic solids, radius ratio rules, calculation of some limiting radius ratio values coordination number 3 (planar triangle) coordination number 4 (tetrahedral) coordination number 6 (octahedral), close packing, classification of ionic structures, ionic compounds of the type AX (ZnS, NaCl, CsCl), ionic compounds of the type AX₂ (CaF₂, TiO₂, SiO₂), layer structures (CdI₂, CdCl₂, NiAs).

UNIT-II:

The covalent bond:

13Hrs

The Lewis theory, the octet rule, sidgwick- powell theory, valence shell electron pair repulsion (VSEPR) theory, effect of lone pairs, effect of electro negativity, iso electronic principle, examples using the VSEPR theory (Ammonia, water chlorine trifluoride, iodine heptafluoride), valence bond theory, hybridization, molecular orbital method, LCAO method (s-s, s-p, p-p, and d-d combinations of orbitals), rules for linear combination of atomic orbitals, examples of molecular orbital treatment for heteronuclear diatomic molecules(NO, CO, & HCl molecule).

UNIT-III:

Co-ordination Compounds:

13Hrs

Classification of coordination compounds, Werner's theory of coordination, electronic interpretation of coordination compounds, factors effecting the formation of complex ions, detection of complex ion in solution, nomenclature of coordination compounds, isomerism geometrical isomerism, optical isomerism, chelation, factors influencing the stability of metal chelates, importance of chelates, inner complexes, polynuclear complexes, theories of complex dcompounds, valence bond theory (VBT),crystal field theory(CFT),kinetic applications of crystal field theory, ligand field theory.

UNIT-IV:

Review of Acid-Base concepts:

13Hrs

Introduction different definitions, types of reactions, solvent system and leaving effect. A generalized acid-base concept(basicity of metal oxides hydration and hydrolysis). Measurement of acid-base strengths, steric effects (back strain, front strain and internal strain). Solvation effects with reference to liquid ammonia, anhydrous sulphuric acid, acetic acid and liquid sulphur dioxide. Hard-Soft Acids and Bases: classification, Strength of hardness and softness, Irving-William series, theoretical basis of hardness and softness.

BOOKS RECOMMENDED:

1. Concise inorganic chemistry - By: J. D. Lee, 5th edition Wiley India
2. Advanced Inorganic Chemistry – By: S. K. Agarwal, Keemtilal, A Pragati Edition.
3. Principles of Inorganic chemistry- By: Puri, Sharma and Pathiana, VPC (Vishal Publishing Co.)

PRACTICAL-I (Based on Inorganic and organic Theory)

Subject Code	CH-HCP 1.4	IA Marks	30
No. of Lecture Hrs./Week	08	Exam Hours	03
		Exam Marks	70

PART A:

Preparations

1. Preparation of Hexathioureaplumbus nitrate.
2. Preparation of potassium trioxalatochromate(III) & determine its purity.
3. Preparation of Hexamine nickel(II)chloride complex.
4. Preparation of Hexamine cobalt(III) chloride.
5. Preparation of Mercury tetra thiocyanato cobaltate(II)
6. Preparation of sodium hexanitritocobaltate(III)

PART B:

Preparations:

1. p-bromoaniline from acetanilide.
2. p-nitroaniline from acetanilide.
3. Synthesis of dibenzalacetone from benzaldehyde.
4. Synthesis of 4-chlorobenzoic acid & 4-chlorobenzyl alcohol from 4-chloro benzaldehyde.
5. Aniline from benzene.
6. m-nitro benzoic acid from ethyl benzoate.

BOOKS RECOMMENDED:

1. Advanced practical chemistry by Jagdamba Singh, R.K.P. Singh, Jaya Singh, LDS Yadav, I.R.Siddigni, Jaya shrivastava A pragati edition'

PRACTICAL-II (Based on Physical and Analytical Theory)

Subject Code	CH-HCP 1.5	IA Marks	30
No. of Lecture Hrs./Week	08	Exam Hours	03
		Exam Marks	70

PART A:

1. Determination of the rate constant of hydrolysis of an ester catalysed by 0.5M HCl
2. Determination of order of hydrolysis of ethyl acetate by NaOH
3. Studies on the kinetics of saponification of ethyl acetate by NaOH
 - i) Determine the rate constant
 - ii) Studies on the influence of ionic strength on the rate constant.
4. Conductometric determination of the kinetic order of saponification of ethyl acetate by NaOH
5. Surface tension determination by stalgmometer methods.

PART B:

Complexometric titrations

1. To estimate calcium with EDTA.
2. To estimate magnesium with EDTA.
3. To determine total permanent and temporary hardness of water by complexometric method using EDTA.
4. Analysis of sodium carbonate & sodium bicarbonate in baking soda by acid base titration

BOOKS RECOMMENDED:

1. Advanced practical chemistry by Jagdamba Singh, R.K.P. Singh, Jaya Singh, LDS Yadav, I.R.Siddigni, Jaya shrivastava. A pragati edition.
2. Practical chemistry by Dr. O.P.Pardey D.N.Bajpai, Dr.S.Giri

ANALYTICAL CHEMISTRY-I

Subject Code	CH-SCT 1.6.1	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I: Data handling & spreadsheets in Analytical Chemistry: **13Hrs**

Accuracy & precision, determinate errors, indeterminate errors, significant figures, standard deviation, propagation of errors, significant figures & propagation of errors, the confidence limit, test of significance, statistics for small data sets, linear least squares, correlation coefficient and coefficient of determination, slope intercept and coefficient of determination.

UNIT-II: Acid base titrations, complexometric reactions & titrations, gravimetric analysis & precipitation equilibria: **13Hrs**

Strong acid versus strong base, standard acid & base solutions, weak acid versus strong base titration of sodium carbonate, titration of amino acids, mixtures of acids and bases, kjeldahl analysis, complexes and formation constants, chelates, EDTA, metal EDTA titration curves, detection of end point, fraction of dissociating species in polyligand complexes, beta values, gravimetric analysis with examples, gravimetric calculations, precipitation equilibria, the diverse ion effect on solubility (K^0 and activity coefficients)

UNIT-III: Solvent extraction-I: **13Hrs**

General discussion principle, factors affecting solvent extraction, quantitative treatment of solvent extraction synergistic extraction ion association complex, extraction reagents acetyl acetone, 8-hydroxyquinoline dimethylglyoxime, 1-nitroso 2-naphthal cupferron dithiazole, sodium diethyl dithiocarbamate, ammonium pyrrolinedithiocarbamate, tri-n-butylphosphate poly compounds cetyltrimethyl ammonium bromide. Some practical considerations: choice of the solvent extraction. Some applications: Determination of iron as 8-hydroxy quinolate, determination of lead by dithiazone method, determination of molybdenum by thiocyanate method.

UNIT-IV: ION EXCHANGE METHODS: **13Hrs**

Introduction, definitions principle cation exchangers, anion exchangers and their synthesis, regeneration ion exchange columns used in chromatographic separation, selection of suitable systems, ion exchange capacity ion exchange technique batch method column method. Application of ion exchangers: separation of similar ion from one another removal of interfering radicals, softening of hard water complete demineralization of water separation of lanthanides, separation of actinides, purification of organic compounds extracted in water separation sugars, separation of amino acids, preparation of pure reagents hydro metallurgy.

BOOK RECOMMENDED:

1. Analytical chemistry by G.D.Christian.
2. Fundamental of analytical chemistry, D.A.Skoog D.M.West, Holler and Crouch 8th edition 2005, Saunders college publishing new York.
3. Analytical chemistry principles, John H. Kennedy, 2nd edition saunders college publishing California, 1990.
4. Instrumental methods of chemical analysis Chatwal and Anand-5th edn
5. Chromatography E.Heftman 5th edition part A and part B. Elsevier science publishers 1992.
6. Chromatography today, C.F. Poole and S.K. Poole Elsevier science publishers
7. Analytical chemistry by Alka L. Gupta A Pragathi edition
8. Separation methods by M.N. Sastri, Himalaya publisher.
9. Modern analytical chemistry Harvey Harcourt publishers.
10. An introduction to chromatography theory and practical V.K. Srivastav and K.K. Srivastav
11. Instrumental methods of chemical analysis, Gurudeep R Chatwal, Sharma K Anand. Himalaya publishers.
12. Chromatography by B.K. Sharma, GOEL publishers
13. Basic concepts of analytical chemistry, S.M. Khopkar, New age International publications 3rd edition.

NANO SCIENCE AND ENGINEERING CHEMISTRY-I

Subject Code	CH-SCT 1.6.2	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I: The big world of Nanomaterials:

History and scope, how small things make a big difference, classification of Nano structured materials, fascinating Nano structures, applications of Nano materials, nature : the best nanotechnologist, challenges and future prospects, microstructure and defects in Nanocrystalline materials, effects of Nano-dimensions on material behavior.

UNIT-II: Applications of Nanomaterials:

Nano electronics, micro and Nano-electromechanical systems (MEMS/NEMS), Nano-sensors, Nano catalysts, food and agriculture industry.

UNIT-III: Fuels and combustion

Types of fuels, calorific values of fuels, combustion of fuels, combustion equation for a hydrocarbon fuel, fuel gas analysis, conversion of gravimetric analysis to volumetric analysis and vice versa, carbon burnt to carbon di oxide and CO, excess air, supplied, enthalpy of formation, energy balanced for a reactive system, enthalpy and internal energy of combustion, actual combustion process.

UNIT-IV: Gas power cycle:

Air cycles, assumptions made, Carnotcycle, Otto cycle, diesel cycle, dual combustion cycle, comparison : Otto, diesel & dual cycles, comparison: Otto and diesel cycles, sterling cycle, gas turbine cycle Vapour Power cycle, Carnot cycle, Rankine cycle, types of feed water heaters, reheat cycle, regenerative cycle

BOOKS RECOMMENDED:

1. Text book of Nanoscience and technology by B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday Universe press.
2. Chemistry for engineering students by B. S. Jai Prakash, R. Venugopal, Shiva Kumaraih, Puspha Jyrngar.
3. Applied thermodynamics by R. K. Hegde, Niranjana Murthy.
4. Engineering chemistry second edition by R. V. Gadag, A. Nityananda Shetty I. K. International publishing House Pvt.Ltd.

GENERAL CHEMISTRY-I

Subject Code	CH-SCT 1.6.3	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I:

Atmosphere:

13Hrs

Composition of the atmosphere, atmosphere structure, evolution of the atmosphere, earth's radiation balance, particles, ions & radicals in the atmosphere, chemical & photochemical reactions in the atmosphere (oxygen & ozone chemistry, sulphur dioxide, nitrogen oxides & organic compounds), greenhouse effect, ozone hole, human activities & meteorology, the earth's mechanism & global climate, El Niño phenomenon, Asian brown cloud

UNIT-II:

13Hrs

- i) **Lithosphere**-Composition of lithosphere/soil, water & air in soil, inorganic & organic components in soil, acid base and ion exchange reactions in soil, micro & macro nutrients, nitrogen pathways & NPK in soil, water and pollutants in soil.
- ii) **Hydrosphere**-Water resources (hydrologic cycle), physical chemistry of sea water decomposition, complexation on natural water and waste water, sea water equilibrium, pH, PE, sea water model, micro organisms.

UNIT-III:

Metals and metallurgical methods:

13Hrs

Occurrence of elements, minerals & ores, refractory materials, minerals wealth of India, rare minerals, oil, different metals ores, metallurgical principles. For different ores (for sulphide ores, halide ores, oxides ores), processes involved in metallurgy (crushing & pulverization, ore dressing or concentration, gravity separation, hydraulic classifier, froth flotation, calcinations & roasting reaction of free metals, reduction to metallic state, smelting), flux, types of fluxes, amalgamation.

UNIT-IV:

Fuels and Furnaces:

13Hrs

Modern definition, requirements of a fuel, no by products, calorific value, fuel cost, supply position, moderate velocity of composition, highest pyrometric effect, proper ignition point, types of fuels, uses of water gas ($\text{CO} + \text{H}_2$), water gas generator, superheater, purifier, composition & uses, producer gas (properties), solid fuels, coal, types of coal, types of furnaces (kilns, blast furnace, reverberatory furnace, muffle furnace, electric furnace, open hearth furnace), solvent extraction, choice of solvent, ionexchange method.

BOOKS RECOMMENDED:

1. Environmental chemistry -By A.K.De 5th edition
2. Industrial chemistry-By Ayodhya Singh

SECOND SEMESTER

ORGANIC CHEMISTRY-II

Subject Code	CH-HCT 2.1	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I: Heterocyclic Compound

13Hrs

Nomenclature, structure, reactivity, synthesis and chemical reactions of indole, quinoline, sesquinolines, pyrazole, imidazole, benzimidazole, α -pyrone, γ -pyrone, coumarins.

UNIT-II: Synthetic Polymers

13Hrs

Classification of Polymers, Addition or chain growth polymerization, Some important Vinyl polymers (Polyethene, Polypropylene, polyvinylchloride, polyesterene, polyvinyl acetate, Acrylonitrile, tetrafluoroethylene), Condensation or step growth polymerization (polyesters, polyamides, phenol, Urea, melamine, silicon resins, polyurathanes), Natural and Synthetic Rubber; Structure and isolation of rubber, Vulcanization, Non-Sulphur Vulcanization, polyisoprene, polyisobutylene, polybutadiene, polychloroprene, SBS, Buna-N.

UNIT-III:

13Hrs

i) Aliphatic Nucleophilic substitution

SN1 mechanism, SN2 mechanism, SNi mechanism, mixed SN1 & SN2 mechanism, the SET mechanism, esterification & ester hydrolysis.

ii) Aliphatic Electrophilic Substitution

Unimolecular mechanism (SE1), Bimolecular mechanism (SE2 & SEi), aliphatic diazonium coupling, diazo transfer reaction.

UNITIV:

13Hrs

Oxidations, Reductions and reagents:

Oxidations: Oxidations of organic compounds using, OsO₄, SeO₂, and Oppenauer oxidation.

Reductions: Reductions of organic compounds using the following reagents: LiAlH₄, NaBH₄, Birch reduction and Wolff-Kishner reduction.

Reagents: Methods of preparation, mechanism of reaction and applications of the following reagents in organic synthesis DCC, 1,3-Dithiane, LDA, DDQ, Wilkinson catalyst, Crown ether.

BOOK RECOMMENDED:

1. Advanced organic chemistry by Dr. Jagdamba Singh, Dr. LDS Yadav A Pragati edition
2. Text book of Organic Chemistry-Vol III - By: V. K. Ahluwalia.
 1. Organic chemistry Vol-II, III-S.M.Mudherji, S.P.singh and R.P.Kapoor, new age international, Ltd new Delhi
 2. Organic chemistry Vol-I,II-I.L.finar, 6th edition ELBS London
 3. Heterocyclic chemistry – T.L.Gilchrist, 3rd edition Pearson education delhi
 4. Heterocyclic chemistry – J.A.Joule and G.F.smith, 2nd edition, van nostrand London
 5. Heterocyclic chemistry R.K.Bansal, 3rd edition, new-age international, new delhi,
 6. Stereochemistry of organic compounds, E. L. Eliel et. Al John Wiley and sons inc.

PHYSICAL CHEMISTRY-II

Subject Code	CH-HCT 2.2	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I: Elementary Quantum Mechanics: 13Hrs

Black body radiation, Quantum mechanics(Wien's displacement law, Boltzmann's law), Plank's radiation law, Photoelectric effect, Bohr's model of Hydrogen atom, Compton effect, Heisenberg Uncertainty principle, Sinusoidal wave equation, Hamiltonian Operator, Schrödinger wave equation, Postulates of wave mechanics, Schrödinger wave equation for H-atom, Molecular Orbital theory, Constructions of MOs by LCAO, Physical picture of bonding and antibonding.

UNIT-II:Photochemistry 13Hrs

Interaction of radiation with matter, differences between thermal and photochemical processes, Laws of photochemistry, Quantum Yield, The Jablonski Diagram(Singlet and triplet excited state), Non-Radiative process, Fluorescence, Phosphorescence, Photosensitization reaction, Laser, Resonance energy transfer, New form of energy transfer process.

UNIT-III: ELECTROCHEMISTRY 13Hrs

Activity and Activity coefficients: forms of activity coefficients and their interrelationship, Types of electrodes, Determination of activity coefficients of an electrolyte using concentration cells, instability constant of silver ammonia complex. Acid and alkaline storage batteries, Abnormal ionic conductance of hydroxyl and hydrogen ions. Electrokinetic phenomena: Electrical double layer, theories of double layer-Helmholtz-Perrin theory, Gouy and Chapman theory, Stern theory. electro-capillary phenomena, electro-capillary curve. Electro-osmosis, electrophoresis. Streaming and Sedimentation potentials. Zeta potentials and its determination by electrophoresis, influence of ions on Zeta potential.

UNIT-IV: Atomic spectra and atomic structure: 13Hrs

Review of hydrogen spectrum hydrogen like spectra. Atomic spectra of alkali and alkali like elements. Atomic spectra of helium atomic spectra, Mosely lines multiple structures, simple and compound doublets and triplets. Stern – Gerlach experiment, Normal Zeeman effect, Anomalous Zeeman effect, Paschen Back effect, stark effect. Comparison between stark and Zeeman Effect.

BOOKS RECOMMENDED:

1. A text book of Physical chemistry- Vol -3 -By: N. K. Vishnoi, R. J. Shukla, Ane's student edition.
2. Quantum mechanics : Fundamentals second edition by Kurt Tung-Mow Yan Springer publication.
3. Atomic structure and Atomic spectra by G.Herzberg
4. Introduction to atomic spectra by white.
5. Elements of Spectroscopy-By:

INORGANIC CHEMISTRY-II

Subject Code	CH-HCT 2.3	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I:

Theories of coordination compounds:

13Hrs

Early structural theories (Blomstrand Jorgenses's chain theory, warner's coordination theory, sidgwick's electronic concept of coordination, later structural theories (The valence Bond Theory), crystal field theory, measurements of Δ_o , determination of crystal field stabilization energy, factors affecting the magnitude of Δ_o values, consequences of crystal field splitting, merits & limitations of crystal field theory.

UNIT-II:

Spectral & Magnetic characteristics of Metal complexes:

13Hrs

Types of absorption spectra, spectral terms Russell-Saunders states, selection rules of electronic transitions in complexes, width of absorption spectra, terms generated in ligand fields, correlation diagrams (Orgel diagrams, High Spin d ion, High Spin OH ions), Tanabe Sugano Diagrams for d3 complex $[\text{Cr}(\text{NH}_3)_6]^{3+}$, electronic spectra of d^2 $\{\text{V}(\text{H}_2\text{O})_6\}^{3+}$, d^3 ions $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$, d^4 ion $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$, d^5 ion $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$, d^6 ion $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$, d^7 ion $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$.

UNIT-III:

13Hrs

i). Metal π -Complexes: Introduction and classification, general methods of preparation, general properties, structure of metal complexes, vibrational spectra of metal carbonyls for bonding and structural Elucidation, metal carbonyl halides, Nitrosyls; structures, Dinitrogen complexes, Dioxygen complexes.

ii) Metal Clusters: Introduction, carbonyl clusters, electron counting scheme for HNCCs (Wade's rule), Halide type clusters, Boron hydrides, structure of diborane, types of bonds found in higher boranes, carboranes, metalloboranes, metallo carboranes.

UNIT-IV:

Organometallic chemistry:

13Hrs

18 electron and 16 electron rules: reactions of metal alkyls, aryls and olefin complexes. Reactions of organometallic complexes-substitution reactions.

Catalysis by organometallic complexes: Alkene hydrogenation hydroformylation; water – Gas shift reaction monosanto acetic process; the wicker process synthetic gasoline and Ziegler Natta catalysis.

BOOK RECOMMENDED:

1. Consise coordination chemistry by R. Gopalan, V. Ramalingam
2. Advanced inorganic chemistry by S. K. Agarwal & Keemtilal, A Pragati edition

PRACTICAL-I (Based on Inorganic and organic Theory)

Subject Code	CH-HCP 2.4	IA Marks	30
No. of Lecture Hrs./Week	08	Exam Hours	03
		Exam Marks	70

PART A:

Separation & Estimation of two metal ions

- a. copper-Nickel
- b. Barium-copper
- c. copper-zinc
- d. silver-zinc
- e. calcium-magnesium
- f. iron nickel

PART B:

Separation of Binary mixture and identification of compounds donating two functional groups.

BOOKS RECOMMENDED:

1. Advanced practical chemistry by Jagdamba Singh, R.K.P. Singh, Jaya Singh, LDS Yadav,
2. R. Siddigni, Jaya Shrivastava. A pragati edition.
3. Vogel's text book of practical Organic chemistry revised- By: B. S. Furnis, A. J. Hannaford, W. G. Smith, A. R. Tatchell, 5th edition
4. Practical chemistry – By: Dr. O. P. Panday, D. N. Bajpai, Dr. S. Giri, S.Chand publication.

PRACTICAL-II (Based on Physical and Analytical Theory)

Subject Code	CH-HCP 2.5	IA Marks	30
No. of Lecture Hrs./Week	08	Exam Hours	03
		Exam Marks	70

PART A:

1. Conductometric determination of the kinetic order of saponification of ethyl acetate by NaOH.
2. Determine the composition of a mixture of acetic acid and HCl by conductometric titration.
3. Determination of the partition coefficient of Iodine between water & carbon tetrachloride & determination of equilibrium constant for tri-iodide formation
4. Determine the equilibrium constant for the reaction $K_1 + I_2 = KI_3$ by distribution method.
5. Determination of optical rotation and rate constant by polarimeter

PART B:

1. Determination of molybdenum by solvent extraction using KSCN as reagent.
2. Determination of Iron by solvent extraction using 8 hydroxyquinoline as reagent.
3. Analysis of copper nickel alloy.
4. Analysis of hematite.
5. Determination of pH of soil.
6. Determination of total dissolved salts and conductivity of water.

BOOKS RECOMMENDED:

1. Fundamentals of analytical chemistry by D. A. Skoog, D.M. West, Holler and Crouch 8th edition 2005 Saunders College Publishing New York.
2. Standard method of chemical analysis J. Welcher Robert E. K. Krieger publisher CO USA
3. Advanced practical chemistry by Jagdamba Singh, R.K.P Singh, Jaya Singh, LDS Yadav, I. R. Siddiqui, Jaya Shrivastava A Pragati edition.
4. Advanced practical chemistry by Jagdamba Singh, R.K.P. Singh, Jaya Singh, LDS Yadav, I.R. Siddigni, Jaya Shrivastava A pragati edition.

ANALYTICAL CHEMISTRY-II

Subject Code	CH-SCT 2.6.1	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I:

Solvent Extraction-II:

13Hrs

Principles of solvent extraction, classification of extractions, mechanism of extraction, extraction by chelation, extraction of solvating, extraction equilibria for solvation, techniques of extraction, extraction by ion pair formation, solid phase extraction.

UNIT-II:

Supramolecules in solvent extraction:

13Hrs

Origin of macro cyclic & supramolecular compounds, nomenclature, classification, synthesis of crown ethers, Cryptands and calixarenes, solvent extraction with crown ethers & cryptands, rotaxanes, synthesis of rotaxanes, metal complexes with rotaxanes, analytical application.

UNIT-III:

Electrophoresis:

13Hrs

Principles of electrophoresis, properties of charged molecules, theory of electric double layer, zone electrophoresis, isotachopheresis, isoelectric focusing, immunoelectrophoresis, techniques of electrophoresis, continuous electrophoresis, instrumentation, preparative electrophoresis, theory of capillary electrophoresis, instrumentation, sample separation, sample detections, application of capillary electrophoresis, capillary electrochromatography, miscellar electrokinetic capillary chromatography.

UNIT-IV:

Inductively coupled plasma-atomic emission spectroscopy:

13Hrs

Principles of plasma spectroscopy process of atomisation and excitation plasma as an excitation source, inductively coupled plasma source ICP-AES instrumentation application of plasma spectroscopy, comparison of ICP-AES with AES, comparison of AFS, AAS and ICP – AES.

BOOK RECOMMENDED:

1. Basic concepts of analytical chemistry by S. M. Khopkar New Age International.
2. Principles of instrumental analysis D.S.Kooj.
3. Fundamentals of analytical chemistry-skoog & west holler 7th edition Harcourt agra publication harcourt publishers.

NANO SCIENCE AND ENGINEERING CHEMISTRY-II

Subject Code	CH-SCT 2.6.2	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I:

Unique properties of Nanomaterials:

13Hrs

Microstructure and Defects in Nanocrystalline materials, effects of Nano-dimensions on material behavior.

Synthesis Routes:

Bottom-Up approach, Top-Down approach, Consolidation of Nanopowders.

UNIT-II:

Applications of Nanomaterials:

13Hrs

Applications to Cosmetics and consumer Goods, Structure and Engineering, Automotive Industry, Water treatment and the environment, Nano-medical applications, Textiles, paints, energy, Defence and space applications, Structural applications.

UNIT-III:

Electrochemical cells:

13Hrs

Introduction, electro chemical cells, galvanic cell, electromotive force of the cell, single electrode potential, Nernst equation, electrochemical conventions, electrochemical series, types of electrodes, reference electrodes, ion selective electrodes, concentration cells.

UNIT-IV:

Metal Finishing:

13Hrs

Introduction, technological importance of metal finishing, electroplating, polarization, decomposition potential & overvoltage, theory electroplating, electroplating process, characteristics of a good deposit, methods of cleaning the metal surface to be coated, factors influencing the nature of deposit, requirements of an electrolyte solution for electroplating, applications of electroplating, electroplating of gold, Nickel, Copper.

BOOKS RECOMMENDED:

1. Text book of Nanoscience and technology by B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday Universe press.
2. Chemistry for engineering students by B. S. Jai Prakash, R. Venugopal, Shiva Kumaraih, Puspha Jyngar.
3. Applied thermodynamics by R. K. Hegde, Niranjan Murthy.
4. Engineering chemistry second edition by R. V. Gadag, A. Nityananda Shetty I. K. International publishing House Pvt.Ltd.

GENERAL CHEMISTRY-II

Subject Code	CH-SCT 2.6.2	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNI-I:

Chemical Toxicology:

13Hrs

Toxic chemicals in the environment, impact of toxic chemicals on enzymes, biochemical effects of Arsenic, cadmium, lead, mercury, carbon monoxide, nitrogen oxides, sulphur dioxide, ozone and PAN, cyanide, pesticides, carcinogens, bio warfare agents, environment and public health, pollution and public health issues

UNIT-II:

Air Pollution:

13Hrs

Air pollutants (carbon monoxide, nitrogen oxides, hydrocarbons, sulphur dioxide, acid rain, particulates, and radioactivity), effects of atmospheric pollution, some air pollutant accidents, air quality standards, sampling, monitoring, instrumental techniques for air pollution.

UNIT-III:

Water Pollution:

13Hrs

Aquatic environment, water pollutants (organic pollutants, Pesticides, organochlorine insecticides, detergents, marine pollution, oil pollution), path ways of oil spill on marine environmental and Impact on the environment, Toxic organic chemicals, Inorganic pollutants, sediments, Radioactive materials, Thermal pollution, Coral-reef crisis, waste water treatment, Trace element in water, The River systems and Riverine environment, Arsenic contamination in ground water, water quality parameters.

UNIT-IV:

Natural Resources, Energy and Environment:

13Hrs

Mineral Resource: Metals & Non-metals, Wood-a major renewable resources, Fuel & energy resources (Coal, Petroleum, Natural gas, Nuclear fission, Nuclear fusion, Solar energy, Hydrogen, Gasohol) World energy resources-Consumption and conservation, Environmental management

BOOKS RECOMMENDED:

1. Environmental Chemistry by A .K. De, S5th Edition, New age International.

THIRD SEMESTER
ORGANIC CHEMISTRY-III

Subject Code	CH HCT 3.1	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I:

Electronic, Chiroptical and Vibration Spectroscopy: 13Hrs

Introduction energy considerations, experimental methods, Beer-Lambert's law. Theory and classification of electronic transitions. Woodward-Fieser rules and their application in structural elucidation of organic compounds. UV spectral study of alkenes, dienes, polyenes. Carbonyl and aromatic compounds. Steric effects, model compounds and charge transfer bands.

UNIT-II:

Vibration spectroscopy: 13Hrs

Introduction and experimental methods. Units notation and regions. Dispersive and FT-IR sampling techniques. Fundamental vibrations, overtones, Inductive resonance static effects. Mechanical coupling Fermi resonance. Applications of IR in the study of H-bonding stereoisomerism, tautomerism. Identification of the following organic compounds by IR; alkenes, alkynes aromatic compounds aldehydes, ketones alcohols, thiols, acids acid chlorides, amides, amines esters halides and nitro compounds.

UNIT-III:

Proton Magnetic Resonance spectroscopy: 13Hrs

Introduction magnetic properties of nucleus, resonance condition field frequency Diagram, Precession of nuclei, relaxation-CW and PFT methods. Instruction and sample handling, chemical shift- mechanism of shielding and deshielding in alkanes. Alkenes, alkyl halides, aromatic compounds, carbonyl compounds and annulenes. Chemical shifts of different types of organic compounds empirical rules. Spin-spin coupling geminal and vicinal coupling.

UNIT-IV:

Multi-Nuclear NMR and correlation spectroscopy: 13Hrs

¹³C-NMR broad band and off resonance decoupling methods of detection. ¹³C chemical shifts of different classes of organic compounds – alkenes, alkyl halides, alkenes, alcohols, ethers, carbonyl compounds and aromatic compounds. ¹³C-H coupling DEPT. Introductory aspects of ¹⁵N ¹⁹F ³¹P –NMR. FT methods ¹H-¹H(Cosy) and ¹³C-H(Heterotopy) methods.

BOOK RECOMMENDED:

1. Introduction to spectroscopy by D. L. Paxia, G. M. Lamman and G. S. Kriz
2. Spectroscopy of organic compounds by P. S. Kalsi
3. Organic spectroscopy by William demp 3rd edn. Palgrave publishers
4. Organic structural spectroscopy by-J.B.Lambert, H.F.Shurvell, D.A.Lightner and R.G.Cooks .Hall publishers, jersey
5. Organic spectroscopy-by D.W.Brown,A.J.floyd and M.Sainsbury,John wiley and sons.
6. Applications of absorption spectroscopy of organic compounds by- J.R.Dyer,Prentice Hall publishers, New Delhi

PHYSICAL CHEMISTRY-III

Subject Code	CH-HCT 3.2	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I:

Statistical Thermodynamics and quantum Statistics:

13Hrs

Microstates and Macrostates, phase space, and ensembles.

Classical statistics: Maxwell – Boltzmann distribution law for ideal gases Maxwell-boltzmann distribution of energies.

Quantum Statistics: Relationship between probabilities and entropy, Sterling approximation. Bose – Einstein, Fermi-dirac and Maxwell – Boltzmann statistics and their applications.

Partition Function: Definition, Translational, Vibration, Rotational and electronic partition functions for monatomic, diatomic. Sackur – Tetrode equation. Calculation of thermodynamic quantities in terms of partition functions and residual entropy.

UNIT-II:

Thermodynamics, Non –equilibrium Thermodynamics:

13Hrs

Introduction Gibbs function of mixing and other thermodynamic mixing functions, chemical potential of liquids and liquid mixtures excess function for non-ideal solutions.

Non–equilibrium thermodynamics: Microscopic reversibility entropy production in irreversible process. Stationary states phenomenological equations. Onsager's reciprocity.

UNIT-III:

Surface collides:

13Hrs

Introduction, Classification, properties, preparation and purification of colloids, stability and degree of solvation, protective colloids and gold number. Electro kinetic phenomena of colloids, classification of surface active agent's, Micelle formation, Shape and structure of micelle, critical micelle concentration, factors effecting CMC, thermodynamics of micellization.

UNIT-IV:

Quantum Chemistry:

13Hrs

General principle of Quantum Mechanics: The state of a system, quantum mechanical operators, the time dependence of wave functions, quantum mechanical operators must be Hermitian operators.

The Harmonic Oscillator: A harmonic oscillator obeys Hooke's law, the energy of a Harmonic oscillator is conserved, the equation for a Harmonic oscillator model of a diatomic molecule, the harmonic oscillator accounts for the IR spectrum of a diatomic molecule, Hermite polynomials, The asymptotic solution of the harmonic oscillator, Schrodinger equation, Hermite's differential equation.

BOOKS RECOMMENDED:

1. Text book of Physical chemistry – By: N.K.Vishnoi, R.T.Shukla, Ane's Book Pvt Ltd Vol I
2. Elements of Statistical thermodynamics –E.K.Nash
3. Principles of Physical Chemistry- By: Puri, Sharma and Pathiana, VPC (Vishal Publishing Co.)
4. Molecular quantum chemistry by A.J.Atkins.

INORGANIC CHEMISTRY

Subject Code	CH-HCT 3.3	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I:

Photo Inorganic chemistry:

13Hrs

Laws of Photochemistry, Thermal emission and Photoluminescence, The Rules Governing the transition between two energy states, Life times of excited electronic states of atoms and molecules, Two-Photon Adsorption spectroscopy, electronic, Vibrational & Rotational energies, Frank-Condon principle, Emission spectra, Wigner's spin conversion Rule, Types of photochemical pathways, Radiation less transitions, state diagrams, Delayed fluorescence.

UNIT-II:

Organometallic Chemistry:

13Hrs

Definitions, Classification, Nomenclature, Characteristics, Stability of organometallic compounds, Pre-palatine Routes for metals-carbon bond formation, Group trends, Multiple bonded silicon and Arsenic organometallics, Cyclopentadienyl complexes of main group elements, δ & π -bonded organometallics, organometallic compounds of Lanthanides and Actinides, Transition metal organometallics as catalytic & Synthetic reagents.

UNIT-III:

Nuclear and Radio chemistry:

13Hrs

Fundamentals units of radioactivity, interaction of α , β and γ radiation with matter; determination of half life period, radioactive decay, kinetics, parent daughter decay-growth relationships; detection and measurement of radioactivity, construction and operation of ionization chambers, G.M.counters and scintillators, Induced radioactivity nuclear fission and nuclear fusion.

UNIT-IV:

Industrial chemistry:

13Hrs

Introduction physical and chemical properties raw materials, methods, manufacturing, types and uses with respect to glass, iron, steel and alloys.

Industrial Pollution: Industrial Pollution with respect to cement, thermal power plants and metallurgy disposal of waste and its management, nuclear waste management including waste storage and disposal procedures.

BOOKS RECOMMENDED:

1. Advanced Inorganic chemistry-By- S. K. Agarwal, Keentilal-A Pragati edition.
2. Fundamentals of Photochemistry by K. K. Rohatgi- Mukherjee
3. Organometallic chemistry by R. C. Mehrotra, A. Singh- New Age International 2nd addition.
4. Industrial chemistry – Rogers
5. Environmental chemistry – 4th edition A.K.Dey
6. Test book of environmental chemistry –O.D.Tyagi and M.Mehra
7. Environmental pollution analysis – S.M.Khopakar

PRACTICAL-I (Based on Organic and Physical theory)

Subject Code	CH-HCP 3.4	IA Marks	30
No. of Lecture Hrs./Week	08	Exam Hours	03
		Exam Marks	70

PART-A:

i) Preparations

(One stage preparations involving various types of reactions and confirmation of product by TLC)

1. Coumarin Synthesis- 7-OH-4-methyl coumarine from Resorcinol and EAA.
2. Knoevenagel condensation reaction-Reaction of aldehyde and malononitrile.
3. Synthesis of triazoles- Reaction of aldehyde and thiosemicarbazide.
4. Preparation of Orange II
5. Fischer Indole Synthesis-Reaction of phenyl hydrazine and cyclohexanone.

(Any suitable Expt. may be added)

ii) Estimations:

1. Estimation of Unsaturation.
2. Estimation of formalin.
3. Colorimetric Estimation of Dyes.
4. Estimation of Amino acids.
5. Estimation of Glycine.

(Any suitable Expt. may be added.)

PART-B:

I) Solutions:

1. Determination of the molecular weight of nonvolatile substance cryoscopically using water as the solvent.
2. Determination of the solubility product of a sparingly soluble electrolyte and to investigate the effect of common ion on its solubility.

II) Electrochemistry

1. Determine the equivalent conductance of a strong electrolyte at several concentrations and hence verify the Onsagars equation.
2. Determine the equivalent conductance of weak electrolyte at infinite dilution following the Kohlrausch law.
3. Determine the activity coefficient of zinc ions in the solution of 0.002M zinc sulphate using Debye Hückel's limiting law Z.
4. Determine the equivalent conductance of a weak electrolyte at different concentrations and hence the validity of ostwald's dilute law also determine the dissociation constant of the weak electrolyte.

BOOKS RECOMMENDED:

1. Advanced practical chemistry by Jagadamba Singh, R. K. P. Singh, LDS Yadav, I. R. Siddiqui, Jaya Shrivastava
2. A text book of practical organic chemistry- A. I. Vogel.
3. Practical organic chemistry- Mann and Saunders.
4. A handbook of quantitative and qualitative analysis- H. T. Clarke.
5. Organic Synthesis Collective Volumes by Blat.
6. Practical Med. Chem.- Dr. K. N. Jayveera, Dr. S. Subramanyam, Dr. K. Yogananda Reddy.

ANALYTICAL CHEMISTRY-III

Subject Code	CH-SCT 3.5.1	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I: Basic concepts of chromatography:

General description, definition, terms and parameters used in chromatography. Classification of chromatographic methods. Criteria for selection of a stationary and mobile phase, nature of adsorbents, factors influencing the adsorbents, nature and types of mobile phases.

Elution chromatography: theories: rate theory, band broadening, eddy diffusion, longitudinal diffusion and resistance to mass transfer. Column efficiency: plate theory and rate theory approach. Vandimeter's equation and its modern version. Inter relationship capacity factor, selectivity factor and column resolution.

UNIT-II:

13 Hrs

i) Thin layer chromatography: principle, methodology, determination of R_f value and its significance, variables that affect R_f value and applications.

ii) Gas Chromatography: Performing GC separations, GC Columns, GC Detectors, Temperature selections, quantitative measurements, Head space analysis, Thermal desorption, Purging and trapping, Small and fast GC-Mass spectroscopy.

iii) Liquid Chromatography: High Performance Liquid Chromatography (HPLC), Size exclusion Chromatography, Ion exchange Chromatography, ion Chromatography.

UNIT-III:

13 Hrs

i) Partition chromatography: Principles of Liquid-liquid partition chromatography, reversed phase partition chromatography, applications of extraction chromatography paper chromatography, techniques in paper chromatography, Ion-pair chromatography.

ii) Supercritical Fluid chromatography and Extraction: Characteristics of supercritical fluid, mechanism of working of SFC, comparison with other chromatographic techniques, selection of super critical fluid for SFC, application of super critical fluid chromatography, super critical fluid extraction (SFE), selection of supercritical fluid for extraction, applications of super critical fluid extraction.

UNIT-IV:

13 Hrs

iii) Exclusion chromatography: Gel permeation chromatography, applications of gel permeation chromatography, ion exclusion, mechanism of the ion exclusion process, merits and demerits of the ion exclusion techniques, applications of ion exclusion techniques, ion retardation inorganic molecular sieves.

iv) Electro chromatography: Principles of electro chromatography, instrumentation, certain electro chromatography, applications of electro chromatography, reverse osmosis, electro dialysis.

BOOKS RECOMMENDED:

1. Analytical chemistry by G. D. Christian.
2. Basic concepts of Analytical Chemistry by S. M. Khopkar.
3. Fundamentals of analytical chemistry D.A.Skoog, D.M.west , holler and crouch 8th edition 2005 saunders college publishing new York.

NANO SCIENCE AND ENGINEERING CHEMISTRY-III

Subject Code	CH SCT 3.5.2	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I:

Characterization of Nanomaterials:

13Hrs

By X-ray diffraction(XRD), Small angle X-ray scattering (SAXS), Scanning Electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy(AFM), Scanning Tunnelling microscope(STM), Nanoindentation.

UNIT-II:

Nanostructured Materials With High Application Potentials:

13Hrs

Quantum Dots, Carbon Nanotubes, GaN Nano Wires, Nanocrystalline ZnO, Nanocrystalline Titanium Oxide, Multilayered Films.

UNIT-III:

Refrigeration and Psychometrics:

13Hrs

Coefficient of performance, units of refrigeration, properties of a good refrigerant, important refrigerants, air-refrigeration, vapour compression cycle, vapour absorption cycle, steam jet refrigeration, definitions and brief explanation of superheated vapour, saturated vapours, dew point temperature,(DBT,WBT), Dalton's law of partial pressure, relative humidity degree of saturation, enthalpy of moist air, psychrometric charts, psychrometric processes, comfort air conditioning, summer air conditioning systems, winter air conditioning systems.

UNIT-IV:

Water Technology:

13Hrs

Introduction, impurities in natural water, chemical analysis of water, determination of hardness of water including alkalinity, chloride, nitrates, sulphates using gravimetric method, determination of dissolved oxygen (DO) by iodometric method, pot able water, electro dialysis, water pollution (sources, sewage), BOD(Biological Oxygen Demand), COD (Chemical Oxygen Demand),treatment of domestic sewage, Hazardous chemicals with its effects.

BOOKS RECOMMENDED:

1. Text book of Nanoscience and technology by B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday Universe press.
2. Chemistry for engineering students by B. S. Jai Prakash, R. Venugopal, Shiva Kumaraih, Puspha Jyrngar.
3. Applied thermodynamics by R. K. Hegde, Niranjan Murthy.
4. Engineering chemistry second edition by R. V. Gadag, A. Nityananda Shetty I. K. International publishing House Pvt.Ltd.

GENERAL CHEMISTRY-III

Subject Code	CH-SCT 3.5.3	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I: 13Hrs

Body fluids: Composition and detection of abnormal level of certain constituents leading to diagnosis, sample collection and preservation of physiological fluids,

Blood: Estimation of glucose, cholesterol, urea, hemoglobin and bilirubin.

Enzymes: Biological significance, analysis and assay of enzymes (pepsin, tyrosinase), vitamins (thiamine, ascorbic acid, vitamin A) and hormones (progesterone, oxytocin, insulin), chemical, instrumental and biological assay to be discussed wherever necessary.

UNIT-II: 13Hrs

Automated systems: An over view, definition, distinction between automatic and automated systems, advantages disadvantages by automation, types automated techniques. Non-discrete techniques. Segmented flow methods and basic equipment, special techniques and devices, theoretical considerations and problems, applications. Single channel and multi channel auto analyser, BUN analysers, automatic glucose analysers and ammonia in water analyser, COD analyser, CFA in industry.

UNIT-III: 13Hrs

Food Analysis: Historical perspectives, objectives of food analysis. Sampling procedures. General methods for the determination of moisture, crude fibre and ash contents of foods. Analysis of foods for minerals-phosphorus, sodium, potassium and calcium. Food additives. Chemical preservatives-inorganic preservatives-sulphur dioxide and sulphites, their detection and determination. Organic preservatives- benzoic acid and benzoates, their detection and determination. Pesticide residues in foods.

UNIT-IV: 13Hrs

Radioanalytical methods:

Radioactive tracers, principles and applications, Isotopic dilution analysis-direct and inverse; special analytical applications and radiometric titrations. Neutron activation analysis: Principle, instrumentation, application and limitations.

Thermal methods:

Thermogravimetry- instrumentation, factors affecting thermogram, applications. Differential thermal analysis (DTA)-theories, Apparatus and applications. Differential scanning calorimeter (DSC)- introduction, instrumentation and applications.

BOOKS RECOMMENDED:

- 1) Pharmaceutical analysis. T. Higuchi and E.B.Hanssen., John-wiley and sons.
- 2) Quantitative analysis of drugs. P.D.Sethi, 3rd edition. CBS publishers delhi.
- 3) Practical clinical biochemistry methods and interpretations. R. Chatwal, J.P. Brothers medical publishers.
- 4) Laboratory manual in biochemistry. J. Jayaraman, New Age international
- 5) Pharmaceutical analysis. Modern methods- Part-A and B, edited by James W Munson
- 6) Hawks Physiological chemistry. Edited by B.L.Oser. 14th edition Tata-McGraw Hill.

CH OET-3.6 – BIO-CHEMISTRY

Subject Code	CH-OET 3.6	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I:

Chemical Constituents of Life: 13Hrs

Introduction, structure, classification, Functions, and Nomenclature of Biomolecules, Carbohydrates, Lipids, Proteins and Amino acids, Nucleic acids and nucleotides, Enzymes, Vitamins,

UNIT-II:

Clinical Biochemistry and Nutrition: 13Hrs

Hormones: Classification, mechanism of hormones action, Growth hormones, Biochemical functions, Thyroid hormones.

Organ Function Test: Liver function test, Kidney function test, Gastric function test, pancreatic function test. Water, Electrolytes and Acid-Base balance.

UNIT-III:

Basics to learn Biochemistry: 13Hrs

Introduction to Bioorganic chemistry: Introduction, Isomerism, Asymmetric Carbon, Optical activity, Configuration of chiral molecules.

Overview of Biophysical chemistry: Introduction, Structure of Water, Acids and Bases, Buffers, Solutions, Colloidal state, Diffusion, Osmosis, Viscosity, Surface Tension, Adsorption and isotopes.

UNIT-IV:

Tools of Biochemistry: 13Hrs

Introduction, Chromatography: Principle and classification, Electrophoresis: Types, Photometry-Colorimeter and Spectrophotometer.

Immunology:

Immune System, Complement system, Immune response, Cytokines, immunity in health and diseases.

Genetics:

Brief history and development of Genetics, Inheritance, Genetic Diseases in Humans.

BOOKS RECOMMENDED:

1. Biochemistry, By- U.Satyanarayana and U.Chakrapani, 3rd Edition, Books and Allied (P) Ltd.
2. Text book of Biochemistry, By-DM Vasudevan, Sreekumari S, Jaypee Brothers, Medical Publishers (P) LTD.

FOURTH SEMETER

ORGANIC CHEMISTRY-IV

Subject Code	CH-HCT 4.1	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I: Mass spectroscopy: 13Hrs

I) Ionization & mass analysis: Instrumentation, methods of ionization EI, CI, DI, SI-methods.

II) Fragmentation Principle, odd and even electron ions, molecular ion and base peak, nitrogen rule, meta stable ions, isotopic effect in chloro and bromo compounds,

III) Fragmentation of Normal & branched alkanes, alkenes, benzene & its derivatives, alcohols, aldehydes, ketones, acids, esters, ethers, amines, nitro compounds, halo compounds, calculation of molecular formula, composite problems.

UNIT-II: Pericyclic reactions: 13Hrs

Introduction, symmetry in linear conjugated pi-systems symmetry in allyl and 2,4-pentadienyl systems, types of pericyclic reactions, electrocyclic reactions: FMO method, cyclisation of $(4n+2)\pi$ system, Hückel-Mobius $(4n)$ method, cycloaddition reactions, FMO method : $(2+2)$ & $(4+2)$ cycloaddition reactions, Hückel –Mobius method, 1,3-dipolar cycloadditions, chelotropic reactions, sigmatropic rearrangement, analysis of sigmatropic rearrangement by FMO method, Claisen rearrangement, Hückel-mobius method in sigma tropic rearrangements, group transfer reactions : Ene reactions.

UNIT-III: Molecular Rearrangement: 13Hrs

Classification and general mechanistic pattern for electrophilic, free radical and nucleophilic rearrangements.

Mechanism of the following rearrangement reactions:

Claisen rearrangements, Favorski rearrangements, Sommelet-Hauser rearrangements, Anderson, Schmidt, Smiles, Shapiro, Hofmann rearrangements, Curtius rearrangements, Lossen rearrangements, Beckmann rearrangements, Baeyer-villiger rearrangements: Baker-Venkataraman, Fries rearrangements and Wittig rearrangements.

UNIT-IV: i) Study of Organometallic compounds: 13Hrs

Organo-lithium, Use of lithium dialkyl cuprate, their addition to carbonyl and unsaturated carbonyl compounds. Study of coupling reactions *viz* Heck, Suzuki, Stille, Nigeshi and Sonogashira coupling.

ii) Methodologies in organic synthesis

Ideas of syntheses and retrones, Functional group transformations.

BOOKS RECOMMENDED:

1. Advanced organic chemistry by Dr.Jagadamba Singh, Dr.L.D.S. Yadav 4th edition a pragati edition.
1. Advanced organic chemistry part A and B-F.A. Carey and R.J.sundberg, 4th edition plenum publishers
2. Advanced organic chemistry, reactions, mechanism and structure- J. March, third edition, wiley – eastern Ltd.,
3. Organic chemistry Vol-I,II-I .L. finar, 6th edition ELBS London
4. Homogeneous Hydrogenation-(J. K.) B. R. James.
5. Comprehensive Organic Chemistry- (Pargamon) Barton and Ollis.
6. Organic reactions- various volumes- R. Adams.
7. Some modern methods of Organic synthesis-(Cambridge) W. Carruthares.
8. Organic chemistry- Jonathan clayden.

PRACTICAL (Based on Inorganic, Organic and physical theory)

Subject Code	CH-HCP 4.2	IA Marks	30
No. of Lecture Hrs./Week	08	Exam Hours	03
		Exam Marks	70

PART-A:

I) Gravimetric Determinations

1. Determinations of Ni as Ni(Dmg)₂
2. Determinations of Al as Oxinate

II) Masking experiments

1. Determination of Copper in the presence of Iron using F⁻ as masking agent.

III) Analysis of ores

1. Analysis of Limestone
2. Analysis of Hematite

PART-B:

Preparation of derivatives (at least two derivatives)

1. Derivatives of aromatic hydrocarbons
2. Derivatives of phenols
3. Derivatives of ethers
4. Derivatives of amides
5. Derivatives of nitro compounds

PART-C:

I) Colourimetry:

1. To determine dissociation constant of Phenolphthalein colourimetrically.
2. To study colourimetrically the complex formation between ferric ions and thiocyanate ions.

II) Determination of Order of a reaction:

1. To study the Kinetic features of decomposition of Benzene diazonium chloride.
2. To study the Kinetics of reaction between permanganate and Oxalate ions catalysed by Mn²⁺ ions.
3. To study decomposition of H₂O₂ catalyzed by Iodide ions.

III) Thermochemical measurements:

1. Determination of heat of neutralization of Hydrochloric acid and Sodium hydroxide.
2. Determination of heat of solution of Potassium Nitrate in water.
3. Determination of heat of Hydration of Sodium Sulphate.

BOOKS RECOMMENDED:

1. Advanced Practical Chemistry-BY-Jagdamba singh, R.K.P singh, Jaya singh, LDS yadav, I.R.Siddiqui, Jaya Shrivastava-Pragati edition.
2. Practical Inorganic Chemistry-G.Pass and H.sutchliff chapman and hall Ltd.
3. Advanced practical chemistry by Jagdamba Singh, R. K. P. Singh, Jaya Singh, LDS Yadav, I. R. Siddiqui, Jaya Shrivastava.
4. Senior Practical Physical Chemistry -By: B.D.Khosla, V.C.Garg, and Adarsh Gulati.

MAJOR PROJECT WORK

Subject Code	CH-HCP 4.3	IA Marks	30
No. of Lecture Hrs./Week	08	Exam Hours	03
		Exam Marks	70

The Project work may include training in industries/short term work in the department/other department or institution/R and d organization / review of current literature/theoretical method computer applications/experimental work may involve studies on synthesis of novel and known organic compounds, metal complexes and their characterization by physical and chemical methods/drug analysis/biological activity of reported or unreported research work/water, air and soil analysis / pollution studies/estimation of food adulterants.

In case of students working outside the campus the supervisor/staff member in charge visit the place of work during the period and may be eligible for TA and DA as per university rules.

BOOKS RECOMMEND:

1. Applications of computers in chemistry – Raman
2. Computers and their applications to chemistry – Ramesh kumar , narosa publishing house 2002
3. Laboratory experiments in organic chemistry-arun sethi, new age international ltd. New Delhi
4. A hand book of organic chemistry – H.T.Clarke
5. Vogels text book of practical organic chemistry, revised 5th edn addition Wesley longman Ltd, UK 1997.

PHYSICAL CHEMISTRY-IV

Subject Code	CH-SCT 4.4.1	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I: Electrochemistry and Photochemistry: **13Hrs**

Ion-solvent interaction, Born model, solvation number and their determination, overvoltage, Butler – volmer equation, Tafel equation, electroplating, fundamentals of batteries, Primary and secondary batteries, fuel cells, types of fuel cells,

Interaction of radiation with matter, review of laws of photochemistry, Jablonkiss diagram, radiative and non-radiative processes. Stern –volume equation, photo physical kinetics of uni and bimolecular processes. Photolysis of water. Bioluminescence and Chemiluminescence.

UNIT-II: Catalysis and Group theory: **13Hrs**

Adsorption isotherms – Langmuir, Freundlich, BET and Gibbs adsorption isotherms, mechanism of unimolecular surface reactions, Homogeneous and Heterogeneous catalysis

Enzyme catalysis: Single substrate mechanism, Michaelis- Menten equation, effect of pH, temperature and inhibition on kinetics of enzyme catalyzed reaction

Group theory: Symmetry operators and symmetry elements, products of symmetry operations C_{2v}, C_{3v}, C_{2h} , groups, point groups, groups multiplication table, character table, matrix representation of groups reducible and irreducible representations.

UNIT-III: Molecular Spectroscopy: **13Hrs**

Characterization of electromagnetic radiation, quantization of energy levels,

Rotational spectroscopy, classification of molecules based on their moment of inertia, rotation of rigid diatomic molecules and non rigid diatomic molecules.

Infrared spectra: vibration of diatomic molecule, simple harmonic oscillator model, vibration energy levels and vibration spectra, the harmonic oscillator model fundamental bands, overtones and hot bands.

Vibration and rotational spectra of diatomic and polyatomic molecules. Overtone and combination frequencies PQR branches, Born Oppenheimer approximation.

Electronic spectra of diatomic molecules, Frank-Condon principle, rotational fine structure of electronic vibrations. Raman spectroscopy: introduction Stokes and anti Stokes lines, classical and quantum theory of Raman Effect, mutual exclusion principle, resonance Raman spectroscopy.

UNIT-IV: Polymer Science and Technology: **13Hrs**

General introduction to polymers, molecular weight distribution curves, determination of molecular weight by end group analysis and GPC method, determination of chain dimension from light scattering technique, understanding of thermo mechanical behaviour, thermal behaviour of polymers from TMA and DMA techniques, kinetics of chain polymerization, types of polymerization, linear step polymerization, radical polymerization, ionic polymerization, ring opening polymerization and copolymerization. Swelling of polymers, stress behavior, viscoelastic behavior.

BOOKS RECOMMENDED:

1. Modern aspects of electrochemistry vol-I and Vol-II-J.O.MBockris and A.K.N reddy
2. Electrochemistry by Glasstone
3. Heterogeneous catalysis – G.C.Bond
4. The basic applications of heterogeneous catalysis- Michael Bowker
5. Fundamentals of molecular spectroscopy – CN BANWELL and Mc Cash
6. Introduction to molecular spectroscopy – G.M.Barrow
7. Polymer chemistry-Billayer
8. Polymer chemistry – P.J.Flory
9. Physical chemistry of macromolecules by D.D.Deshpande
10. Polymer science-gowariker
11. Physical chemistry-P.W.Atkins
12. Chemical Kinetics – Laidler

INORGANIC CHEMISTRY-IV

Subject Code	CH-SCT 4.4.2	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I: Metal-Ligand Equilibrium in Solution: **13Hrs**

Kinetic and thermodynamic stability, liability and inertness. Stepwise and overall formation constants and their interaction, factors affecting the stability of metal complexes with reference to nature of metal and ligand chelate effect. Determination of stability constants and stoichiometry by spectrophotometric, potentiometric pH methods. Calculations of ΔG° , ΔH° and ΔS° from overall stability constants.

UNIT-II: Bio-Inorganic Chemistry: **13Hrs**

Essential and trace metals chlorophyll and its role in photosynthesis; transport and storage of dioxygen-heme proteins; oxygen uptake- functions of haemoglobin, myoglobin, hemerythrin and hemocyanins, synthetic oxygen carriers. Metal storage and transport, ferritin, transferring and ceruloplasmin. Biological nitrogen fixation; in vivo and in vitro nitrogen fixation.

Chemical toxicology: Toxic chemicals in the environment; impact of toxic chemicals on enzymes; biochemical effect of As, Cd, Pb, Hg, CO, NO_x, SO₂, ozone and PAN Cyanide pesticides and carcinogens.

UNIT-III: Mossbauer Spectroscopy: **13Hrs**

Basic principle spectral parameters, spectral display, Doppler effect, Zeeman splitting, isomer shift, quadrupled splitting, magnetic interaction. Mossbauer spectrometers, components. Applications of Mossbauer techniques to the studies of (i) bonding and structure of Fe⁺² and Fe⁺³ compounds (ii) detection of oxidation states.

NQR Spectroscopy : Consequence of nuclear spin larger than ½ prolate and oblate nucleus nuclear quadrupolar charge distribution – theory and instrumentation, relations between electric field gradients and molecular structure, applications.

UNIT-IV: Electron spin Resonance Spectroscopy: **13Hrs**

Basic principles zero field splitting kramers degeneracy factors affecting g-values. Interpretation of g-values. Isotopic and anisotropic hyperfine coupling constants. Spin Hamiltonian, spin densities and Mc Connel relationship measurement techniques.

Photoelectron spectroscopy: Basic principles photo – electric effect, ionization process Koopmans theorem. Photoelectron spectra of simple molecules chemical information from ESCA, instrumentation and application.

BOOKS RECOMMENDED:

1. Advanced inorganic chemistry – F.A. Cotton and G. Wilkinson
2. Inorganic chemistry- J. Huheey, Harper and Rao
3. Principles of Instrumental Analysis- Skoog, Holler and Nieman (Harcourt Asia Pvt Ltd., India New Delhi 5th edition 1998)
4. Instrumental methods of chemical analysis – Chatwal and Anand 5th edition
5. Organic chemistry William Kemp (3rd edition ELBS 1991)
6. Organic spectroscopy – P.S. Kalasi Tata Mc Graw Hill 1993
7. NMR, NQR, EPR and Mossbauer spectroscopy in inorganic chemistry – R.V. Parish Ellis Horwood.
8. Instrumental method of analysis – Wollard Mseri and Dean
9. Instrumental methods of chemical analysis- B.K. Sharma goel publishing house Meerut 2000
10. Introduction to spectroscopy – Pavia Lampman and Kriz
11. Structural methods in inorganic chemistry – E. A. Ebsworth, D.W.H. Rankin and S. Craddock, ELBS
12. Instrumental methods of chemical analysis – H. Kaur.
13. Environmental chemistry – 4th edition A.K. Dey
14. Test book of environmental chemistry – O.D. Tyagi and M. Mehra
15. Environmental pollution analysis – S.M. Khopkar

ANALYTICAL CHEMISTRY-IV

Subject Code	CH-SCT 4.4.3	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I:

13Hrs

Air pollution, analysis and control:

Historical overview global implications of air pollution sources of pollutants, classification pollutants. Sources and effects of particulates, carbon monoxide sulphur oxides, nitrogen oxides hydrocarbons and photochemical oxidants on human health vegetation and material standards for air pollutants.

Air quality monitoring:

Sampling methods and devices for particulates and gaseous pollutants. SO₂: ambient air measurements and stack gas measurements turbid metric, colorimetric conductometric and volumetric methods. NO_x: Griess-olosvay and Jacobs-hockheiser colorimetric methods, chemiluminiscent technique. CO: NDIR, amperometric, FID and catalytic oxidation methods. Hydrocarbons: total and individual hydrocarbons by gas chromatography.

Air pollution control:

Atmospheric cleaning processes, approaches to contaminant control detection and control at source.

UNIT-II:

13Hrs

Water pollution and analysis:

Water resources, origin of wastewater, types of water pollutants of their sources and effects, chemical analysis for water pollution control objectives of analysis parameters of analysis sample collection and preservation. Measurement of color turbidity, total solids, acidity, alkalinity, hardness, chloride, residual chlorine, chlorine demand, sulphate, fluoride, phosphates and different forms of nitrogen in natural and in water/polluted waters, heavy metal pollution, measurement of DO, BOD, COD, TOD, and TOC, phenols, pesticides, surfactants tannin and lignin as water pollutants and their determination.

UNIT-III:

13Hrs

Waste water treatment:

Waste water characteristics, effluent standards, terminology in waste water treatment. Treatment of domestic waste water – preliminary treatment.

Primary treatment: sedimentation equalization neutralization

Secondary treatment:

Aerated lagoons, trickling fulters, activated sludge process, oxidation dit h, oxidation pond and anaerobic digestion. Sludge treatment and disposal

Tertiary treatment:

Evaporation ion-exchange, adsorption electro dialysis electrolyte recovery and reverse osmosis.

Advanced waste water treatment:

Nutrient removal –nitrogen and phosphorous removal solid removal. Waste water disposal and reuse. Industrial waste water and its treatment

UNIT-IV:**13Hrs****Soil analysis:**

Inorganic and organic components of soil collection and preparation of soil samples for analysis. Measurements of soil pH and nitrogen nitrate nitrogen, nitrite nitrogen available phosphorus and sulphur, their determination. Analysis of soil for sodium potassium calcium and magnesium. Micronutrient elements and their analysis. Pesticide residues in soil, their separation and determination soil pollution and control.

Fuel analysis:

Characteristics of fuels sampling proximate and ultimate analysis of coal and determination of calorific value. Liquid fuels; determination flash point fire point aniline point knocking of petrol and diesel octance and cetenennumbers, carbon residue. Gaseous fuels-analysis of coal gas water gas producer gas, gobar gas and blast furnace gas. Calorific value, determination of Junkers gas calorimeter.

BOOKS RECOMMENDED:

1. Standard methods of chemical analysis A.J.welher , Robert E.Kriengor publishing Co., USA 1975
2. Environmental chemistry S.E.Manahan, Willard grants press London
3. Environmental chemical analysis . Iain L Marr and Malcomms cresses, blackie and son Ltd., London
4. Chemistry for environmental engineering chair N.Sawyer and perry L.M Canty McGraw Hill Book Co., New York
5. The air pollution hand book richardmabey, penguin
6. The pollution hand book Richardmabey penguin
7. Soil chemical analysis M.L.Jackson prentice hall of India Pvt,Ltd., New Delhi
8. Experiments in environmental chemistry P.D.Woweler D.W.counel pergamon press Oxford
9. Manual soil laboratroy testing vol-I K.H.Head,Pentech Press, London
10. A text book of environmental chemistry and pollution control S.S.Dara S.Chand and co,Ltd.New Delhi.
11. Instrumental methods for automatic air monitoring systems in air pollution control part-III edn, by W.stranss,John – wiley and sons , New York
12. Air pollution Vol-IIedn.A.C.Stern,Academic press new York
13. Analysis of air pollutions P.O.Warner,John wiley and sons, New York.
14. The chemical analysis air pollutants interscience New York
15. The analysis of air pollutats .W.Liethe ann Arbor Science pub Inc Michigan
16. Environmental chemistry A.K.De.New age international (p) Limited publishers

CHEMISTRY IN DAY TODAY LIFE

Subject Code	CH-OET 4.5	IA Marks	30
No. of Lecture Hrs./Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	70

UNIT-I:

Environment: **13Hrs**

Scope of Environmental Chemistry, Environmental pollution, Environmental segments, Vertical temperature, vertical structure of the atmosphere.

Biogeochemical cycles in the environment: Oxygen, Carbon, Nitrogen cycles.
Biodistribution of elements.

UNIT-II:

Ozone Layer-The Earth's Protective Umbrella: **13Hrs**

Creation of Ozone layer, mechanism of ozone formation and depletion, probing the ozone shield, ozone hole over Antarctica, Effects of ozone depletion.

Chlorofluro Carbon:Harmful effects of CFCs, remedial steps and control strategies.

UNIT-III:

Smog and Acid rain: **13Hrs**

Sulphurous or London smog, Photochemical or Los Angeles smog, Mechanism of smog formation, Adverse effects of photochemical smog, Control of photochemical smog pollutants.

Introduction to Acid rain, Theories of acid rains, Adverse effects of acid rains, Control of acid rains.

UNIT-IV:

Green House effect and Global Warming: **13Hrs**

Green house effect and Green house gases, Sources, earth's mechanism and global climate, and its causes.

Global warming and climate changes: Implications of climate change, consequences, Control measures of green house effect, El Nino and La Nina Phenomenon. Asian and Malasian brown clouds.

BOOKS RECOMMENDED:

1. Environmental Chemistry- By, H.Kaur- Pragati Prakashan.
2. Environmental chemistry S.E.Manahan, Willard grants press London