Course No: PCHCR15101  
Title: Inorganic Chemistry (04 Credits)

Max. Marks: 100  
Duration: 80 Contact hours (48L + 32P)
End Term Exam: 80 Marks  
Continuous Assessment: 20 Marks

Unit-I  
Stereochrerny and Bonding in the Compounds of Main Group Elements  
(16 Contact hours)

Valence bond theory: Energy changes taking place during the formation of diatomic molecules; factors affecting the combined wave function. Bent's rule and energetics of hybridization.

Resonance: Conditions, resonance energy and examples of some inorganic molecules/ions.


VSEPR: Recapitulation of assumptions, shapes of trigonal bipyramidal, octahedral and pentagonal bipyramidal molecules / ions. (PCl5, VO3-, SF6, [SiF6]2-, [PbCl6]2- and IF7).

Limitations of VSEPR theory.

Molecular orbital theory: Salient features, variation of electron density with internuclear distance. Relative order of energy levels and molecular orbital diagrams of some heterodiatomic molecules /ions. Molecular orbital diagram of polyatomic molecules / ions.

Delocalized Molecular Orbitals: Butadiene, cyclopentadiene and benzene.


Unit-II  
Metal-Ligand Equilibria in Solution  
(16 Contact hours)


Metal Chelates: Characteristics, Chelate effect and the factors affecting stability of metal chelates.

Determination of formation constants by pH-metry and spectrophotometry.

Structural (ionic radii) and thermodynamic (hydration and lattice energies) effects of crystal field splitting. Jahn -Teller distortion, spectrochemical series and the nephleuxetic effect.

Evidence of covalent bonding in transition metal complexes.

Unit-III  
Pi-acid Metal Complexes  
(16 Contact hours)

Transition Metal Carbonyls: Carbon monoxide as ligand, synthesis, reactions, structures and bonding of mono- and poly-nuclear carbonyls. Vibrational spectra of metal carbonyls for structural diagnosis.

Prepration, reactions, structure and bonding of transition metal nitrosyls, dinitrogen and dioxygen complexes.

Tertiary phosphine as ligand.
Unit-IV Laboratory Course in Inorganic Chemistry (32 Contact hours)

A Gravimetry:
Skill and importance of weighing in Chemistry, Gravimetric calculations.
Precipitation process in homogenous mixtures, Precipitating agents & conditions of precipitation. Precipitate processing (Digestion, Ignition), reducing precipitation errors (co- and post precipitation).

B Titrimetry:
Types and skill of titration, concept of complexometric titrations, calculations.

Metallochromic Indicators: Selection, structure, and mechanism of action.
Role and selection of buffers in complexometric titrations, EDTA back titrations.

C Separation and Estimation of following binary Metal ion systems using Gravimetry & Titrimetry simultaneously:
1. Silver (Ag⁺) as AgCl and Nickel (Ni²⁺) as [Ni(EDTA)]²⁻ complex.
2. Barium (Ba²⁺) as BaSO₄ and Zinc as [Zn(EDTA)]²⁻ complex.
3. Barium (Ba²⁺) as BaSO₄ and Nickel (Ni²⁺) as [Ni(EDTA)]²⁻ complex.
4. Nickel (Ni²⁺) as Ni (dmg)₂ complex and Magnesium (Mg²⁺) as [Mg(EDTA)]²⁻ complex.
5. Copper (Cu²⁺) as CuSCN and Magnesium (Mg²⁺) as [Mg(EDTA)]²⁻ complex.

Books Recommended
Course No: PCHCR15102
Title: Organic Chemistry (04 Credits)

Max. Marks: 100
End Term Exam: 80 Marks
Duration: 80 Contact hours (48L + 32P)
Continuous Assessment: 20 Marks

Unit-I  Delocalized Chemical Bonding and Introduction to Determination of Reaction Mechanism  (16 Contact hours)

Overview: Conjugation, cross conjugation, rules of resonance, steric inhibition of resonance.

Aromaticity: Huckel rule and concept of aromaticity, molecular orbital description of aromaticity and antiaromaticity. Relation between NMR and aromaticity. Annulenes (Two to more than ten π-electron systems), aromaticity of hetero annulenes and fullerenes (C-60). Homoaromaticity.

Hyperconjugation: Explanation of hyperconjugative effect, isovalent and sacrificial hyperconjugations

Tautomerism: Different types including valence tautomerism.

Reactive Intermediates: Generation, Structure, fate and stability of carbocations, (classical and non-classical) carbanions, free radicals, carbenes, nitrenes and radical ions.

Determination of Reaction Mechanism: Methods of determination of reaction mechanism, identification of products, determination of presence of intermediate, isotopic labeling, kinetic evidence and stereochemical evidences.

Unit-II  Stereochemistry  (16 Contact hours)

Chirality: Introduction, chirality due to chiral centre, molecules with more than one chiral centres, Threo and erythro isomers, convention for configurations D, L & R, S systems. Optical activity due to chiral axis, stereo plane and helicity. Chirality involving atoms other than carbon. Chirality in metallic complexes. Enantiotopic and diastereotopic atoms, groups and faces.


Unit-III  Mechanistic Study of Organic Reactions  (16 Contact hours)

Aliphatic Nucleophilic Substitutions
Mechanism and stereochemical implications of S_N2, S_N1, S_Ni and neighbouring Group Participation (by π and σ-bonds) reactions. Comparison of S_N1 and S_N2 reactions. Effect of substrate structure, attacking nucleophile, leaving group and solvent on the rates of S_N1 and S_N2 reactions. Mixed S_N1 and S_N2 reactions. Nucleophilic substitution at allylic, benzylic, aliphatic trigonal and vinylic carbons. Nucleophilic substitution in alcohols, Mitsunobu
reactions. Substitutions on other elements. Functional group transformation using \( S_{N2} \) reactions in organic synthesis. Nucleophilic substitutions in biological systems

**Elimination reactions**: Factors affecting elimination reactions, Mechanism of E1, E2, E1cB and E2C reactions. Competition between substitution and elimination reactions. Stereochemistry and regioselectivity of E2 eliminations, Elimination in cyclic systems and vinyl halides. Mechanism and orientation in pyrolytic eliminations, Shapiro reaction.

**Aliphatic Electrophilic Substitutions**

General mechanism of \( S_E1 \), \( S_E2 \) and \( S_Ei \) reactions. Mechanisms of reactions involving migration of double bond. Effect of substrate, leaving group and solvent on reactivity. Stork-enamine reaction.

**Unit-IV Laboratory Course in Organic Chemistry**

**(32 Contact hours)**

**A Qualitative Analyses of Organic Compounds**

*Physical Properties*: Physical state, colour, odour, solubility behavior and melting / boiling points.

*Chemical Properties*:

(i) **Flame test**

(ii) **Detection of elements**: Nitrogen, Sulphur and Halogens

(iii) **Detection of Functional Groups**: Detection of Carbohydrates, Unsaturation, Carboxylic acids, Carbonyl compounds, Phenols, Alcohols, Halides, Amines, Amides, Imides, Ureas, Thioureas, Nitrocompounds and Hydrocarbons. Group tests for compounds of natural origin (Carbohydrates, amino acids, steroids, alkaloids, terpenes and flavonoids.

Preparation and Crystallization of the Derivatives of above mentioned group of Compounds.

**B Identification of Single Organic Compounds with Multiple Functionalities.**

**C Quantitative Estimation of the following**:

(a) Carbohydrates

(b) Glycine

(c) Carboxylic acids

(d) Phenols/Aniline

**Books Recommended**

Course No: PCHCR15103  
Title: Physical Chemistry (04 Credits)  

Max. Marks: 100  
Duration: 80 Contact hours (48L + 32P)  
End Term Exam: 80 Marks  
Continuous Assessment: 20 Marks

Unit-I  Quantum Chemistry  
(16 Contact hours)  


Unit-II  Equilibrium Thermodynamics  
(16 Contact hours)  

Maxwell Relations and thermodynamic equations of state.  
Phase Equilibria: Phase equilibria of three component systems: CHCl₃-H₂O-H₂O, NH₄Cl-(NH₄)₂SO₄-H₂O and Pb-Bi-Sn systems. First and second order phase transitions.  
Ion solvent Interactions: Non structural (Born) treatment and an introduction to structural (Ion-dipole, Ion-quadruple) treatments of ion-solvent interactions.  

Unit-III  Chemical Kinetics  
(16 Contact hours)  

Theories of Chemical Reactions: Activated complex theory of reaction rates, statistical & thermodynamic formulations, Applications of activated complex theory for determination of rate constants, comparison with collision theory. Theories of unimolecular reactions (Lindman, Hinshelwood, RRK and RRKM theories), Introduction to potential energy surfaces.  
Fast reactions: General features of fast reactions, study of fast reactions by flow method, relaxation method, NMR method and flash photolysis.  

Unit-IV  Laboratory Course in Physical Chemistry  
(32 Contact hours)  

A. Chemical Kinetics:  
1. Study of kinetics of hydrolysis of an ester catalysed by Dil. HCl.  
2. Determination of order of reaction between K₂S₂O₈ and KI by Initial rates method.  

B. Viscometry:  
1. Investigation of variation of viscosity with conc. and determination of unknown concentration.  
2. Estimation of molecular radius of a solute using viscometry.
C. Calorimetry
1. Determination of heat of neutralisation of a strong acid and weak acid with a strong base.
2. Determine the integral heat of solution of KNO₃.

Books Recommended
5. Quantum Chemistry; Prasad; New Age Publishers; 2000.
10. An Introduction to Aqueous Electrolyte Solutions; Margaret Robson Wright; Wiley; 2007.
12. Practical Physical Chemistry; Findley, Kitchener; Longman;1977.
15. Experimental Physical Chemistry; Arthur M. Halpern, George C. McBane; Freeman; 2006.
Course No: PCHDC15104
Title: Bonding in Inorganic Compounds (02 Credits)

Max. Marks: 50
Duration: 32 Contact hours
End Term Exam: 40 Marks
Continuous Assessment: 10 Marks

Unit-I Bonding in Boron Clusters (08 Contact hours)
Structural classification and topology, types of bonds, isolobal analogy, empirical rules for bonding in boron clusters, Selected examples of bonding in higher boranes, Carboranes and Metallacarboranes. Boranes as ligands.

Unit-II Bonding in Non Metal Nitrogen Compounds (08 Contact hours)
Bonding in Boron–Nitrogen Compounds (Borazine), Phosphorous–Nitrogen (Cyclophosphazenes, polyphosphazenes and phosphonitrillic halides), Sulphur-Nitrogen compounds (polythiazyls and Sulphur Nitrides)

Unit-III Molecular Orbital Treatment of Bonding in Metal Complexes (08 Contact hours)
Molecular orbital treatment of bonding in octahedral, tetrahedral and square planar coordination compounds. Effect of Pi Bonding in ML₆ type octahedral Systems. Applications of CFT from MOT. Molecular orbital treatment of bonding in Metalloccenes with reference to Ferrocene.

Unit-IV Bonding in Metal Clusters and Polymetallates (08 Contact hours)
Factors favoring metal–metal bond, bonding in di- and trinuclear metal clusters, cotton rationale and quadruple bonding, selected examples of bonding in homo dinuclear metal clusters. Bonding in transition metal poly and hetero-polymetallates.

Books Recommended
Course No: PCHDC15105  
Title: Infrared, Raman and Electronic Spectroscopy (02 Credits)  
Max. Marks: 50  
End Term Exam: 40 Marks  
Continuous Assessment: 10 Marks  
Duration: 32 Contact hours

Unit-I  
**Fundamentals of Spectroscopy**  
(08 Contact hours)  
Interaction of light with matter, transition probability, transition moment integral, derivation of selection rules.  
Intensity of spectral lines; Einstein’s treatment of absorption and emission processes.  
Oscillator strength.  
Natural spectral line width, broadening of spectral lines - Doppler and Collision effects.

Unit-II  
**Infrared Spectroscopy**  
(08 Contact hours)  
Linear harmonic oscillator - classical and quantum treatment of vibrations, vibrational energies of diatomic molecules, zero point energy, force constant and bond strength, anharmonicity, Morse potential energy levels. Fundamental bands, overtones and hot bands. Vibration-rotation spectra of diatomic molecules; P, Q and R branches; Vibrations of polyatomic molecules: Normal vibrational modes, selection rules; combination and difference bands. Factors influencing the band positions and intensities. Group frequencies and fingerprint region.

Unit-III  
**Raman Spectroscopy**  
(08 Contact hours)  
Classical and Quantum theories of Raman scattering, Molecular polarizability, rotational, vibrational, and vibrational-rotational Raman spectra. Selection rules; rule of mutual exclusion. Applications.

Unit-IV  
**Electronic and Photoelectron Spectroscopy**  
(08 Contact hours)  
*Photoelectron Spectroscopy:* Basic principles- photoionization process; ionization energies; Koopman’s theorem.  
Photoelectron spectra of simple molecules (N₂, O₂).

**Books Recommended**  
4. Electronic Absorption Spectroscopy and related techniques; D N Sathyanarayna; Universities Press.
Course No: PCHDC15106
Title: Mathematics for Chemists (02 Credits)

Max. Marks: 50 Duration: 32 Contact hours
End Term Exam: 40 Marks Internal Assessment: 10 Marks

Unit-I Probability and Vectors (08 Contact hours)
Vectors: Vectors, dot, cross and triple products with applications. Gradient, divergence and curl of a vector, vector calculus, Gauss’ theorem, divergence Theorem

Unit-II Determinants and Matrix Algebra (08 Contact hours)
Determinants, basic concepts, types and properties
Matrices: rectangular, square, diagonal & triangular matrices, trace of a matrix; addition and multiplication of matrices, zero & identity matrix, transpose, adjoint & inverse of matrices, special matrices (symmetric, skew-symmetric, hermitian, skew-hermitian, unitary matrices.)
Matrix equations: Homogeneous and non-homogeneous linear equations and conditions for their solutions. Eigen-value problem

Unit-III Calculus (Differentiation and Integration) (08 Contact hours)
Functions & their continuity and differentiability. Rules for differentiation, applications of differential calculus including maxima & minima finding (Examples: Maximally populated rotational levels, Bohr's radius, most probable velocity from Maxwell distribution), exact and inexact differentials; applications to thermodynamic properties.
Integration, basic rules for integration, integration by substitution, by parts, partial fractions. Applications of integral calculus.

Unit-IV Elementary Differential Equations (08 Contact hours)
Partial differentiation, Co-ordinate transformations (Cartesian to spherical polar co-ordinates) Variables-separable and exact first order differential equations, homogeneous, exact and linear equation. Solutions of differential equation by power series method, Fourier series, second order differential equations and their solutions. (Applications to chemical kinetics and quantum chemistry.)

Books Recommended
1. Physical Chemistry; Thomas Engel & Philip Reid; Pearson Education;
2. The Chemistry Mathematics Book; E. Steiner; Oxford;
6. Chemical Mathematics; D. M. Hirst; Longman;
7. Basic Mathematics for Chemists; Tebbutt; Wiley;
10. Mathematical Method in Physical Science; 2nd edn; M.L. Boas, John Wiley and Sons;
Course No: PCHGE15107  
Title: Chemistry of the Environment     (02 Credits)  

Max. Marks: 50  
Duration: 32 Contact hours  
End Term Exam: 40 Marks  
Internal Assessment: 10 Marks  

Unit I  
Environment  
(08 Contact hours)  


Pollution: Fertilizers, Pesticides, Plastics and Metals.  

Unit II  
Hydrosphere  
(08 Contact hours)  

Chemical Composition of Water Bodies: Lakes & rivers, Factors determining composition (thermal stratification, acid-base, pE concept).  

Aquatic pollution: Inorganic, Organic, Pesticide, Agricultural, Industrial and Sewage.  


Analytical Methods for determining BOD, DO, COD, and metals (As, Cd, Hg, Pb & Se)  

Choice of methods for determination.  

Purification and treatment of water: Chlorination, Ozonation, UV radiation.  

Unit III  
Atmosphere-I  
(08 Contact hours)  

Chemical Composition of the Atmosphere: Particles, ions, radicals and their formation.  

Vertical profile of the atmosphere, Heat budget of earth’s atmospheric system. Chemical and photochemical reactions in atmosphere, photochemical smog formation.  

Oxides of N, C, S and their effects.  

Ozone layer: Formation of ozone and mechanism of ozone depletion.  

Unit IV  
Atmosphere-II  
(08 Contact Hours)  

Pollution by chemicals: Chlorofluorocarbons, hydrocarbons and ozone.  

Green house effect: Cause, source and impact on global climate.  

Consequences of Green house effect and remedial measures.  

Acid rain: Chemical aspects, adverse effects and control.  

Books Recommended  
1. Environmental Chemistry; 5th edn; Colin Baird; Freeman & Co; 2012.  
2. Environmental Chemistry; 9th edn.S.E.Manahan; Lewis Publishers;2009  
5. Environmental pollution Analysis; S. M.Khopkar; Wiley Eastern.  
Course No: PCHGE15108
Title: Surfactants and their Applications  (02 Credits)

Max. Marks: 50  Duration: 32 Contact hours
End Term Exam: 40 Marks.  Continuous Assessment: 10 Marks

Unit-I  Self-Assembly of Surfactants  (08 Contact hours)
Surfactants and Micelles: Classification of Surfactants, Solubility of Surfactants: Kraft temperature and cloud point, Micellization of surfactants: critical micelle concentration (cmc), aggregation number, counterion binding, factors affecting cmc in aqueous media. Thermodynamics of micellization: pseudophase model and mass action models. Structure and shape of micelles: geometrical consideration of chain packing, variation of micellar size and shape with surfactant concentration.

Unit-II  Micellar Solubilization and Catalysis  (08 Contact hours)
Introduction, factors affecting micellar solubilization: nature of surfactant/solubilizate, effect of additive and temperature. Effect of solubilization on micellar structure, cloud point and cmc of surfactants. Solubilization of drugs into micelles and its importance in drug delivery systems and controlled release. Theoretical consideration of reactions in micellar media. Examples of micellar catalysis for hydrolysis, oxidation and reduction reactions

Unit-III  Mixed Surfactant Systems  (08 Contact hours)
Mixed micelle formation, mixed monolayer formation, synergism, various models of mixed micelle formation(Clint, Rubingh, Motamurra, Blankschtein, and Rubing-Holland models) and mixed monolayer formation(Rosen’s model). Importance and practical applications of mixed surfactant systems.

Unit-IV  Surfactant-Polymer Systems  (08 Contact hours)
Effect of polymers on aggregation behavior of surfactants and the factors governing their interaction. Phase behavior of polymer-surfactant mixtures. Characterization of polymer-surfactant systems by various techniques like viscosity, light scattering, spectroscopic and conductance measurements. Applications of surfactant-polymers systems.

Books Recommended
5. Colloid and Interface Chemistry; R. D. Vold and M. J. Vold; Addison-Wesley; 1982.
Course No: PCHGE15109  
Title: Chemistry of Bio-molecules  (02 Credits)

Max. Marks: 50  
Duration: 32 Contact hours  
End Term Exam: 40 Marks  
Internal Assessment: 10 Marks

Unit-I  Carbohydrates  (08 Contact hours)
Definition, classifications. Significance of right and left handedness.
Production through photosynthesis
Composition and functions of:
**Monosaccharides**: Glucose, Fructose and Galactose.
**Disaccharides**: Sucrose, lactose and Maltose. Invert Sugar.
**Polysaccharides**: Starch, glycogen and Cellulose.
Aerobic and Anaerobic metabolism

Unit-II  Lipids  (08 Contact hours)
**Steroids**: Cholesterol, transport of Cholesterol in blood stream. Cholesterol and heart diseases, Recommended values of HDL and LDL ; Steroidal hormones and anabolic steroids

Unit-III  Proteins and Enzymes  (08 Contact hours)
**Proteins**: Introduction, Amino Acids: Structural features and classification.
Primary, Secondary, Tertiary and Quaternary structures of proteins and their significance.
Denaturation and Renaturation of proteins. Urea cycle.
**Enzymes**: Classification. Theories of mechanism of action of Enzymes ; Fisher Lock and Key Theory, Koshland’s Induced Fit Theory. Mechanism of action of Chymotrypsin and Carboxypeptidase.

Unit-IV  Nucleic Acids, Vitamins and Minerals  (08 Contact hours)
**Nucleic acids**: Structural features of nucleotides, Nucleotides : DNA and RNA.
**Vitamins**: Classes of Vitamins and their functions. Vitamin deficiency diseases.
**Minerals**: Macro and Micro minerals. Their functions and diseases caused by their deficiencies.

**Books Recommended**
4. Introduction to Nucleic Acids and Related Natural Products; Ulbight; Oldborn Press.
Course No: PCHOE15110  
Title: Chemistry in Everyday Life-I  (02 Credits)

Max. Marks: 50  
Duration: 32 Contact hours

External Exam: 40 Marks.  
Internal Assessment: 10 Marks

Unit-I  Household Chemicals  (08 Contact hours)
Chemistry of Soaps, detergents, optical brighteners and bleaching agents, shampoo, conditioners, dyes, hair curling and permanents, deodorants and antiperspirants, perfumes, tooth pastes and sunscreen lotions.

Unit-II  Water- An Amazing Chemical Stuff  (08 Contact hours)

Unit-III  Fossil Fuels  (08 Contact hours)

Unit-IV  Polymers and Plastics  (08 Contact hours)
Characteristics and Types of Polymers. The big six of Polymer: Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), Polypropylene PP, Polystyrene (PS), Polyvinyl Chloride (PVC) and Polyethylene -Tetra phthalate (PET or PETE)- their chemical characteristics and uses.

Books Recommended
1. Industrial Chemistry; by B.K.Sharma; Goel publishing House.
4. Chemistry Fundamentals An Environmental Prospective; 2nd edn; Buell and Girad; Jones and Barlett; 2013.
5. www.chemistryincontext; (American Chemical Society)