Programme Outcome (PO) for BSc(H) Program

1. **Knowledge and Problem Solving** Acquire in-depth scientific knowledge of their discipline both in theory and practical, demonstrate basic skills, investigate, apply, and solve the problems in a variety of contexts related to science and technology.
2. **Communication and Teamwork -** Develop skills to communicate effectively to diverse platforms and contribute meaningfully to different capacities as a leader, team member or individual.
3. **Modern tools and techniques for Scientific Experiments** – Apply modern tools and techniques to carry out scientific experiments accurately, record, analyze and predict the result for valid conclusion with clear understanding of limitations.
4. **Logical thinking:** Develop logical thinking and expertise with precision, analytical mind, innovative thinking, clarity of thought, and systematic approach for proving or disproving the facts after mathematical formulation. with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach
5. **Skill development and Employability: develop elementary computing and soft skills** to prepare students for industry, entrepreneurship and higher education with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach.
6. **Ethics and citizenship**: Able to recognize different value systems and ethical principles; and commit to professional ethics, norms, and responsibilities of the science practice and act with informed awareness to participate in civic life activities.
7. **Society, Environment and Sustainability:** Enhance ability to elicit views of others and understand the impact of various solutions in the context of societal, economic, health, legal, safety and environment for sustainable development.
8. **Life-long learning**: Acquire fundamental knowledge for lifelong learning to participate in the extensive context of socio-technological change as a self-directed member and a leader.

Program Specific Outcomes (PSO) for B.Sc. (Hons) Chemistry:

PSO_1 Acquire sound knowledge in every branch and the key areas of Chemistry, the fundamentals and applications of chemical and scientific theories.

PSO_2 Ability to design & conduct experiments; and demonstrate the understanding of the scientific methods, processes, different analytical procedures and application of theoretical aspect to practical work.

PSO_3 Develop proficiency in acquiring data using a variety of instruments, analyse & interpret the data and applications of numerical techniques

PSO_4 Acquire the ability to synthesise, separate and characterize compounds using laboratory & instrumentation techniques; and exhibit wide range of computational skill using open source software

PSO_5 Ability to present knowledge of Chemistry from basic concepts to specific areas in various ways and capability to think critically and work independently as well as a group; and Understand the impact of Chemistry on society.

Programme :	**B.Sc. Honours**	**Semester :**	**I**
Name of the Course:	**CC I: Inorganic Chemistry- I**	**Course Code :**	**SOS-B-CH101**
Credits :	**6**	**No of Hours :**	**40**
Max Marks :	**150**		

Course Description:

This course aims at giving students theoretical understanding about the basic constituents of matter – atoms, ions and molecules in terms of their electronic structure and reactivity. Structure and bonding in/of these are to be dealt with basic quantum chemistry treatment. Reactivity of chemical species based on their electron transfer affinity is introduced. Further, periodic classification of elements in the periodic table and changes in properties along the periods and groups to be studied in detail. Accompanying laboratory course is designed for students to have hands-on experience of basic quantitative analytical techniques related to volumetric titrations.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand and explain the different nature and behavior of concepts related to atomic and molecular structure.
CO 2	Understand the periodicity of elements and their relative properties.
CO 3	Acquire the knowledge of elements of S, P, D and F block elements.
CO 4	Understand the fundamental concepts of Chemical bonding and their general characteristics.
CO 5	Understand the resonance, hybridization in molecule, MOT , and Valence shell electron pair repulsion theory (VSEPR) in molecules
CO 6	Understand the Redox equations, Standard Electrode Potential and its application.

Syllabus

Atomic Structure:

- Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2.
- Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams.
- Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

(14 Lectures)

Periodicity of Elements:

- s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s & p-block
  a. Effective nuclear charge, shielding or screening effect, Slater rules, variation of

effective nuclear charge in periodic table.

b. Atomic radii (Van der Waals)
c. Ionic and crystal radii.
d. Covalent radii (octahedral and tetrahedral)
e. Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
f. Electron gain enthalpy, trends of electron gain enthalpy.
g. Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron densityratio.

(16 Lectures)

Chemical Bonding:

- Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.
- Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N2, O2, C2, B2, F2, CO, NO, and their ions; HCl, BeF2, CO2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths.
- Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.
- Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.
- Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
- Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

(26 Lectures)

Oxidation-Reduction:

- Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.

(4 Lectures)

Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
2. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
3. Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
4. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

CC- I Lab: Inorganic Chemistry- I Lab

60 Lectures

Titrimetric Analysis

- Calibration and use of apparatus
- Preparation of solutions of different Molarity/Normality of titrants

Acid-Base Titrations

- Estimation of carbonate and hydroxide present together in mixture.
- Estimation of carbonate and bicarbonate present together in a mixture.
- Estimation of free alkali present in different soaps/detergents

Oxidation-Reduction Titrimetry

- Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.
- Estimation of oxalic acid and sodium oxalate in a given mixture.
- Estimation of Fe(II) with K2Cr2O7 using internal (diphenylamine, anthranilic acid) and external indicator.

Reference text:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

CO- PO & PSO Correlation

Course Name: CHEMISTRY-CC I: INORGANIC CHEMISTRY-I													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2							1	2				
CO2				1									1
CO3	1												2
CO4				2					1				
CO5			1										2
CO6			2								2		

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**I**
Name of the Course:	**CC II: Physical Chemistry I**	**Course Code:**	**SOS-B-CH102**
Credits :	**6**	**No of Hours :**	**40**
Max Marks :	**150**		

Course Description:

This course contains states of matter- gaseous, liquid and solid sates along with ionic equilibria. A small unit of molecular and crystal symmetry is also there in the course. we are also trying to teach rate of the reaction, what are the factor involves in every chemical reactions and how to control the chemistry between two states of compounds. Student must also be aware with the transform of material from one state to another. Why any chemical compound behaves totally different on changing their states only.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand the kinetic theory of gases and different laws of real and ideal gas.
CO 2	Acquire the knowledge of Maxwell distribution law and different molecular velocities.
CO 3	Explain the properties of liquids and effect of solutes, temperature on it.
CO 4	Describe condition required for liquification of gases.
CO 5	Explain the ionization of different types of electrolytes

Syllabus

Gaseous State:

- Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.
- Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.
- Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. vander Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

(18 Lectures)

Liquid State:

- Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and

coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.

- Qualitative discussion of structure of water.

(6 Lectures)

Solid State:

- Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices.
- X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

(16 Lectures)

Ionic Equilibria:

- Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment).
- Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.
- Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.
- Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

(20 Lectures)

Reference Books:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press (2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

CC- II Lab: Physical Chemistry- I Lab

60 Lectures

Surface Tension measurements

- Determine the surface tension by
  - i) drop number
  - ii) drop weight method
- Study the variation of surface tension of detergent solutions with concentration.

Viscosity measurement using Ostwald's viscometer

- Determination of viscosity of aqueous solutions of

i) Polymer
ii) ethanol and
iii) sugar at room temperature.

- Study the variation of viscosity of sucrose solution with the concentration of solute.

Indexing of a given powder diffraction pattern of a cubic crystalline system.

pH metry

- Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
- Preparation of buffer solutions of different pH
  i) Sodium acetate-acetic acid
  ii) Ammonium chloride-ammonium hydroxide
- pH metric titration of
  i) strong acid vs. strong base
  ii) weak acid vs. strong base.
- Determination of dissociation constant of a weak acid.

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

CO- PO & PSO Correlation

Course Name: CHEMISTRY-CC II: PHYSICAL CHEMISTRY- I													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1								1				
CO2			2	1							1		
CO3					1								2
CO4	2									1			
CO5			1										1

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**II**
Name of the Course:	**CC III: Organic Chemistry- I**	**Course Code:**	**SOS-B-CH-201**
Credits :	**6**	**No of Hours :**	**40**
Max Marks :	**150**		

Course Description:

The core course Organic Chemistry I is designed in a manner that it forms a cardinal part of the learning of organic chemistry for the subsequent semesters. The course is infused with the recapitulation of fundamentals of organic chemistry and the introduction of a new concept of visualizing the organic molecules in a three-dimensional space. To establish the applications of these concepts, the functional groups- alkanes, alkenes, alkynes and aromatic hydrocarbons are introduced. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand and explain the different nature and behavior of organic compounds based on fundamental concepts
CO 2	Understand the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved
CO 3	Identify the types of organic reaction & their mechanisms- Free Radical, Substitution, Addition and Elimination reactions
CO 4	Understand the fundamental concepts of Geometrical & Optical isomerism
CO5	Understand chirality in molecule, understand and assign D/L, R/S, E/Z nomenclature

Syllabus

Basics of Organic Chemistry

- Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.
- Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyper conjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.
- Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.
- Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

(6 Lectures)

Stereochemistry

- Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions.
- Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.

- Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

(18 Lectures)

Chemistry of Aliphatic Hydrocarbons

- Carbon-Carbon sigma bonds: Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.
- Carbon-Carbon pi bonds: Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.
- Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.
- Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.
- Cycloalkanes and Conformational Analysis: Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

(24 Lectures)

Aromatic Hydrocarbons

- Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples.
- Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

(12 Lectures)

Reference Books:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling **Kindersley** (India) Pvt. Ltd. (Pearson Education).
4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

CC- III LAB: Organic Chemistry- I Lab

60 Lectures

Melting/Boiling Point determination

- Checking the calibration of the thermometer
- Determination of the melting points of unknown organic compounds
- Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
- Determination of boiling point of liquid compounds (boiling point lower than and more than 100 °C by distillation and capillary method)

Purification of organic compounds by crystallization using the following solvents:

- Water
- Alcohol
- Alcohol-Water

Chromatography

- Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
- Separation of a mixture of two sugars by ascending paper chromatography
- Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Reference Books

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

CO- PO & PSO Correlation

Course Name: CHEMISTRY-CC III: ORGANIC CHEMISTRY- I													
Course Outcomes	Program Outcome								PSOs				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2												1
CO2								1		2			
CO3				1							1		
CO4	1								2				
CO5			1							2			

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**II**
Name of the Course:	**CC IV: Physical Chemistry- II**	**Course Code:**	**SOS-B-CH-202**
Credits :	**6**	**No of Hours :**	**40**
Max Marks :	**150**		

Course Description:

In this course the students are expected to learn laws of thermodynamics, thermochemistry, thermodynamic functions, relations between thermodynamic properties, Gibbs Helmholtz equation, Maxwell relations etc. Moreover, the students are expected to learn partial molar quantities, chemical equilibrium, solutions and colligative properties. After completion of this course, the students will be able to understand the chemical systems from thermodynamic point of view.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand and apply the laws of thermodynamics; perform calculations with ideal and real gases
CO 2	Predict chemical equilibrium and spontaneity of reactions by using thermodynamic principles
CO 3	Determine the relationship between K_p and K_c for gas phase equilibria
CO 4	Predict qualitatively the effects of changes in concentration, temperature and pressure on an equilibrium based on Le Chatelier's principle
CO 5	Explain the different laws of solutions and colligative properties

Syllabus

Chemical Thermodynamics:

- Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.
- First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.
- Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.
- Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.
- Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.
- Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz

equation; Maxwell relations; thermodynamic equation of state.

(36 Lectures)

Systems of Variable Composition:

- Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs- Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

(8 Lectures)

Chemical Equilibrium:

- Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants Kp, Kc and Kx. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

(8 Lectures)

Solutions and Colligative Properties

- Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions.
- Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point,
- Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

(8 Lectures)

Reference Books

1. Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
4. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.
6. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
7. Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
8. Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006)

CC- IV Lab: Physical Chemistry- II Lab

60 Lectures

Thermochemistry

- Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).
- Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
- Calculation of the enthalpy of ionization of ethanoic acid.
- Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
- Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
- Determination of enthalpy of hydration of copper sulphate.
- Study of the solubility of benzoic acid in water and determination of ΔH.

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).

CO- PO & PSO Correlation

Course Name: CHEMISTRY CC- IV: PHYSICAL CHEMISTRY- II													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1				1									1
CO2								1					2
CO3				1							1		
CO4					2		1						
CO5			1								1		

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**II**
Name of the Course:	**AECC-2: Environmental science**	**Course Code:**	**SOS-B-AE101**
Credits :	**2**	**No of Hours :**	**40**
Max Marks:	**50**		

Course Description:

The course will empower the undergraduate students by helping them to Gain in-depth knowledge on natural processes and resources that sustain life. Understand the consequences of human actions on the web of life and quality of human life. Develop critical thinking for shaping strategies for environmental protection, conservation of biodiversity, environmental equity, and sustainable development.Acquire values and attitudes towards understanding complex environmental-economic-social challenges, and active participation in solving current environmental problems and preventing the future ones. Adopt sustainability as a practice in life, society, and industry.

Course Outcomes (CO)

Students will be able to	
CO 1	Acquire the knowledge of natural processes and resources that sustain life
CO 2	Understand the consequences of human actions on the web of life and quality of life
CO 3	Develop critical thinking for shaping strategies for environmental protection, conservation of biodiversity, environmental equity, and sustainable development
CO 4	Acquire values and attitudes towards understanding complex environmental-economic-social challenges
CO 5	Identify problems, solving current environmental problems and preventing the future ones.

Syllabus

Ecology and Bio-Diversity

Ecology, Environment & Ecosystem, Biotic & Abiotic Components; Structure & functions of Ecosystem, Productivity, Decomposition, Energy Flow, Nutrient cycling, Food Chain & Food Web, Ecological Pyramids; Ecological succession; Bio-diversity: Concept, Importance, and Threats & Conservation

(5 Lectures)

Environment and Natural Resources

Earth's Environment: Atmosphere, Lithosphere, Hydrosphere & Biosphere, functions and related problems; Environmental degradation and its causes; Natural resources, Renewable and Non-renewable Resources & associated problems; Study of major Resources on Earth (overview): Forest, Water, Mineral, Food, Energy and Land.

(5 Lectures)

Air Pollution

Classification of air pollutants, sources and effects of CO, SOx, NOx, Hydrocarbons, PM, Acid Rain, Ozone, Photochemical Smog & Peroxy Actyl Nitrate (PAN). Earth's energy balance, Green House Effect, Global warming; Stratospheric Ozone & its Depletion;

Ambient Air Quality standard; Air pollution control methods

(7 Lectures)

Water Pollution & Soil Pollution

Point & non-point source; Water pollutants & types, sources and effects; Water Quality measurement, Dissolved Oxygen, BOD & COD; Wastewater Management, Primary, Secondary & Tertiary stages: Objective, Process overview and Equipment used.
Sources of Soil pollution & effect; Solid Waste Management: Objective, Process & Disposal Techniques.

(8 Lectures)

Social issues & Sustainability

Population Growth, variation among nations, Population explosion, Family Welfare Programme; HIV/AIDS; Environment and human health.
Concept of Sustainable Development (SD), models, indicators and principles of Sustainability.

(5 Lectures)

References books:

1. Keerthinarayana & Daniel Yesudian, "Environmental Science and Engineering", 1st Edition, Hi-Tech publications, 2004.
2. Erach Bharucha, “A Text Book for Environmental Studies”, Text Book of University Grants Commission, 2004.
3. Peavy, H.S., D.R. Rowe & T. George, “Environmental Engineering”, New York: Mc Graw Hill, 1987.
4. Metcalf & Eddy, “Wastewater Engineering: Treatment and Reuse", New Delhi, Tata McGraw Hill, 2003.
5. Principles of Environmental Science Inquiry & Applications by W.P. Cunningham & Mary Ann Cunningham (Tata Mc Graw Hill Publishing Company Ltd.).

CO- PO & PSO Correlation

Course Name: AECC-2: ENVIRONMENTAL SCIENCE													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2						1		1				1
CO2							1			1			
CO3			2							2			
CO4								1	1				
CO5		1					1						1

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**III**
Name of the Course:	**Inorganic Chemistry- II**	**Course Code:**	**SOS-B-CH-301**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

This course aims at giving students theoretical understanding about the basics of metallurgy based on the metal's electrode potential and different metallurgic processes. Different theories of acids and bases and acid-base reactions. Properties of elements from s and p blocks and their hydrides, oxides and other compounds. Properties of noble gases and their compounds. Synthesis and properties of inorganic polymers. Accompanying laboratory course is designed for students to have hands-on experience of basic quantitative analytical techniques related to Iodi /Iodometric titrations, and synthesis of inorganic compounds

Course Outcomes (CO)

Students will be able to	
CO 1	Understand the General Principles of Metallurgy Chief modes of occurrence of metals based on standard electrode potentials.
CO 2	Understand the Acid Base, their concept Acid Base reaction and HSAB principle and their application.
CO 3	Understand the S and P block elements, Allotropy and catenation. Complex formation tendency of s and p block elements.
CO 4	Understand the preparation and properties of noble gas compounds, Inorganic Polymers and their synthesis.

Syllabus

General Principles of Metallurgy:

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

(6 Lectures)

Acids and Bases:

Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle.

(8 Lectures)

Chemistry of s and p Block Elements:

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements.

Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.
Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses.
Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

(30 Lectures)

Noble Gases:
Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).

(8 Lectures)

Inorganic Polymers:
Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

(8 Lectures)

Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
2. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth- Heinemann. 1997.
4. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
5. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.
6. Shriver & Atkins, Inorganic Chemistry 5th Ed.

CHEMISTRY LAB: CC- V LAB

Iodo / Iodimetric Titrations

- Estimation of Cu(II) and and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).
- Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically
- Estimation of available chlorine in bleaching powder iodometrically.

Inorganic preparations

- Cuprous Chloride, Cu_2Cl_2
- Preparation of Manganese(III) phosphate, $MnPO_4.H_2O$
- Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

Reference text:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

CO- PO & PSO Correlation

Course Name: CHEMISTRY-CC V: INORGANIC CHEMISTRY-II													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2								2				1
CO2	2										1		
CO3			2										2
CO4	1												1

Programme :	**B.Sc. Honours**	**Semester :**	**III**
Name of the Course:	**Organic Chemistry- II**	**Course Code:**	**SOS-B-CH-302**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

This course aims at giving students theoretical understanding about the hydrocarbons containing halogen atoms, their preparation, reactions with mechanism. Some organometallic compounds with their preparation methods and their application in C-C bond formation. Organic compounds with different functionality (Alcohol, Phenol, Ester, Epoxide, Carbonyls, acids, etc.), their preparation, reactions with mechanism. Some famous name reactions and their mechanism. The experimental part includes the functional group test for different functionality and also the preparation of organic compounds with different functionality.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand the preparation, properties and reactions of haloalkanes & haloarenes and oxygen containing functional groups and write their mechanism
CO 2	Understand the reactivity of carboxylic acid functional group
CO 3	Understand the synthetic applications of reagents like ethyl acetoacetate, malonic ester, organo-lithium and organo-magnesium compounds
CO 4	Understand the reactions of Sulphur containing compounds

Syllabus

Chemistry of Halogenated Hydrocarbons:

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

(16 Lectures)

Alcohols, Phenols, Ethers and Epoxides:

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$ (16 Lectures)

Carbonyl Compounds:
Structure, reactivity and preparation;Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α- substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaB H_4$, MPV, PDC and PGC);
Addition reactions of unsaturated carbonyl compounds: Michael addition.
Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate (14 Lectures)

Carboxylic Acids and their Derivatives:
Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids;Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann- bromamide degradation and Curtius rearrangement. (10 Lectures)

Sulphur containing compounds:
Preparation and reactions of thiols, thioethers and sulphonic acids. (4 Lectures)

Reference Books:
1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

CHEMISTRY LAB: CC- VI LAB
1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
2. Organic preparations:
   i) Acetylation of one of the following compounds: amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method:
      (a) Using conventional method.
      (b) Using green approach
   ii) Benzolyation of one of the following amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and one of the following phenols (β-naphthol, resorcinol, p- cresol) by Schotten-Baumann reaction.
   iii) Oxidation of ethanol/ isopropanol (Iodoform reaction).
   iv) Bromination of any one of the following:
      (a) Acetanilide by conventional methods
      (b) Acetanilide using green approach (Bromate-bromide method)
   i) Nitration of any one of the following:
      (a) Acetanilide/nitrobenzene by conventional method

(b) Salicylic acid by green approach (using ceric ammonium nitrate).

ii) Selective reduction of meta dinitrobenzene to m-nitroaniline.
iii) Reduction of p-nitrobenzaldehyde by sodium borohydride.
iv) Hydrolysis of amides and esters.
v) Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
vi) S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
vii) Aldol condensation using either conventional or green method.
viii) Benzil-Benzilic acid rearrangement.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.

Reference Books

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
4. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

CO- PO & PSO Correlation

Course Name: CHEMISTRY CC- VI: ORGANIC CHEMISTRY-II													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		1									1	1
CO2								1				2	
CO3			2									1	2
CO4	1							1					2

Programme :	**B.Sc. Honours**	**Semester :**	**III**
Name of the Course:	**Physical Chemistry- III**	**Course Code:**	**SOS-B-CH-303**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

This course aims at giving students theoretical understanding about the Phases, Components, and degree of freedom. Gibb's phase rule for different systems and different type of equilibria, Clausius-Clapeyron equation and its applications; Systems containing different number of components. The second unit contains the concepts of order, molecularity, differential and integrated rate law expressions for the 1st and 2nd order reactions, Kinetics of complex reactions, Arrhenius equation, Lindemann theory, Concepts of catalysis and types of catalysts. Enzyme catalysis, Principal of Adsorption, chemisorption and adsorption isotherms. Accompanying laboratory course is designed for students to have hands-on experience of distribution law, phase diagram construction of different systems, surface phenomenon and their corresponding isotherms.

Course Outcomes (CO)

Students will be able to	
CO 1	Explain the different phases and concepts of phase, component, and degree of freedom
CO 2	Draw the phase diagram of one, two and three component system
CO 3	Write the integrated and differential rate laws of different types of reactions
CO 4	Explain the types and mechanism of catalyzed reactions
CO 5	Explain different surface adsorption processes and adsorption isotherms.

Syllabus

Phase Equilibria:

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid- liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications.

Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions.

Three component systems, water-chloroform-acetic acid system, triangular plots.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation.

Nernst distribution law: its derivation and applications. (28 Lectures)

Chemical Kinetics

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex

reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.
Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates. (18 Lectures)

Catalysis:
Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis. (8 Lectures)

Surface chemistry:
Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state. (6 Lectures)

Reference Books

1. Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
2. Castellan, G. W. Physical Chemistry, 4th Ed., Narosa (2004).
3. McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi (2004).
4. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.
6. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
7. Zundhal, S.S. Chemistry concepts and applications Cengage India (2011).
8. Ball, D. W. Physical Chemistry Cengage India (2012).
9. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
10. Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill (2011).
11. Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).

CHEMISTRY LAB: CC- VII LAB

I. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.

II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:

a. simple eutectic and
b. congruently melting systems.

III. Distribution of acetic/ benzoic acid between water and cyclohexane.

IV. Study the equilibrium of at least one of the following reactions by the distribution method:

(i) $I_2\ (aq) + I^- \rightarrow I_3^-\ (aq)$

(ii) $Cu^{2+}(aq) + n\mathrm{NH} \rightarrow Cu(NH)_n^{2+}$

V. Study the kinetics of the following reactions.

VI. Initial rate method: Iodide-persulphate reaction

1. Integrated rate method:
   a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Saponification of ethyl acetate.
c. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

VI Adsorption (i) Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

CO- PO & PSO Correlation

Course Name: CHEMISTRY CC- VII: PHYSICAL CHEMISTRY-III													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1					1					1			1
CO2	2									2			
CO3								1					1
CO4								1					2
CO5		1									2		

Programme :	**B.Sc. Honours**	**Semester :**	**IV**
Name of the Course:	**Inorganic Chemistry- III**	**Course Code:**	**SOS-B-CH-401**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

The objective of this course is to make students understand about the basic concepts of coordination compounds, their different theories with their applications, geometries, nomenclature and reactivity of Coordination compounds**.** Physical and chemical properties of transition elements, stable oxidation states. General chemistry of f-block elements. Organometallic compounds in biological systems and different chemical processes inside a living organism. Accompanying laboratory course is designed for students to have hands-on experience of basic quantitative analytical techniques related to gravimetric analysis of metal ions, and synthesis of some coordination compounds.

Course Outcomes (CO)

Students will be able to	
CO 1	Gain theoretical understanding of chemistry of Coordination compounds IUPAC nomenclature, isomerism and their CFT and MOT theory.
CO 2	Understand the Transition elements , their properties , valency coloured compound and variable oxidation state and applications of these compounds.
CO 3	Understand the Lanthanides and Actinides series elements Electronic configuration, oxidation states, colour , spectral and magnetic properties.
CO 4	Understand the Bioinorganic Chemistry metal ions present in biological systems, classification of elements according to their action in biological system.
CO 5	Understand the Excess and deficiency of some trace metals and Toxicity of metal ions

Syllabus

Coordination Chemistry:

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes. (26 Lectures)

Transition Elements:

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various

oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series.
Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy) (18 Lectures)

Lanthanoids and Actinoids:
Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).
(6 Lectures)

Bioinorganic Chemistry:
Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine.
Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.
(10 Lectures)

Reference Books:
1. Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977.
2. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
3. Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
4. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. Wiley-VCH, 1999
5. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
6. Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, Butterworth-Heinemann,1997.

CHEMISTRY LAB: CC- VIII LAB
Gravimetric Analysis:
i) Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii) Estimation of copper as CuSCN
iii) Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.
iv) Estimation of Al (III) by precipitating with oxine and weighing as Al(oxine)3 (aluminium oxinate).

Inorganic Preparations:
i. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
ii. *Cis* and *trans* $K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III)
iii. Tetraamminecarbonatocobalt (III) ion
iv. Potassium tris(oxalate)ferrate(III)

Chromatography of metal ions
Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:
i. Ni (II) and Co (II)
ii. Fe (III) and Al (III)

Reference Books

1. Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.

CO- PO & PSO Correlation

Course Name: CHEMISTRY CC- VIII: INORGANIC CHEMISTRY-III													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1										1		
CO2				2									2
CO3				1					2				
CO4	2									1			
CO5								2					2

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**IV**
Name of the Course:	**Organic Chemistry- III**	**Course Code:**	**SOS-B-CH-402**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

The objective of the course is to make students understand the properties, synthesis and reactions of nitrogen containing functional groups and polynuclear hydrocarbons. Properties, synthesis and reaction mechanism of 5 and 6 membered heterocyclic compounds containing O, N and S as heteroatom. Occurrence, structural features, isolation and physiological action of some alkaloids and terpenes. In the experimental part students will get the hand on experience for the detection of elements, different functional group test containing nitrogen and qualitative test of some functional groups.

Course Outcomes (CO)

Students will be able to	
CO 1	Gain theoretical understanding of compounds having nitrogen containing functional groups
CO 2	Become familiar with properties, chemical reactions, criterion of aromaticity, trends in basicity and their behaviour at different pH
CO 3	Understand the practical approach to structural elucidation of organic compounds with specific examples of terpenes and alkaloids
CO4	Understand the molecular structural elucidation of compounds
CO5	Understand the applications of these compounds including their medicinal applications through their reaction chemistry

Syllabus

Nitrogen Containing Functional Groups:

Preparation and important reactions of nitro and compounds, nitriles and isonitriles

Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid.

Diazonium Salts: Preparation and their synthetic applications.

(18Lectures)

Polynuclear Hydrocarbons:

Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.

(8 Lectures)

Heterocyclic Compounds:

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-

membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner- Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction
Derivatives of furan: Furfural and furoic acid.

(22 Lectures)

Alkaloids:
Natural occurrence, General structural features, Isolation and their physiological action. Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

(6 Lectures)

Terpenes:
Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral and α-terpineol.

(6 Lectures)

Reference Books

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).
5. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
6. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
8. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Pragati Parakashan (2010).

CHEMISTRY LAB: CC- IX LAB

1. Detection of extra elements.
2. Functional group test for nitro, amine and amide groups.
3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)

Reference Books

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education

(2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
4. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

CO- PO & PSO Correlation

Course Name: CHEMISTRY-CC IX: ORGANIC CHEMISTRY-III													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1				1					1				
CO2	1										1		
CO3													1
CO4	1										2		
CO5								1				2	2

Programme :	**B.Sc. Honours**	**Semester :**	**IV**
Name of the Course:	**Physical Chemistry- IV**	**Course Code:**	**SOS-B-CH-403**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

The objective of this course is to give the students a theoretical understanding of different theories and laws of electrolytes. Properties of electrolytes like conductivity, ionic velocities, mobilities, etc. Determination of transference numbers and applications of conductance measurement. In the electrochemistry unit, students will learn about the concepts and applications of Faraday's law and Nernst equation and also the applications of EMF in the determination of free energy, enthalpy and entropy, equilibrium constant and pH of a cell reaction. Liquid junction potential and theory of potentiometric titration. In the last unit, students will understand the basics of electrostatics, and measurement of dipole moment, polarizability and other magnetic properties. The accompanying lab course will give the students a hand on experience about the analytical techniques of conductometric and potentiometric titration of different electrolytes.

Course Outcomes (CO)

Students will be able to	
CO 1	Explain the different types of conductance and their applications
CO 2	Explain the concept of transference number and methods of their determination
CO 3	Explain Faraday's laws and their application in metallurgy and industry
CO 4	Calculate EMF of cell using Nernst equation and applications of EMF measurement
CO 5	Explain the concept of electrostatics and different types of magnetism in atoms & molecules

Syllabus

Conductance:

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules.

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

(20 Lectures)

Electrochemistry:

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.

Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

(28 Lectures)

Electrical & Magnetic Properties of Atoms and Molecules

Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation

(12 Lectures)

Reference Books

1. Atkins, P.W & Paula, J.D. Physical Chemistry, 9th Ed., Oxford University Press (2011).
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
4. Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
5. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
6. Rogers, D. W. Concise Physical Chemistry Wiley (2010).
7. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005).

CC- X LAB: PHYSICAL CHEMISTRY IV LAB

60 Lectures

Conductometry

- Determination of cell constant
- Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
- Perform the following conductometric titrations:
    i. Strong acid vs. strong base
    ii. Weak acid vs. strong base
    iii. Mixture of strong acid and weak acid vs. strong base
    iv. Strong acid vs. weak base

Potentiometry

- Perform the following potentiometric titrations:

i) Strong acid vs. strong base
ii) Weak acid vs. strong base
iii) Dibasic acid vs. strong base
iv) Potassium dichromate vs. Mohr's salt

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

CO- PO & PSO Correlation

Course Name: CHEMISTRY CC- X: PHYSICAL CHEMISTRY-IV													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1						1			1			
CO2				1							1		
CO3				1					1				
CO4							1				2		
CO5								1					1

Programme :	**B.Sc. Honours**	**Semester :**	**V**
Name of the Course:	**Organic Chemistry- IV**	**Course Code:**	**SOS-B-CH-501**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

The objective of this course to introduce the learner to the fascinating chemistry of some biomolecules, i.e., amino acids, peptides, proteins, carbohydrates, lipids and nucleic acids that work within biological systems. It aims to build the concept of metabolism by the study of chemistry and energetics of biological system. On completion of this course, the students will be able to: Understand and demonstrate how structure of biomolecules determines their reactivity and biological functions; Gain insight into concepts of heredity through the study of genetic code, replication, transcription and translation; Demonstrate understanding of metabolic pathways, their inter-relationship, regulation and energy production from biochemical processes.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand and demonstrate how structure of biomolecules determines their reactivity and biological functions
CO 2	Gain insight into concepts of heredity through the study of genetic code, replication, transcription and translation
CO 3	Demonstrate understanding of metabolic pathways
CO 4	Understand inter-relationship, regulation and energy production from biochemical processes

Syllabus

Nucleic Acids

- Components of nucleic acids, Nucleosides, and nucleotides.
- Structure, synthesis, and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides.
  (8 Lectures)

Amino Acids, Peptides and Proteins

- Amino acids, Peptides, and their classification.
- α-Amino Acids - Synthesis, ionic properties, and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis.
- Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis
  (16 Lectures)

Enzymes

- Introduction, classification, and characteristics of enzymes. Salient features of active site of enzymes.
- Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme

action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive, and non-competitive inhibition including allosteric inhibition).
(8 Lectures)

Lipids

- Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenntion of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.
(8 Lectures)

Concept of Energy in Biosystems

- Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism, anabolism).
- ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: NAD+, FAD.
- Conversion of food to energy: Outline of catabolic pathways of carbohydrate-glycolysis, fermentation, Krebs cycle.
- Overview of catabolic pathways of fat and protein.
- Interrelationship in the metabolic pathways of protein, fat and carbohydrate. Caloric value of food, standard caloric content of food types.
(8 Lectures)

Pharmaceutical Compounds: Structure and Importance

- Classification, structure, and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).
(12 Lectures)

Reference Books:

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.
2. Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.

CC- XI LAB: ORGANIC CHEMISTRY-IV LAB

60 Lectures

- Estimation of glycine by Sorenson's formalin method.
- Study of the titration curve of glycine.
- Estimation of proteins by Lowry's method.
- Study of the action of salivary amylase on starch at optimum conditions.

- Effect of temperature on the action of salivary amylase.
- Saponification value of an oil or a fat.
- Determination of Iodine number of an oil/ fat.
- Isolation and characterization of DNA from onion/ cauliflower/peas.

Reference Books:

1. Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
2. Arthur, I. V. Quantitative Organic Analysis, Pearson.

CO- PO & PSO Correlation

Course Name: CHEMISTRY CC- XI: ORGANIC CHEMISTRY-IV													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2			2					2				
CO2	1			2					2				2
CO3	1								1				2
CO4	1			2					1				

Programme	**B.Sc. Honours**	**Semester :**	**V**
Name of the Course:	**Physical Chemistry- V**	**Course Code:**	**SOS-B-CH-502**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

The aim of this course is to introduce the students with three important areas- quantum chemistry, molecular spectroscopy and photochemistry. In quantum chemistry unit the students will be taught the postulates of quantum mechanics and the application of quantum mechanical ideas in some simple systems such as particle in a box, rigid rotor, simple harmonic oscillator etc. In spectroscopy unit, rotational, vibrational, Raman, electronic, spin resonance, and electronic spectroscopy will be introduced.

Course Outcomes (CO)

Students will be able to	
CO 1	Explain the basic concepts of quantum chemistry and its applications on different chemical systems
CO 2	Explain the basic concept of molecular spectroscopy
CO 3	Explain the principles and applications of different types of spectroscopies
CO 4	Explain the mechanism of photochemical reactions with applications

Syllabus

Quantum Chemistry

- Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.
- Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.
- Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.
  (20 Lectures)

Molecular Spectroscopy:

- Interaction of electromagnetic radiation with molecules and various types of spectra; Born- Oppenheimer approximation.
- Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.
- Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands,

degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

- Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.
- Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.
- Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.
- Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.
  (24 Lectures)

Photochemistry

- Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemicalreactions in biochemical processes, photostationary states, chemiluminescence.
  (16 Lectures)

Reference Books:

1. Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
3. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
4. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
5. Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015).

CC XII LAB: PHYSICAL CHEMISTRY- V LAB

60 Lectures

UV/Visible spectroscopy

- Study the 200-500 nm absorbance spectra of KMnO4 and K2Cr2O7 (in 0.1 M H2SO4) and determine the λmax values. Calculate the energies of the two transitions in different units (J molecule-1, kJ mol^{-1}, cm^{-1}, eV).
- Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of K2Cr2O7.
- Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Colorimetry

- Verify Lambert-Beer's law and determine the concentration of CuSO4/ KMnO4/ K2Cr2O7 in a solution of unknown concentration
- Determine the concentrations of KMnO4 and K2Cr2O7 in a mixture.
- Study the kinetics of iodination of propanone in acidic medium.
- Determine the amount of iron present in a sample using 1,10-phenathroline.
- Determine the dissociation constant of an indicator (phenolphthalein).
- Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.
- Analysis of the given vibration-rotation spectrum of HCl(g)

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

CO- PO & PSO Correlation

Course Name: CHEMISTRY CC- XII: PHYSICAL CHEMISTRY- V													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1				2					2				
CO2	1		3						1		1		
CO3	2		2						1		1		
CO4	2								1				1

Programme	**BSc Honours**	**Semester**	**VI**
Name of the Course:	**Inorganic Chemistry- IV**	**Course Code:**	**SOS-B-CH-601**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

The unit on reaction mechanism is included for the students to get acquainted with the kinetic and thermodynamic factors governing the reaction path and stability of inorganic compounds. Organometallic compounds are introduced so as to apprise students about the importance of metal carbon bond to form complexes and their application as catalysts. Students are expected to learn factors leading to stability of organometallic compounds, their synthesis, reactivity and uses. Qualitative inorganic analysis is included to give students an idea and hands on experience of application of inorganic chemistry. Students should learn how differential reactivity under different conditions of pH can be used to identify variety of ions in a complex mixture. Experiments related to synthesis and characterization of coordination compounds is included to supplement their theoretical knowledge.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand how ligand substitution and redox reactions take place in coordination complexes.
CO 2	Gain knowledge about organometallic compounds, comprehend their bonding, stability, reactivity and uses..
CO 3	Familiar with the variety of catalysts based on transition metals and their application in industry
CO 4	Learn inorganic reaction mechanisms, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution.
CO 5	Understand the catalytic reaction and their applications and catalysis of organometallic compounds.

Syllabus

Theoretical Principles in Qualitative Analysis (H2S Scheme)

- Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.
  (10 Lectures)

Organometallic Compounds

- Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands.
- Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear

carbonyls of Cr, Mn, Fe, Co and Ni using VBT. □-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

- Zeise's salt: Preparation and structure, evidence of synergic effect and comparison of synergic effect with that in carbonyls.
- Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicenter bonding in these compounds. Role of triethylaluminium in polymerization of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.
- Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

(22 Lectures)

Reaction Kinetics and Mechanism

- Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

(18 Lectures)

Catalysis by Organometallic Compounds

- Study of the following industrial processes and their mechanism:
  - Alkene hydrogenation (Wilkinson's Catalyst)
  - Hydroformylation (Co salts)
  - Wacker Process
  - Synthetic gasoline (Fischer Tropsch reaction)
  - Synthesis gas by metal carbonyl complexes

(10 Lectures)

Reference Books:

1. Vogel, A.I. Qualitative Inorganic Analysis, Longman, 1972
2. Svehla, G. Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall, 1996-03-07.
3. Cotton, F.A. G.; Wilkinson & Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.;
4. Wiley India,
5. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson,2006.
6. Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005
7. Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry3rd Ed., John Wiley and Sons, NY, 1994.
8. Greenwood, N.N. & Earnshaw, A. Chemistry of the Elements, Elsevier 2nd Ed, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
9. Lee, J.D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008.
10. Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
11. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press,

1994.
12. Basolo, F. & Person, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.
13. Purcell, K.F. & Kotz, J.C., Inorganic Chemistry, W.B. Saunders Co. 1977
14. Miessler, G. L. & Donald, A. Tarr, Inorganic Chemistry 4th Ed., Pearson, 2010.
15. Collman, James P. et al. Principles and Applications of Organotransition Metal Chemistry. Mill Valley, CA: University Science Books, 1987.
16. Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals. j
17. New York, NY: John Wiley, 2000.
18. Spessard, Gary O., &Gary L. Miessler. Organometallic Chemistry. Upper Saddle River, NJ: Prentice-Hall, 1996.

CC- XIII LAB: INORGANIC CHEMISTRY-IV LAB
60 Lectures

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

- CO32-, NO2-, S2-, SO32-,S2O32-, CH3COO-, F-,Cl-, Br-, I-, NO3-, BO33-, C2O42-, PO43-, NH4+, K+, Pb2+, Cu2+, Cd2+, Bi3+, Sn2+, Sb3+, Fe3+, Al3+,, Cr3+, Zn2+, Mn2+, Co2+, Ni2+, Ba2+,Sr2+, Ca2+, Mg2+
- Mixtures should preferably contain one interfering anion, or insoluble component (BaSO4, SrSO4, PbSO4, CaF2 or Al2O3)or combination of anions e.g. CO32-and SO32-, NO2- and NO3-, Cl- and Br-, Cl- and I-, Br-and I-, NO3- and Br-, NO3- and I-.
- Spot tests should be done whenever possible.

Spectrophotomerty

- Measurement of 10 Dq by spectrophotometric method
- Verification of spectrochemical series.

Complex Synthesis

- Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs thermodynamic factors.
- Preparation of acetylacetanato complexes of Cu2+/Fe3+. Find the λmax of the complex.
- Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

Reference Books

1. Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla.
2. Marr & Rockett Inorganic Preparations.

CO- PO & PSO Correlation

Course Name: CHEMISTRY CC- XIII: INORGANIC CHEMISTRY-IV													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2								1				
CO2	2								1				
CO3	1				1				1				
CO4	2				1				1				
CO5	2								2				

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme	**BSc Honours**	**Semester**	**VI**
Name of the Course:	**Organic Chemistry- V**	**Course Code:**	**SOS-B-CH-602**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

The course introduces the learner to various tools and techniques for identifying and characterizing the organic compounds through their interactions with electromagnetic radiation viz. UV-Visible, IR and NMR spectroscopy. This course also deals with some classes of organic compounds finding applications in everyday life namely, polymers, dyes, and pharmaceutical compounds. The chemistry of these compounds in general will be explained through naturally occurring and synthetic compounds.

Course Outcomes (CO)

Students will be able to	
CO 1	Gain insight into the basic principles of UV, IR and NMR spectroscopic techniques
CO 2	Use spectroscopic techniques to determine structure and stereochemistry of known and unknown compounds
CO 3	Develop a sound understanding of the structure of Pharmaceutical Compounds
CO 4	Understand the importance of different classes of drugs and their applications for treatment of various diseases
CO 5	Learn the chemistry of natural and synthetic polymers including fabrics and rubbers
CO 6	Understand the chemistry of biodegradable and conducting polymers and appreciate the need of biodegradable polymers with emphasis on basic principles
CO 7	Learn the theory of colour and constitution as well as the chemistry of dyeing; Know applications of various types of dyes including those in foods and textiles

Syllabus

Organic Spectroscopy

- General principles Introduction to absorption and emission spectroscopy.
- UV Spectroscopy: Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.
- IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.

- NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpetation of NMR spectra of simple compounds.
- Applications of IR, UV and NMR for identification of simple organic molecules.
  (24 Lectures)

Carbohydrates

- Occurrence, classification and their biological importance.
- Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani- Fischer synthesis and Ruff degradation;
- Disaccharides – Structure elucidation of maltose, lactose and sucrose. Polysaccharides – Elementary treatment of starch, cellulose and glycogen.
  (16 Lectures)

Dyes

- Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing;
- Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet; Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes – structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.
  (8 Lectures)

Polymers

- Introduction and classification including di-block, tri-block and amphiphilic polymers; Number average molecular weight, Weight average molecular weight, Degree of polymerization, Polydispersity Index.
- Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene).
- Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives; Introduction to liquid crystal polymers; Biodegradable and conducting polymers with examples.
  (12 Lectures)

Reference Books:

1. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
2. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Billmeyer, F. W. Textbook of Polymer Science, John Wiley & Sons, Inc.

4. Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. Polymer Science, New Age International (P) Ltd. Pub.
5. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
8. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Prakashan (2010).
9. Kemp, W. Organic Spectroscopy, Palgrave

CC- XIV LAB: ORGANIC CHEMISTRY-IV LAB

60 Lectures

- Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols etc.
- Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
- Preparation of sodium polyacrylate.
- Preparation of urea formaldehyde.
- Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.
- Preparation of methyl orange.

Reference Books:

1. Vogel, A.I. Quantitative Organic Analysis, Part 3, Pearson (2012).
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
4. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
5. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

CO- PO & PSO Correlation

Course Name: CHEMISTRY CC- XIV: ORGANIC CHEMISTRY-IV													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1		2		1				1				1
CO2	2		2						1		1		
CO3	2				1				1				1
CO4	2							1	1				
CO5	1								1				
CO6	2						2		2				
CO7	1								1				

Programme :	**B.Sc. Honours**	**Semester :**	**V**
Name of the Course:	**DSE I: Applications of computers in chemistry**	**Course Code:**	**SOS-B-CH503 (i)**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

This course intends to make learners familiar with basics of computer language, computer programming, handling of experimental data, curve fitting etc to analyze experimental results. This basic knowledge will help the students to perform and interpret results of various chemistry practical's. After the completion of this course, it will help the student to interpret laboratory data, curve fitting of experimental work, also perform quantum mechanical calculations for various molecular models.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand the basics of computer language & computer programming
CO 2	Learn the Numerical methods of data handling
CO 3	Understand the interpretation of laboratory data & curve fitting of experimental work
CO 4	Perform quantum mechanical calculations for various molecular models

Syllabus

Basics:

- Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

Numerical methods:

- Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton-Raphson method, Binary bisection and Regula-Falsi.
- Differential calculus: Numerical differentiation.
- Integral calculus: Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values.
- Simultaneous equations: Matrix manipulation: addition, multiplication. Gauss-Siedal method.
- Interpolation, extrapolation and curve fitting: Handling of experimental data.

Conceptual background of molecular modeling

- Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods.

Reference Books:

1. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
2. Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001) 487 pages.
3. Noggle, J. H. Physical chemistry on a Microcomputer. Little Brown & Co. (1985).
4. Venit, S.M. Programming in BASIC: Problem solving with structure and style. Jaico Publishing House: Delhi (1996).

APPLICATIONS OF COMPUTERS IN CHEMISTRY LAB

- Computer programs based on numerical methods forRoots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid).
- Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).
- Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values.
- Matrix operations. Application of Gauss-Siedel method in colourimetry.
- Simple exercises using molecular visualization software.

Reference Books:

1. McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).
2. Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005).
3. Steiner, E. The Chemical Maths Book Oxford University Press (1996).
4. Yates, P. Chemical Calculations. 2nd Ed. CRC Press (2007).
5. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
6. Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001) 487 pages.
7. Noggle, J. H. Physical Chemistry on a Microcomputer. Little Brown & Co. (1985).
8. Venit, S.M. Programming in BASIC: Problem solving with structure and style. Jaico Publishing House: Delhi (1996).

CO- PO & PSO Correlation

Course Name: APPLICATIONS OF COMPUTERS IN CHEMISTRY													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1			1		3								1
CO2	1			1					1				
CO3	1		1						1				
CO4	1				2				1				

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**V**
Name of the Course:	**DSE I: Novel Inorganic Solids**	**Course Code:**	**SOS-B-CH503 (ii)**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

This introductory course intends to make learners familiar with a wide variety of technologically important and emerging materials. It will prepare the learners for studying materials further at the master's level. Prior completion of one introductory UG level course on inorganic and physical chemistry will be essential.

Course Outcomes (CO)

Students will be able to	
CO 1	Know about a wide variety of technologically important and emerging materials
CO 2	Understand the various methods of synthesis of inorganic materials and their modifications
CO 3	Understand various method of synthesis of composites, polymers, engineering and nanomaterials
CO 4	Learn applications of various materials of technological importance

Syllabus

Synthesis and modification of inorganic solids:

- Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods. (10 Lectures)

Inorganic solids of technological importance:

- Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments.
- Molecular material and fullerides, molecular materials & chemistry – one-dimensional metals, molecular magnets, inorganic liquid crystals. (10 Lectures)

Nanomaterials:

- Overview of nanostructures and nanomaterials: classification.
- Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires. Bio-inorganic nanomaterials, DNA and nanomaterials, natural and antisical nanomaterials, bionano composites. (10 Lectures)

Introduction to engineering materials for mechanical construction:

- Composition, mechanical and fabricating characteristics and applications of various

types of cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials.
(10 Lectures)

Composite materials:

- Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applicationsof composites.
(10 Lectures)

Speciality polymers:

- Conducting polymers - Introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrole, applications of conducting polymers, Ion-exchange resins and their applications. Ceramic & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications.
(10 Lectures)

Reference Books:

1. Shriver & Atkins. Inorganic Chemistry, Peter Alkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)
2. Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry.
3. Frank J. Ovens, Introduction to Nanotechnology

NOVEL INORGANIC SOLIDS LAB

60 Lectures

- Determination of cation exchange method
- Determination of total difference of solids.
- Synthesis of hydrogel by co-precipitation method.
- Synthesis of silver and gold metal nanoparticles.

Reference Book:

1. Fahan, Materials Chemistry, Springer (2004).

CO- PO & PSO Correlation

Course Name: NOVEL INORGANIC SOLIDS													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1		2						1				1
CO2	2			1					1				
CO3	1						1		1				
CO4	2						1		1				

Programme :	**B.Sc. Honours**	**Semester :**	**V**
Name of the Course:	**DSE II: Analytical Methods in Chemistry**	**Course Code:**	**SOS-B-CH504 (i)**
Credits :	**6**	**No of Hours :**	**40**
Max Marks :	**150**		

Course Description:

This is an elective course designed to complement the needs of students who wish to learn more about the qualitative/quantitative characterization and separation techniques. The content of this course aims to cover some of the widely used instrumental techniques for characterization of samples. Experiments included aim at giving students hands on experience using different instrumental techniques and chemical analysis.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand the concept of sampling, errors, precision and accuracy
CO 2	Understand the choice of various analytical techniques used for qualitative and quantitative characterization of samples
CO 3	Understand the principles and instrumentation of various optical methods of analysis
CO 4	Learn the thermal and electroanalytical methods of analysis
CO 5	Explain the principles of separation techniques

Syllabus

Qualitative and quantitative aspects of analysis:

- Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.
  (5 Lectures)

Optical methods of analysis:

- Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.
- UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;
- Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.
- Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.
- Structural illustration through interpretation of data, Effect and importance of isotope substitution.
- Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of

background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.
(25 Lectures)

Thermal methods of analysis:

- Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.
  (5 Lectures)

Electroanalytical methods:

- Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.
  (10 Lectures)

Separation techniques:

- Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation.
- Technique of extraction: batch, continuous and counter current extractions.
- Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.
- Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange.
- Development of chromatograms: frontal, elution and displacement methods.
- Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.
- Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiralchromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis.
  (15 Lectures)

Reference Books:

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.

6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
8. Ditts, R.V. Analytical Chemistry – Methods of separation.

ANALYTICAL METHODS IN CHEMISTRY LAB
60 Lectures

Separation Techniques
- Chromatography: Separation of mixtures
  - Paper chromatographic separation of Fe3+, Al3+, and Cr3+.
  - Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values.
  - Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.
  - Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

Solvent Extractions:
- To separate a mixture of Ni2+ & Fe2+ by complexation with DMG and extracting the Ni2+- DMG complex in chloroform, and determine its concentration by spectrophotometry.
- Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.
- Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
- Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques.

Analysis of soil:
- Determination of pH of soil.
- Total soluble salt
- Estimation of calcium, magnesium, phosphate, nitrate
- Ion exchange:
  - Determination of exchange capacity of cation exchange resins and anion exchange resins.
- Separation of metal ions from their binary mixture.
- Separation of amino acids from organic acids by ion exchange chromatography.

Spectrophotometry
- Determination of pKa values of indicator using spectrophotometry.
- Structural characterization of compounds by infrared spectroscopy.
- Determination of dissolved oxygen in water.
- Determination of chemical oxygen demand (COD).
- Determination of Biological oxygen demand (BOD).
- Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by

Job's method.

Reference Books:

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
8. Ditts, R.V. Analytical Chemistry – Methods of separation.

CO- PO & PSO Correlation

Course Name: ANALYTICAL METHODS IN CHEMISTRY													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1			2				1	1				1
CO2	1		2						1		1		
CO3	2		2								1		
CO4	2		2						1		1		
CO5	3		1						1				

Programme :	**B.Sc. Honours**	**Semester :**	**V**
Name of the Course:	**DSE II: Green Chemistry**	**Course Code:**	**SOS-B-CH504 (ii)**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

The learners will be taught about the emerging discipline of green chemistry particularly to differentiate as to how the principles of green chemistry may be applied to organic synthesis. Apart from introducing learners to the principles of green chemistry, this course will make them conversant with applications of green chemistry to organic synthesis. Students will be prepared for taking up entry level jobs in the chemical industry. They also will have the option of studying further in the area.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand the principles of green chemistry
CO 2	Understand the methods and requirements for designing the process of green synthesis
CO 3	Apply the concept of green chemistry to some reactions and analyze the benefits
CO 4	Understand the scope of Green Chemistry for future

Syllabus

Introduction to Green Chemistry

- What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

(4 Lectures)

Principles of Green Chemistry and Designing a Chemical synthesis

- Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

(24 Lectures)

Examples of Green Synthesis/ Reactions

- Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide,

acetaldehyde, disodium iminodiacetate (alternative to Strecker synthesis), citral, ibuprofen, paracetamol, furfural.

- Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols).
- Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation.
- Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2- dihydrotriazine derivatives; benzimidazoles.
- Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.
- Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayan", a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.

(24 Lectures)

Future Trends in Green Chemistry

- Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development.

(8 Lectures)

Reference Books:

1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry,
2. Anamalaya Publishers (2005).
3. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
4. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
5. M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
6. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

GREEN CHEMISTRY LAB

60 Lectures

Safer starting materials

- The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch.
- Effect of concentration on clock reaction
- Effect of temperature on clock reaction. (if possible)

Using renewable resources

- Preparation of biodiesel from vegetable oil.

Avoiding waste

- Principle of atom economy.
- Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.
- Preparation of propene
- The other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

Use of enzymes as catalysts

- Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide
- Alternative Green solvents
- Diels Alder reaction in water
- Reaction between furan and maleic acid in water and at room temperature rather than in benzene and reflux.
- Extraction of D-limonene from orange peel using liquid CO2 prepared form dry ice.
- Mechanochemical solvent free synthesis of azomethines
- Co-crystal controlled solid state synthesis (C2S3) of N-organophthalimide using phthalic anhydride and 3-aminobenzoic acid.

Alternative sources of energy

- Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
- Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Reference Books:

1. Anastas, P.T & Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. Introduction to Green Chemistry, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore CISBN 978-93-81141-55-7 (2013).
5. Cann, M.C. & Connelly, M. E. Real world cases in Green Chemistry, American Chemical Society (2008).
6. Cann, M. C. & Thomas, P. Real world cases in Green Chemistry, American Chemical Society (2008).
7. Pavia, D. L. Lamponan, G. H. &Kriz, G.S. W B Introduction to organic laboratory

CO- PO & PSO Correlation

Course Name: GREEN CHEMISTRY													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2						1	1	2				
CO2	2		1				1		1				
CO3	2		1						1				
CO4	1						1	1	1				

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. (Honours)**	**Semester :**	**VI**
Name of the Course:	**DSE III: Polymer Chemistry**	**Course Code:**	**SOS-B-CH603 (i)**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

This is an introductory level course in polymer chemistry. The aim of the course is to introduce the theory and applications of polymer chemistry to the students. Some industrially important polymers and conducting polymers, a promising class of polymeric materials for next generation devices will also be introduced in this course.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand the fundamentals and classifications of polymers and their basic properties
CO 2	Understand preparation, structure and properties of some industrially important and technologically promising polymers
CO 3	Understand the kinetics of polymerization, molecular weight determination of polymers and polymer solutions
CO 4	Understand the physical, thermal and mechanical properties of copolymers and conducting polymers

Syllabus

Introduction and history of polymeric materials:

- Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.
  (4 Lectures)

Functionality and its importance:

- Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi- functional systems, Poly-functional systems.
  (8 Lectures)

Kinetics of Polymerization:

- Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.
  (8 lectures)

Crystallization and crystallinity:

- Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.
  (4 Lectures)
- Nature and structure of polymers-Structure Property relationships.
  (2 Lectures)
- Determination of molecular weight of polymers (Mn, Mw, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight

distribution and its significance.
- Polydispersity index.
  (8 Lectures)
- Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).
  (8 Lectures)
- Polymer Solution – Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.
  (8 Lectures)

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).
- Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and relatedpolymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,
- Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].
  (10 Lectures)

Reference Books:
1. Seymour's Polymer Chemistry, Marcel Dekker, Inc.
2. G. Odian: Principles of Polymerization, John Wiley.
3. F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
4. P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
5. R.W. Lenz: Organic Chemistry of Synthetic High Polymers.

POLYMER CHEMISTRY LAB
60 Lectures
Polymer synthesis
- Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).

Purification of monomer
- Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)
- Preparation of nylon 66/6

- Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein

Preparation of IPC
- Purification of IPC
- Interfacial polymerization
- Redox polymerization of acrylamide

- Precipitation polymerization of acrylonitrile
- Preparation of urea-formaldehyde resin
- Preparations of novalac resin/resold resin.
- Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

- Determination of molecular weight by viscometry:
- Polyacrylamide-aq.NaNO2 solution(Poly vinyl proplylidine (PVP) in water
- Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
- Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
- Testing of mechanical properties of polymers.
- Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

- Estimation of the amount of HCHO in the given solution by sodium sulphite method
- Instrumental Techniques
- IR studies of polymers
- DSC analysis of polymers
- Preparation of polyacrylamide and its electrophoresis

*at least 7 experiments to be carried out.

Reference Books:

1. Malcohm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.
2. Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003)
3. Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)
4. Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)
5. Petr Munk and Tejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002)
6. L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005)
7. Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005)
8. Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

CO- PO & PSO Correlation

Course Name: POLYMER CHEMISTRY													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2						1		1				
CO2	2						2		1				1
CO3	3				1								
CO4	2				1				1				

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**VI**
Name of the Course:	**DSE III: Research Methodology for Chemistry**	**Course Code:**	**SOS-B-CH603 (ii)**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

This course is introduced to impart knowledge about the basic concepts of research and to provide a road map for conducting research Students are expected to identify, explain and apply basic concepts of research; acquire information, recognize various issues related to research and to learn instrumental methods required for research in chemistry**.**

Course Outcomes (CO)

Students will be able to	
CO 1	Understand the process of literature survey and various aspects related to it
CO 2	Understand the ways of representing scientific writings
CO 3	Understand safety and handling of chemicals
CO 4	Construct a rational research proposal to generate fruitful output in terms of publications and patents in the field of chemical sciences
CO 5	Understand the analysis and representation of data

Syllabus

Literature Survey:

- Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.
- Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups andcommunities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus.
- Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information.

(20 Lectures)

Methods of Scientific Research and Writing Scientific Papers:

- Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation.
- Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.

(20 Lectures)

Chemical Safety and Ethical Handling of Chemicals:

- Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.
  (12 Lectures)

Data Analysis

- The Investigative Approach: Making and Recording Measurements. SI Units and their use.Scientific method and design of experiments.
- Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, r and its abuse. Basic aspects of multiple linear regression analysis.
  (13 Lectures)

Electronics

- Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.
  (10 Lectures)

Reference Books

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011)
2. Practical skills in chemistry. 2nd Ed. Prentice-Hall, Harlow.
3. Hibbert, D. B. & Gooding, J. J. (2006) Data analysis for chemistry. Oxford University Press.
4. Topping, J. (1984) Errors of observation and their treatment. Fourth Ed., Chapman Hall, London.
5. Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2007) Chapters 3-5.
6. Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis. Cambridge Univ. Press (2001) 487 pages.
7. Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
8. OSU safety manual 1.01.

CO- PO & PSO Correlation

Course Name: RESEARCH METHODOLOGY FOR CHEMISTRY													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1		1							1				
CO2		2							1				
CO3				1								1	
CO4				1					1				
CO5	1		1						1				

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**VI**
Name of the Course:	**DSE III: Molecular modelling & drug design**	**Course Code:**	**SOS-B-CH603 (iii)**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

The course introduces students to the basic principles of computer assisted drug design, modelling and the important theoretical concepts and programming. Students will be able to identify basic components of computer and programming as applied to computer assisted design and modelling of molecules.

Course Outcomes (CO)

Students will be able to	
CO 1	Identify basic components of modelling of molecules
CO 2	Understand the basic principles of computer assisted drug design
CO 3	Understand various computer simulation methods to analyze the properties of the molecules
CO 4	Learn molecular dynamics & monte-carlo simulation methods

Syllabus

Introduction to Molecular Modelling:

- Introduction. Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.
  (10 Lectures)

Force Fields:

- Fields. Bond Stretching. Angle Bending. Introduction to nonbonded interactions. Electrostatic interactions. van der Waals Interactions. Hydrogen bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.
  (14 Lectures)

Energy Minimization and Computer Simulation:

- Minimization and related methods for exploring the energy surface. Non-derivative method, First and second order minimization methods. Computer simulation methods. Simple thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors.
  (12 Lectures)

Molecular Dynamics & Monte Carlo Simulation:

- Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers.
  (12 Lectures)

Structure Prediction and Drug Design:

- Structure prediction - Introduction to comparative Modeling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design,
- Drug Discovery – Chemoinformatics – QSAR.
  (12 Lectures)

Reference Books:

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

MOLECULA MODELLING & DRUG DESIGN LAB

60 Lectures

- Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds.
  (a) Perform a conformational analysis of butane.
  (b) Determine the enthalpy of isomerization of cis and trans 2-butene.
- Visualize the electron density and electrostatic potential maps for LiH, HF, N2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules.
  (a) Relate the charge on the hydrogen atom in hydrogen halides with their acid character.
  (b) Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.
- Compare the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Note the dipole moment of each molecule.
  - Show how the shapes affect the trend in boiling points: (118 °C, 100 °C, 108 °C, 82 °C, respectively).
- Build and minimize organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound: (a) alkyl halide (b) aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester(j) amide.
- Determine the heat of hydration of ethylene. (b) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
- Arrange 1-hexene, 2-methyl-2-pentene, (E)-3-methyl-2-pentene, (Z)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.
- Compare the optimized bond angles H2O, H2S, H2Se.
- Compare the HAH bond angles for the second row dihydrides and compare with the results from qualitative MO theory.

Note: Software: ChemSketch, ArgusLab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, or any similar software.

Reference Books:

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

CO- PO & PSO Correlation

Course Name: MOLECULAR MODELLING & DRUG DESIGN													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1								1				
CO2	1		2						1				
CO3			2									2	
CO4	1		2									2	

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**VI**
Name of the Course:	**DSE III: Industrial Chemicals and Environment**	**Course Code:**	**SOS-B-CH603 (iv)**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

This course provides an introduction to the various industrial gases and inorganic chemicals, their manufacturing processes, applications, storage and the hazards of handling them. Contribution of these industrial chemicals towards air and water pollution and their effects on living organisms and the environment has also been covered. Students are also expected to learn about metallurgy, energy generation industry and the pollution threat they pose. This course also discusses about management of the different kinds of wastes, their safe disposal and the importance of practicing green chemistry in chemical industry.

Course Outcomes (CO)

Students will be able to	
CO 1	Learn about the manufacture, applications and safe ways of storage and handling gaseous and inorganic industrial chemicals
CO 2	Know about industrial metallurgy and the energy generation industry
CO 3	Learn about environmental pollution by various gaseous, liquid wastes and nuclear wastes and their effects on living beings
CO 4	Learn about industrial waste management, their safe disposal and the importance of environment friendly “green chemistry” in chemical industry

Syllabus

Industrial Gases and Inorganic Chemicals

- Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.
- Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.
  (10 Lectures)

Industrial Metallurgy

- Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.
  (4 Lectures)

Environment and its segments

- Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.
- Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions

in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

- Pollution by SO2, CO2, CO, NOx, H2S and other foul smelling gases. Methods of estimation of CO, NOx, SOx and control procedures.
- Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.
- Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.
- Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.
- Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.
  (30 Lectures)

Energy & Environment

- Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.
- Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.
  (10 Lectures)

Biocatalysis

- Introduction to biocatalysis: Importance in “Green Chemistry” and Chemical Industry.
  (6 Lectures)

Reference Books:

1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel’s Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
4. S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
5. K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.
7. S.E. Manahan, Environmental Chemistry, CRC Press (2005).
8. G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
9. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

INDUSTRIAL CHEMICALS & ENVIRONMENT LAB

- Determination of dissolved oxygen in water.
- Determination of Chemical Oxygen Demand (COD)
- Determination of Biological Oxygen Demand (BOD)
- Percentage of available chlorine in bleaching powder.
- Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO3 and potassium chromate).
- Estimation of total alkalinity of water samples (CO32-, HCO3-) using double titration method.
- Measurement of dissolved CO2.
- Study of some of the common bio-indicators of pollution.
- Estimation of SPM in air samples.
- Preparation of borax/ boric acid.

Reference Books:

1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
4. S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
5. K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.

CO- PO & PSO Correlation

Course Name: INDUSTRIAL CHEMICALS AND ENVIRONMENT													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1				2				1	1			
CO2	1				2				1	2			
CO3	1						2		1				1
CO4	1						2			1			

Programme :	**B.Sc. Honours**	**Semester :**	**VI**
Name of the Course:	**DSE IV: Inorganic Materials of Industrial Importance**	**Course Code:**	**SOS-B-CH604 (i)**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

To learn the synthetic process, properties and the utility of the industrially important inorganic materials (such as silicates, ceramics, cements, fertilizers, paints, batteries, alloys and explosives). To provide opportunity to learn some of the industrial process such as surface coating and catalysis in relevant to industry where heterogeneous catalysis dominates. Experiments are aimed at helping learners acquire hands on experience in qualitative and quantitative analysis of the inorganic materials which are basically manufactured in chemical industries. To learn some industrial techniques such as surface coating etc**.**

Course Outcomes (CO)

Students will be able to	
CO 1	Learn the basic foundation of industrial inorganic chemistry
CO 2	Understand qualitative and quantitative chemical analysis
CO 3	Analyze inorganic materials which are used in our daily life and gain insight of the industrial processes of their manufacturing
CO 4	Understand the manufacturing process of various materials, their variety, properties and applications

Syllabus

Silicate Industries

- Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.
- Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.
- Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.
  (16 Lectures)

Fertilizers:

- Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium

chloride, potassium sulphate.
(8 Lectures)

Surface Coatings:

- Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.
  (10 Lectures)

Batteries:

- Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.
  (6 Lectures)

Alloys:

- Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.
  (10 Lectures)

Catalysis:

- General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.
- Phase transfer catalysts, application of zeolites as catalysts.
  (6 Lectures)

Chemical explosives:

- Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

(4 Lectures)

Reference Books:

1. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.

5. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
7. B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut

INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE LAB

- Determination of free acidity in ammonium sulphate fertilizer.
- Estimation of Calcium in Calcium ammonium nitrate fertilizer.
- Estimation of phosphoric acid in superphosphate fertilizer.
- Electroless metallic coatings on ceramic and plastic material.
- Determination of composition of dolomite (by complexometric titration).
- Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
- Analysis of Cement.
- Preparation of pigment (zinc oxide).

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
- B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut

CO- PO & PSO Correlation

Course Name: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		1		1	1	1		2				2
CO2	1		2	2	1			1		2	1	1	
CO3		1	1	1			2			1	1		
CO4	1		1	2	1	1			2		1	1	1

Programme :	**B.Sc. Honours**	**Semester :**	**VI**
Name of the Course:	**DSE IV: Instrumental Methods of Chemical Analysis**	**Course Code:**	**SOS-B-CH604 (ii)**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

Students shall be introduced to the fundamental concepts/theory and application of different analytical techniques, as applied to chemistry. Students shall be able to explain the theoretical basis of different analytical techniques, identify the experimental requirements and compare/analyze the data/results thereof.

Course Outcomes (CO)

Students will be able to	
CO 1	Explain the theoretical basis of different analytical techniques
CO 2	Identify the experimental requirements and compare & analyze the data & their results
CO 3	Understand the basics of molecular spectroscopic methods and instrumentation
CO 4	Understand various separation techniques, principles & interpret the data/ result

Syllabus

Introduction to spectroscopic methods of analysis:

- Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.
  (4 Lectures)

Molecular spectroscopy:

- Infrared spectroscopy: Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.
- UV-Visible/ Near IR – emission, absorption, fluorescence and photoaccoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoaccoustic, fluorescent tags).
  (16 Lectures)

Separation techniques

- Chromatography: Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.
- Immunoassays and DNA techniques
- Mass spectroscopy: Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).
  (16 Lectures)

Elemental analysis:

- Mass spectrometry (electrical discharges).
- Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence.
- Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).
  (8 Lectures)

NMR spectroscopy

- Principle, Instrumentation, Factors affecting chemical shift, Spin- coupling, Applications.
  (4 Lectures)

Electroanalytical Methods

- Potentiometry & Voltammetry
- Radiochemical Methods
- X-ray analysis and electron spectroscopy (surface analysis)
  (12 Lectures)

Reference Books:

1. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).
2. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.
3. P.W. Atkins: Physical Chemistry.
4. G.W. Castellan: Physical Chemistry.
5. C.N. Banwell: Fundamentals of Molecular Spectroscopy.
6. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
7. W.J. Moore: Physical Chemistry.

INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS LAB

- Safety Practices in the Chemistry Laboratory
- Determination of the isoelectric pH of a protein.
- Titration curve of an amino acid.
- Determination of the void volume of a gel filtration column.
- Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
- Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
- IR Absorption Spectra (Study of Aldehydes and Ketones)
- Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
- Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbontetrachloride)
- Separation of Carbohydrates byHPLC
- Determination of Caffeine in Beverages byHPLC
- Potentiometric Titration of a Chloride-Iodide Mixture
- Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple
- Nuclear Magnetic Resonance
- Use of fluorescence to do “presumptive tests” to identify blood or other body fluids.
- Use of “presumptive tests” for anthrax or cocaine
- Collection, preservation, and control of blood evidence being used for DNA testing
- Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome)
- Use of sequencing for the analysis of mitochondrial DNA
- Laboratory analysis to confirm anthrax or cocaine
- Detection in the field and confirmation in the laboratory of flammable accelerants or explosives
- Detection of illegal drugs or steroids in athletes
- Detection of pollutants or illegal dumping
- Fibre analysis

At least 10 experiments to be performed.

CO- PO & PSO Correlation

Course Name: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		1		1			1	2	1			1
CO2	1	1		2			1				2	1	1
CO3	1		2		2		1	1	1	1	2	2	
CO4	1	1	2	1	1		1	1	1	1	3		

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**I**
Name of the Course:	**GE Chemistry I**	**Course Code:**	**SOS-B-CH103**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

The course reviews the structure of the atom, which is a necessary pre-requisite in understanding the nature of chemical bonding in compounds. It provides basic knowledge about ionic, covalent and metallic bonding and explains that chemical bonding is best regarded as a continuum between the three cases. It discusses the Periodicity in properties with reference to the s and p block, which is necessary in understanding their group chemistry. The course is also infused with the recapitulation of fundamentals of organic chemistry and the introduction of a new concept of visualizing the organic molecules in a three dimensional space. To establish the applications of these concepts, the classes of alkanes, alkenes, alkynes and aromatic hydrocarbons are introduced. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand Atomic Structure: Review of Bohr's theory and its limitations, Quantum numbers and their types.
CO 2	Understand Chemical Bonding and Molecular Structure, resonance and resonating structures in various inorganic and organic compounds
CO 3	Gain knowledge about Fundamentals of Organic Chemistry, Electronic Displacements & effect and cleavage of Bonds
CO 4	Understand about Stereochemistry, Geometrical and Optical isomerism, properties & nomenclature
CO 5	Understand Aliphatic Hydrocarbons and their types physical and chemical properties

Syllabus

Atomic Structure

- Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.
- What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms).

- Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.
(14 Lectures)

Chemical Bonding and Molecular Structure

- Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.
- Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.
- Concept of resonance and resonating structures in various inorganic and organic compounds.
- MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+. Comparison of VB and MO approaches.
(16 Lectures)

Fundamentals of Organic Chemistry

- Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.
- Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.
- Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.
(8 Lectures)

Stereochemistry

- Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).
(10 Lectures)

Aliphatic Hydrocarbons

- Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.
- Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution:

Halogenation.

- Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.
- Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.
- Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. KMnO4.
  (12 Lectures)

Reference Books:

1. J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.
2. F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
3. Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley.
4. James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
5. T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
6. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
7. E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.
8. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
9. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
10. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand

GE- 1 LAB: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

60 Lectures

Volumetric Analysis

- Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
- Estimation of oxalic acid by titrating it with KMnO4.
- Estimation of water of crystallization in Mohr's salt by titrating with KMnO4.
- Estimation of Fe(II) ions by titrating it with K2Cr2O7 using internal indicator.
- Estimation of Cu(II) ions iodometrically using Na2S2O3.

Organic Chemistry

- Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
- Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)
- Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography

- Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books:

1. Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
3. Textbook of Practical Organic Chemistry, A.I. Vogel, Prentice Hall, 5th edition.
4. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

CO- PO & PSO Correlation

Course Name: GE- I: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1			1					2				1
CO2	2			1					2		1		1
CO3	2			1					2				1
CO4	2		1	1					2	1			
CO5	2		1						1	1		1	

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**II**
Name of the Course:	**GE Chemistry II**	**Course Code:**	**SOS-B-CH-203**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

The objective of this paper is to develop basic understanding of the chemical energetics, laws of thermodynamics, chemical and ionic equilibrium. It provides basic understanding of the behaviour of electrolytes and their solutions. It acquaints the students with the functional group approach to study organic chemistry. To establish applications of this concept structure, methods of preparation and reactions for the following classes of compounds: Aromatic hydrocarbons, alkyl and aryl halides, alcohols, phenols and ethers, aldehydes and ketones are described. This course helps the students to relate the structure of an organic compound to its physical and chemical properties.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand laws of thermodynamics and establish the concepts of chemical energetics theoretically and experimentally
CO 2	Acquire the basic knowledge of Ionic Equilibria & Buffer solution and compare the theoretical and experimental concepts
CO 3	Understand preparation and properties of Aromatic hydrocarbons and perform synthesis and purification using documented laboratory procedure
CO 4	Understand synthesis and reaction and application of halogen and oxygen containing functional group aliphatic hydrocarbons

Chemical Energetics

- Review of thermodynamics and the Laws of Thermodynamics.
- Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.
- Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

(10 Lectures)

Chemical Equilibrium:

- Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

(8 Lectures)

Ionic Equilibria:

- Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.
(12 Lectures)

Aromatic hydrocarbons

- Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.
- Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).
(8 Lectures)

Alkyl and Aryl Halides

- Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions.
- Preparation: from alkenes and alcohols.
- Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.
- Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.
- Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3).
- Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.
(8 Lectures)

Alcohols, Phenols and Ethers (Upto 5 Carbons)

- Alcohols: Preparation: Preparation of 1o, 2o and 3o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.
- Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO4, acidic dichromate, conc. HNO3). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.
- Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer- Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.
- Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic) (Formaldehye, acetaldehyde, acetone and benzaldehyde)

- Preparation: from acid chlorides and from nitriles.
- Reactions – Reaction with HCN, ROH, NaHSO3, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction. (14 Lectures)

Reference Books:

1. T. W. Graham Solomons: Organic Chemistry, John Wiley and Sons.
2. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
3. I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
4. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
5. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
6. G. M. Barrow: Physical Chemistry Tata McGraw---Hill (2007).
7. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
8. J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
9. B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
10. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

GE-2 LAB: CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I

Thermochemistry

- Determination of heat capacity of calorimeter for different volumes.
- Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
- Determination of enthalpy of ionization of acetic acid.
- Determination of integral enthalpy of solution of salts (KNO3, NH4Cl).
- Determination of enthalpy of hydration of copper sulphate.
- Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic equilibria- pH measurements

- Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
- Preparation of buffer solutions:Sodium acetate-acetic acid; Ammonium chloride-ammonium hydroxide; Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Preparation & Purification of organic compounds

- Preparations: Mechanism of various reactions involved to be discussed. (Recrystallisation, determination of melting point and calculation of quantitative yields to be done)
  - Bromination of Phenol/Aniline
  - Benzoylation of amines/phenols
  - Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

Reference Books

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

CO- PO & PSO Correlation

Course Name: GE- II: CHEMICAL ENERGETICS EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		1	1					2	1		1	1
CO2	2		2	1			1		2	2	1	1	
CO3	3		1						1	2		2	1
CO4	2								2	1		1	

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**III**
Name of the Course:	**GE III**	**Course Code:**	**SOS-B-CH304**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**100**		

Course Description:

To learn the synthetic process, properties and the utility of the industrially important inorganic materials (such as silicates, ceramics, cements, fertilizers, paints, batteries, alloys and explosives). To provide opportunity to learn some of the industrial process such as surface coating and catalysis in relevant to industry where heterogeneous catalysis dominates. Experiments are aimed at helping learners acquire hands on experience in qualitative and quantitative analysis of the inorganic materials which are basically manufactured in chemical industries. To learn some industrial techniques such as surface coating etc**.**

Course Outcomes (CO)

Students will be able to	
CO 1	Understand the basic concepts of Physical Chemistry- solutions, phase rule, conductance and electrochemistry, and establish them experimentally
CO 2	Gain knowledge about carboxylic acid, amines & diazonium salts containing hydrocarbons and their synthetic applications
CO 3	Learn qualitative organic analysis of functional groups using documented laboratory procedure
CO 4	Acquire basic knowledge of natural compounds- proteins & carbohydrates and learn the experimental procedure for determining their properties

Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes.

Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and
sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).

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

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

Electrochemistry
Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data.
Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge.
pH determination using hydrogen electrode and quinhydrone electrode.
Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

Section B: Organic Chemistry-3 (30 Lectures)
Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.
Carboxylic acids and their derivatives
Carboxylic acids (aliphatic and aromatic)
Preparation: Acidic and Alkaline hydrolysis of esters.
Reactions: Hell – Vohlard - Zelinsky Reaction.
Carboxylic acid derivatives (aliphatic): (Upto 5 carbons)
Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion.
Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.
Amines and Diazonium Salts
Amines (Aliphatic and Aromatic): (Upto 5 carbons)
Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.
Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: Preparation: from aromatic amines.

Reactions: conversion to benzene, phenol, dyes.
Amino Acids, Peptides and Proteins:
Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis.

Reactions of Amino acids: ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.

Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C- activating groups and Merrifield solid-phase synthesis.

Carbohydrates:

Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

Reference Books:

11. G. M. Barrow: Physical Chemistry Tata McGraw---Hill (2007).
12. G. W. Castellan: Physical Chemistry 4th Ed. Narosa (2004).
13. J. C. Kotz, P. M. Treichel, J. R. Townsend, General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
14. B. H. Mahan: University Chemistry, 3rd Edn. Narosa (1998).
15. R. H. Petrucci, General Chemistry, 5th Edn., Macmillan Publishing Co.: New York (1985).
16. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
17. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
18. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
19. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman.
20. Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman

GE- III LAB: SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL ORGANIC CHEMISTR-II

60 Lectures

Section A: Physical Chemistry

Distribution

Study of the equilibrium of one of the following reactions by the distribution method:

$I_2(aq) + I^-(aq) \rightleftharpoons I_3^-(aq)$

$Cu^{2+}(aq) + xNH_2(aq) \rightleftharpoons [Cu(NH_3)_x]^{2+}$

Phase equilibria

a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Conductance

i. Determination of cell constant
ii. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
iii. Perform the following conductometric titrations:
Strong acid vs. strong base
Weak acid vs. strong base

Potentiometry

Perform the following potentiometric titrations:
iv. Strong acid vs. strong base
v. Weak acid vs. strong base
vi. Potassium dichromate vs. Mohr's salt

Section B: Organic Chemistry

I Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

II

i) Separation of amino acids by paper chromatography
ii) Determination of the concentration of glycine solution by formylation method.
iii) Titration curve of glycine
iv) Action of salivary amylase on starch
v) Effect of temperature on the action of salivary amylase on starch.
vi) Determination of the saponification value of an oil/fat.
vii) Determination of the iodine value of an oil/fat
viii) Differentiation between a reducing/nonreducing sugar.
ix) Extraction of DNA from onion/ cauliflower

Reference Books:

1. A.I. Vogel: Textbook of Practical Organic Chemistry, Prentice Hall, 5th Edn.
2. F. G. Mann & B. C. Saunders: Practical Organic Chemistry, Orient Longman, 1960.
3. B.D. Khosla: Senior Practical Physical Chemistry, R. Chand & Co.
4. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry,
5. Universities Press.

CO- PO & PSO Correlation

Course Name: GE- III: SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY-II													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		1	1					2	2		1	
CO2	2			1					2				1
CO3	2		2							2		2	
CO4	2		1	1			1		2	1	1	1	

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**IV**
Name of the Course:	**GE IV**	**Course Code:**	**SOS-B-CH404**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

To learn the synthetic process, properties and the utility of the industrially important inorganic materials (such as silicates, ceramics, cements, fertilizers, paints, batteries, alloys and explosives). To provide opportunity to learn some of the industrial process such as surface coating and catalysis in relevant to industry where heterogeneous catalysis dominates. Experiments are aimed at helping learners acquire hands on experience in qualitative and quantitative analysis of the inorganic materials which are basically manufactured in chemical industries. To learn some industrial techniques such as surface coating etc**.**

Course Outcomes (CO)

Students will be able to	
CO 1	Understand General Principles of Metallurgy, Ellingham diagram, purification of metals
CO 2	Acquire the knowledge of s and p-block elements and related periodic properties; structure & properties of compounds,
CO 3	Understand the basic concepts and theories of Gases, Solids and Liquids and learn various methods and working of instruments for the determination of their properties
CO 4	Understand about the theories of reaction rates and establish its relation on different parameters, experimentally determine order and apply it for establishment of reaction mechanism
CO 5	Learn procedure of semi-micro analysis for the identification of acidic and basic radicals

Syllabus

General Principles of Metallurgy:

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent.

Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process.
(4 Lectures)

s and p-Block Elements

Periodicity in s- and p-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-

Rochow scales). Allotropy in C, S, and P.

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

Compounds of s- and p-Block Elements

Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of p- block elements.

Concept of multicentre bonding (diborane).

Structure, bonding and their important properties like oxidation/reduction, acidic/basic nature of the following compounds and their applications in industrial, organic and environmental chemistry.

Hydrides of nitrogen (NH_3, N_2H_4, N_3H, NH_2OH)
Oxoacids of P, S and Cl.
Halides and oxohalides: PCl_3, PCl_5, $SOCl_2$ and SO_2Cl_2

(26 Lectures)

Section B: Physical Chemistry-3 (30 Lectures)
Kinetic Theory of Gases
Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation.

Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO_2.

Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.

Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Liquids
Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

Solids
Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of

interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

Reference Books:

11. G. M. Barrow: Physical Chemistry Tata McGraw---Hill (2007).
12. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
13. J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
14. B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
15. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
16. J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
17. F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
18. D. F. Shriver and P. W. Atkins: Inorganic Chemistry, Oxford University Press.
19. Gary Wulfsberg: Inorganic Chemistry, Viva Books Pvt. Ltd.

GE-IV LAB: CHEMISTRY OF S- AND P-BLOCK ELEMENTS, STATES OF MATTER & CHEMICAL KINETICS

Section A: Inorganic Chemistry

Semi-micro qualitative analysis using H2S of mixtures- not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations : NH^{4+}, Pb^{2+}, Ag^{+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^{+}

Anions : CO_3^{2-} , S^{2-}, SO^{2-}, $S_2O_3^{2-}$, NO_3^{-}, CH_3COO^{-}, Cl^{-}, Br^{-}, I^{-}, NO_3^{-},SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^{-}

(Spot tests should be carried out wherever feasible)

Section B: Physical Chemistry

I. Surface tension measurement (use of organic solvents excluded).

a. Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
b. Study of the variation of surface tension of a detergent solution with concentration.

II. Viscosity measurement (use of organic solvents excluded).

a. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.
b. Study of the variation of viscosity of an aqueous solution with concentration of solute.

III. Chemical Kinetics
Study the kinetics of the following reactions.
i. Initial rate method: Iodide-persulphate reaction
ii. Integrated rate method:
a. Acid hydrolysis of methyl acetate with hydrochloric acid.
b. Saponification of ethyl acetate.
c. Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate

Reference Books

1. A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

CO- PO & PSO Correlation

Course Name: GE- IV: CHEMISTRY OF S- AND P-BLOCK ELEMENTS, STATES OF MATTER & CHEMICAL KINETICS													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1						1		2	1			
CO2	1			1					2				
CO3	2		1						1	2	1	1	
CO4	2	1		1					1	1	1		
CO5	1			1							2	1	

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**I**
Name of the Course:	**GE I**	**Course Code:**	**SOS-B-CH103**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

The course reviews the structure of the atom, which is a necessary pre-requisite in understanding the nature of chemical bonding in compounds. It provides basic knowledge about ionic, covalent and metallic bonding and explains that chemical bonding is best regarded as a continuum between the three cases. The course is also infused with the recapitulation of fundamentals of organic chemistry and the introduction of a new concept of visualizing the organic molecules in a three dimensional space. To establish the applications of these concepts, the classes of alkanes, alkenes, alkynes and aromatic hydrocarbons are introduced. This course also provides the knowledge of kinetic molecular theory for understanding the gases, gas laws and their applications. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

Course Outcomes (CO)

Students will be able to	
CO 1	Understand Atomic Structure: Review of Bohr's theory and its limitations, Quantum numbers and their types.
CO 2	Understand Chemical Bonding and Molecular Structure, resonance and resonating structures in various inorganic and organic compounds
CO 3	Gain knowledge about Fundamentals of Organic Chemistry, Electronic Displacements & effect and cleavage of Bonds
CO 4	Understand the basic concepts and theories of Gases State
CO 5	Learn basic laboratory procedure of volumetric analysis, pH calculations and buffer solution preparation and chromatographic separation

Atomic Structure

- Atomic Structure: Review of: Bohr's theory and its limitations, dual behavior of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to atomic structure.
- What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum, and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms).

- Rules for filling electrons in various orbitals, electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.
(14 Lectures)

Chemical Bonding and Molecular Structure

- Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.
- Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.
- Concept of resonance and resonating structures in various inorganic and organic compounds.
- MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+. Comparison of VB and MO approaches.
(18 Lectures)

Fundamentals of Organic Chemistry

- Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.
- Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.
- Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.
(10 Lectures)

Gaseous State:

- Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.
- Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.
- Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. vander Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van

der Waals constants, law of corresponding states.
(18 Lectures)

Reference Books:

21. J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.
22. F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
23. Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley.
24. James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
25. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press (2006).
26. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
27. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
28. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
29. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
30. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
31. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand

GE- 1 LAB: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & GASEOUS STATE LAB

Titrimetric Analysis

- Calibration and use of apparatus
- Preparation of solutions of different Molarity/Normality of titrants

Acid-Base Titrations

- Estimation of carbonate and hydroxide present together in mixture.
- Estimation of carbonate and bicarbonate present together in a mixture.
- Estimation of free alkali present in different soaps/detergents

pH-metry

- Study the effect on pH of addition of HCl/ NaOH to solutions of acetic acid, sodium acetate and their mixtures.
- Preparation of buffer solutions of different pH

i) Sodium acetate-acetic acid
ii) Ammonium chloride-ammonium hydroxide

Organic Chemistry

- Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)
- Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).

3. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
4. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

CO- PO & PSO Correlation

Course Name: GE- 1: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & GASEOUS STATE													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1			1					2				1
CO2	2			1					2		1		1
CO3	2			1					2				1
CO4	2								2				
CO5	1		1		1				1	1	1	2	

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**II**
Name of the Course:	**GE II**	**Course Code:**	**SOS-B-CH203**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

To learn the synthetic process, properties and the utility of the industrially important inorganic materials (such as silicates, ceramics, cements, fertilizers, paints, batteries, alloys and explosives). To provide opportunity to learn some of the industrial process such as surface coating and catalysis in relevant to industry where heterogeneous catalysis dominates. Experiments are aimed at helping learners acquire hands on experience in qualitative and quantitative analysis of the inorganic materials which are basically manufactured in chemical industries. To learn some industrial techniques such as surface coating etc**.**

Course Outcomes (CO)

Students will be able to	
CO 1	Explain the symmetry of solids; and apply the principle of XRD for the analysis of solid samples
CO 2	Understand the basics of ionic and chemical equilibria and its applications
CO 3	Understand stereochemistry of different chemical compounds through different types of representations and their interconversion
CO 4	Understand the fundamentals of aliphatic and aromatic hydrocarbons through the study of methods of preparation, properties and chemical reactions with underlying mechanism
CO 5	Learn basic organic laboratory procedure for the determination melting point, purification and identification of extra element

Syllabus

Solid State:

- Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices.
- X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

(14 Lectures)

Ionic Equilibria:

- Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

(8 Lectures)

Chemical Equilibrium:

- Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants Kp, Kc and Kx. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

(12 Lectures)

Stereochemistry

- Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions;
- Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.
- Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

(10 Lectures)

Aliphatic & Aromatic Hydrocarbons

- Carbon-Carbon sigma bonds: Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.
- Carbon-Carbon pi bonds: Formation of alkenes and alkynes by elimination reactions, Mechanism of E^1, E^2, E^1_{cb} reactions. Saytzeff and Hofmann eliminations.
- Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction;
- Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.
- Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples.
- Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

(16 Lectures)

Reference Books:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press (2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
4. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.

5. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
6. G. M. Barrow: Physical Chemistry Tata McGraw---Hill (2007).
7. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
8. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
9. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

GE-2 LAB: SOLID STATE, CHEMICAL & IONIC EQUILIBRIA, STEREOCHEMISTRY AND ALIPHATIC & AROMATIC HYDROCARBONS LAB

Melting/Boiling Point determination

- Checking the calibration of the thermometer
- Determination of the melting points of unknown organic compounds
- Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
- Determination of boiling point of liquid compounds (boiling point lower than and more than 100 °C by distillation and capillary method)

Purification of organic compounds by crystallization using the following solvents:

- Water
- Alcohol
- Alcohol-Water

Organic Chemistry

- Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
- Identify and separate the components of a given mixture of two organic compounds

Reference Books

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.
4. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
5. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).

CO- PO & PSO Correlation

Course Name: GE- II: SOLID STATE, CHEMICAL & IONIC EQUILIBRIA, STEREOCHEMISTRY AND ALIPHATIC & AROMATIC HYDROCARBONS													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		1	1					2				
CO2	2		1	1					2	2	1		
CO3	2			1					2	1			
CO4	2			2	1				2				
CO5	1	1		1					1	1			1

Programme :	**B.Sc. Honours**	**Semester :**	**III**
Name of the Course:	**GE III**	**Course Code:**	**SOS-B-CH304**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

To learn the synthetic process, properties and the utility of the industrially important inorganic materials (such as silicates, ceramics, cements, fertilizers, paints, batteries, alloys and explosives). To provide opportunity to learn some of the industrial process such as surface coating and catalysis in relevant to industry where heterogeneous catalysis dominates. Experiments are aimed at helping learners acquire hands on experience in qualitative and quantitative analysis of the inorganic materials which are basically manufactured in chemical industries. To learn some industrial techniques such as surface coating etc**.**

Course Outcomes (CO)

Students will be able to	
CO 1	Solve the conceptual questions using the knowledge gained by studying the Chemical kinetics and their rate of reactions and determine the order of reaction experimentally
CO 2	Draw the phase diagram of one component system and two component systems involving eutectics, congruent and incongruent melting points and establish the concept by experiments using documented procedures
CO 3	Learn preparation, properties and mechanism of reactions of oxygen containing functional groups organic compounds and perform qualitative analysis for their identification

Syllabus

Chemical Kinetics

- The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.
- Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

(16 lectures)

Phase Equilibrium

- Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component

systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).

(10 Lectures)

Alcohols, Phenols, Ethers and Epoxides:

- *Alcohols:* preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;
- *Phenols:* Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism;
- *Ethers and Epoxides:* Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

(16 Lectures)

Carbonyl Compounds:

- Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation

(14 Lectures)

Carboxylic Acids and their Derivatives:

- Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids;
- Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann- bromamide degradation and Curtius rearrangement.

(14 Lectures)

Reference Books:

1. G. M. Barrow: Physical Chemistry Tata McGraw---Hill (2007).
2. G. W. Castellan: Physical Chemistry 4th Ed. Narosa (2004).
3. J. C. Kotz, P. M. Treichel, J. R. Townsend, General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
4. B. H. Mahan: University Chemistry, 3rd Edn. Narosa (1998).
5. R. H. Petrucci, General Chemistry, 5th Edn., Macmillan Publishing Co.: New York (1985).
6. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H.

Freeman.
10. Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 7th Ed., W. H. Freeman

GE- III LAB: CHEMICAL KINETICS, PHASE EQUILIBRIUM, & FUNCTIONAL GROUP ORGANIC CHEMISTRY LAB

60 Lectures

Section A: Physical Chemistry

Phase equilibria

1. Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
2. Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
3. Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Chemical Kinetics

Study the kinetics of the following reactions.

- Initial rate method: Iodide-persulphate reaction
- Integrated rate method:
    a. Acid hydrolysis of methyl acetate with hydrochloric acid.
    b. Saponification of ethyl acetate.
    c. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate

Section B: Organic Chemistry

Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, alcoholic, aldehydic and ketonic) and preparation of one derivative.

Reference Books:

1. A.I. Vogel: Textbook of Practical Organic Chemistry, Prentice Hall, 5th Edn.
2. F. G. Mann & B. C. Saunders: Practical Organic Chemistry, Orient Longman, 1960.
3. B.D. Khosla: Senior Practical Physical Chemistry, R. Chand & Co.
4. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

CO- PO & PSO Correlation

Course Name: GE- III: CHEMICAL KINETICS, PHASE EQUILIBRIUM, & FUNCTIONAL GROUP ORGANIC CHEMISTRY-I													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		2	1					2	1	1		
CO2	2		1	2		1			1	2		1	
CO3	2		1	1					2	2		1	

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

Department of Chemistry

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme :	**B.Sc. Honours**	**Semester :**	**IV**
Name of the Course:	**GE IV**	**Course Code:**	**SOS-B-CH404**
Credits :	**6**	**No of Hours :**	**40**
Max Marks:	**150**		

Course Description:

To learn the synthetic process, properties and the utility of the industrially important inorganic materials (such as silicates, ceramics, cements, fertilizers, paints, batteries, alloys and explosives). To provide opportunity to learn some of the industrial process such as surface coating and catalysis in relevant to industry where heterogeneous catalysis dominates. Experiments are aimed at helping learners acquire hands on experience in qualitative and quantitative analysis of the inorganic materials which are basically manufactured in chemical industries. To learn some industrial techniques such as surface coating etc**.**

Course Outcomes (CO)

Students will be able to	
CO 1	Gain basic knowledge of the theories of coordination chemistry & Electrochemistry and their applications
CO 2	Understand the procedure of structural elucidation of polynuclear hydrocarbons and related reactions
CO 3	Learn basic knowledge of heterocyclic compounds and compare their nature, structure and reactivity
CO 4	Understand the importance of metal ions in biological systems for performing various functions and applications in medicine
CO 5	Learn methods for the separation of metal ions, perform potentiometric and pH-metric analysis for determination of various parameters

Syllabus

Coordination Chemistry:

- Werner's theory, valence bond theory (inner and outer orbital complexes), electro-neutrality principle and back bonding.
- Crystal field theory, measurement of 10 Dq (Δ_o), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δ_o, Δ_t).
- Octahedral versus tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry.
- Qualitative aspect of Ligand field and MO Theory

(18 lectures)

Polynuclear Hydrocarbons:

- Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene

(8 Lectures)

Heterocyclic Compounds:

- Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom.
- Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole

(Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis.

(12 Lectures)

Electrochemistry:

- Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.
- Application of EMF measurements in determining free energy, enthalpy, and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values

(12 Lectures)

Bioinorganic Chemistry:

- Metal ions present in biological systems, classification of elements according to their action in biological system.
- Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity,
- Use of chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

(10 Lectures)

Reference Books:

1. G. M. Barrow: Physical Chemistry Tata McGraw---Hill (2007).
2. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
3. J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
4. B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
5. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).
6. J. D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.
7. F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
8. D. F. Shriver and P. W. Atkins: Inorganic Chemistry, Oxford University Press.
9. Gary Wulfsberg: Inorganic Chemistry, Viva Books Pvt. Ltd.

GE-IV LAB: CHEMISTRY OF S- AND P-BLOCK ELEMENTS, STATES OF MATTER & CHEMICAL KINETICS LAB

Chromatography of metal ions

- Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:
    a. Ni (II) and Co (II)
    b. Fe (III) and Al (III)
- Perform the following potentiometric titrations:
    a. Strong acid vs. strong base
    b. Weak acid vs. strong base

c. Dibasic acid vs. strong base
d. Potassium dichromate vs. Mohr's salt

pH metry

- pH metric titration of
  a. strong acid vs. strong base
  b. weak acid vs. strong base.
- Determination of dissociation constant of a weak acid

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
3. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
4. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

CO- PO & PSO Correlation

Course Name: GE- IV: CHEMISTRY OF S- AND P-BLOCK ELEMENTS, STATES OF MATTER & CHEMICAL KINETICS													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2			1					3	1			
CO2	1			1			1		2				
CO3	1			1	1				1				
CO4	2								2				
CO5	1		2	1		1			1	1	2	1	1