**UGC CBCS**

**UG COURSE CURRICULUM**

**AND**

**SYLLABI**

**(As per UGC’s Draft Model**

**Syllabi)**

**(PROPOSED SCHEME)**

**CHEMISTRY**

**UGC’s Draft Model Syllabi)**

**(PROPOSED SC**

**HEME)**

***NORTH LAKHIMPUR COLLEGE***

***(AUTONOMOUS)***

SYLLABUS

FOR

UNDER GRADUATE (UG)COURSE

IN

CHEMISTRY

(HONOUR S & PASS)

UND ER

CHOICE BASED CREDIT SYSTEM

NORTH LAKHIMPUR COLLEGE

2019

**CBCS**

**UG - SY LLABI**

**CHEMISTRY**

**(HONOURS)**

**SEMESTER-I**

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(1st Semester)**

Course Code: **CHE-CC-T4-101**

**(Inorganic Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To develop the basic knowledge of chemistry in relation to atomic

structure, bonding, periodicity etc.

**Expected Learner Outcome: Students will gain an understanding of**

i. Sign of wave function, counter boundary and probability diagrams etc.

ii. Variations of orbital energy with atomic number.

iii. Properties of elements, atomic radii, ionic radii, size effect of ionic bond, solvation

energy, covalent character of ionic bond, redox equations, principle involved in volumetric analysis etc.

**Atomic Structure: Marks = 13**

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: Marks = 15**

*s*, *p*, *d*, *f* block elements, the long form of periodic table. Detailed discussion of the followingproperties of the elements, with reference to *s* and *p*-block.

1. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
2. Atomic radii (van der Waals)
3. Ionic and crystal radii.
4. Covalent radii (octahedral and tetrahedral)
5. Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
6. Electron gain enthalpy, trends of electron gain enthalpy.
7. 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 density ratio.

**(16 Lectures)**

**Chemical Bonding: Marks = 24**

1. *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and itslimitations. 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.
2. *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.

1. *Metallic Bond:* Qualitative idea of valence bond and band theories. Semiconductors andinsulators, defects in solids.
2. *Weak Chemical Forces:* van der Waals forces, ion-dipole forces, dipole-dipoleinteractions, 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: Marks = 04**

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:**

* Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
* Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry*

Oxford, 1970

* Atkins, P.W. & Paula, J. *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
* Day, M.C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.
* Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(1st Semester)**

Course Code: **CHE-CC-P2-101**

 **(Inorganic Chemistry)**

**Contact Hours: 60**

**Full Marks = 30**

***Time: 6 hours***

**(A)** Titrimetric Analysis (any one) **Marks - 6**

(i) Calibration and use of apparatus

**(ii) Preparation of solutions of different Molarity/Normality of titrants**

**(B)** Acid-Base Titrations (any one) **Marks - 10**

**(i) Estimation of carbonate and hydroxide present together in mixture.**

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

**(C)** Oxidation-Reduction Titrimetry (any one) **Marks - 10**

**(i) Estimation of Fe(II) or oxalic acid using standardized KMnO4 solution.**

(ii) Estimation of Fe(II) with K2Cr2O7 using diphenylamine as internal

indicator.

**(D) Viva-Voce Marks - 4**

**Reference Books:**

1. Mendham, J., A. I. Vogel’s *Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.

2. Nad, A.K., Mahapatra, B., Ghoshal, A., An Advanced Course in Practical Chemistry, New Central Book Agency (P) Ltd., Kolkata, India.

3. Das, Subhas C, Advanced Practical Chemistry for 3-Year Honours Course.

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(1st Semester)**

Course Code: **CHE-CC-T4-102**

 **(Physical Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To emphasize on different states of matter & their mechanical treatment.

**Expected Learner Outcome: Students will gain an understanding of**

i. Kinetic molecular model of a gas, behaviour of real gases etc

ii. Effect of addition of various solute on surface tension and viscosity. Cleansing action of detergents.

iii. Nature of solid state, elementary idea of symmetry.

iv. Idea of solubility and solubility product of sparingly soluble salts.

**Unit I: Gaseous stat**e

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 behavior: van der 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, Marks - 18**

**Unit II: 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, Marks - 8**

**Unit III: 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, Marks - 12**

**Unit IV: 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, Marks - 18**

**Reference Books:**

**1.** Atkins, P. W. & Paula, J. de Atkin’s Physical Chemistry Ed., Oxford University Press (2006).

**1.** Ball, D. W. Physical Chemistry Thomson Press, India (2007).

**2.** Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).

**3.** Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

**4.** Negi,A.S; Anand,S.C. *A Text book of Physical Chemistry* New Age International Publishers

**5.** Pahari,S *Physical Chemistry Vol I &II* New Central Book Agency (P) Ltd.

**6.** Puri,Sharma,Pathiana *Principles of Physical Chemistry* Vishal Publishing Co.

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(1st Semester)**

Course Code: **CHE-CC-P2-102**

 **(Physical Chemistry)**

**Contact Hours: 60**

**Full Marks = 30 Time: 6 hours**

**One physical experiment from each group is to be carried out in examination.**

**Group A Marks - 13**

1. **Surface tension measurements.**

a. Determine the surface tension of various liquids by drop number method.

b. Study the variation of surface tension of detergent solutions with concentration.

2. **Viscosity measurement using Ostwald’s viscometer**.

a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and

(iii) sugar at room temperature.

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

**Group B Marks - 13**

**3. pH metry**

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

b. Preparation of buffer solutions of different pH

i. Sodium acetate-acetic acid

ii. Ammonium chloride-ammonium hydroxide

c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.

d. Determination of dissociation constant of a weak acid.

**Viva Voce 2+2=4**

**Reference book :**

**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.** Yadav, J.B., *Advanced Practical Physical Chemistry 32nd Ed*; Goel Publishing Ho

**SEMESTER-II**

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(2nd Semester)**

Course Code: **CHE-CC-T4-201**

 **(Organic Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To develop preliminary knowledge in basic organic chemistry,

Hydrocarbons, stereochemistry & conformational analysis.

**Expected Learner Outcome: Students will gain an understanding of ---**

i. Knowledge of basic organic chemistry, definition, classification of stereoisomerism, optical activity, absolute and relative configuration etc.

ii. Knowledge of elimination reaction, electrophilic and nucleophilic addition.

iii. Relative stability of cyclic hydrocarbon, Bayer’s strain theory etc.

**Unit I: Basic Organic Chemistry**

***Organic Compounds****:* Classification and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

***Electronic effects****:* Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; 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, Nitrenes.

Organic acids and bases; their relative strength, Hard and soft acids & bases.

Energy profile diagrams of one step, two steps & three steps reactions, Activation energy,

Kinetically Controlled & Thermodynamically Controlled reactions.

**8 Lectures, Marks - 8**

**Unit II: Stereochemistry**

Definition and classification of streoisomerism, Representation of organic molecules in two & three dimensions, Fischer, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: Restricted rotation about C=C bonds, Physical & Chemical properties of Geometrical isomers, 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 & Epimers,

Racemic mixture and resolution, Threo & Erythro forms, Relative and absolute configuration:

D/L and R/S designations.

**16 Lectures, Marks - 12**

**Unit III: Chemistry of Aliphatic Hydrocarbons**

**A. Carbon-Carbon sigma bond**

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Corey House Reaction, Free radical substitutions: Halogenation -relative reactivity and selectivity.

**Lecture 4, Marks - 4**

**B. Carbon-Carbon pi bonds:**

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Special emphasis on preparation of alkenes by syn elimination – Pyrolysis of esters, Chugaev, Wittig and Heck Reaction.

***Reactions of alkenes:*** Electrophilic additions and their mechanisms (Markownikoff/ Anti Markownikoff addition), Regioselective (directional selectivity) and Streoselective addition reactions. Mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation), Simple effect of Streoselectivity & Streospecificity;

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.

**14 Lectures, Marks - 14**

**Unit IV: Cycloalkanes and Conformational analysis:**

A. Cycloalkanes: Preparation and their relative stability, Baeyer strain theory, B. Conformation analysis of alkanes (Ethane and Butane): Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

**10 Lectures**, **Marks - 10**

**Unit V Aromatic Hydrocarbons**

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

**12 Lectures, Marks - 8**

**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.

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(2nd Semester)**

Course Code: **CHE-CC-P2-201**

 **(Organic Chemistry)**

**Contact Hours: 60**

**Full Marks = 30 [** End Semester Exam (24) Internal Assessment (6)**]**

***Time: 6 hours***

1. Purification of organic compounds by crystallization using the following solvents:

a. Water

b. Alcohol

c. Alcohol-Water **Marks - 4**

2. (Any One Experiment) **Marks - 4**

a . Determination of the melting points of above compounds and unknown organic compounds **(Kjeldahl method and electrically heated melting point apparatus)**

b. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds

3. Chromatography (Any two experiments):

a. Separation of a mixture of two amino acids by paper chromatography

b. Separation of a mixture of two sugars by paper chromatography

c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

**Marks - 6+6 =12**

**4. VIVA Marks = 4**

**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)

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(2nd Semester)**

Course Code: **CHE-CC-T4-202**

 **(Physical Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To develop a strong knowledge on chemical thermodynamics, their mathematical expression & application.

**Expected Learner Outcome: Students will gain an understanding of**

i. The application of mathematical tools to calculate thermodynamic properties

ii. The concept of free energy change and spontaneity.

iii. Thermodynamics derivation of relation between Gibbs free energy of reaction and reaction quotient.

iv. Derive relation between the four colligative properties using chemical potential (Thermodynamics derivation)

**Unit I: 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, Marks -26**

**Unit II: 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, Marks-6**

**Unit III: 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, Marks-12**

**Unit IV: 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, (iii) 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, Marks-12**

**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. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).

**6.** Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill (2010).

**7.** Metz, C.R. *2000 solved problems in chemistry,* Schaum Series (2006)

**8.** Negi,A.S; Anand,S.C. *A Text book of Physical Chemistry* New Age International Publishers

**9.** Pahari,S *Physical Chemistry Vol I &II* New Central Book Agency (P) Ltd.

**10.** Puri,Sharma,Pathiana *Principles of Physical Chemistry* Vishal Publishing Co.

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(2nd Semester)**

Course Code: **CHE-CC-P2-202**

 **(Physical Chemistry)**

**Contact Hours: 60**

**Full Marks = 30 [End** Semester Exam (24) Internal Assessment (6)**]**

***Time: 6 hours***

**1. Thermo chemistry**

Two experiments from the following: **Marks - 2×10=20**

(a) 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).

(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(c) Calculation of the enthalpy of ionization of ethanoic acid.

(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

(e) 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.

(f) Determination of enthalpy of hydration of copper sulphate.

(g) Study of the solubility of benzoic acid in water and determination of Δ *H*.

**2. Viva voce : Marks - 2+2=4**

**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).

**3.** Yadav, J.B., *Advanced Practical Physical Chemistry 32nd Ed*; Goel Publishing House

**SEMESTER-III**

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(3rd Semester)**

Course Code: **CHE-CC-T4-301**

 **(Inorganic Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To make the student familiar with the chemistry of s, p block elements, noble gases, inorganic polymers & metallurgy.

**Expected Learner Outcome: Students will gain an understanding of ---**

i. Predict the purification of metal, study of compounds with emphasis on structure, bonding, preparation and properties.

ii. Real world applications, shapes etc of noble gas.

iii. Structural aspects and applications of inorganic polymer

**Unit I: 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 refinig

**6 Lectures, Marks - 5**

**Unit II: 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, Marks - 7**

**Unit III: 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. 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, Marks - 30**

**Unit IV: Noble gases**

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory).

**8 Lectures, Marks - 7**

**Unit V: 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, Marks - 7**

**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*, 5t h ed.,Wiley, VCH, 1999.

**5.** Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.

**6.** Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* 4th Ed., Pearson, 2010

**7.** Atkin, P. *Shriver & Atkins’ Inorganic Chemistry* 5th Ed. Oxford University Press (2010).

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(3rd Semester)**

**Course Code: CHE-CC-P2-301**

**(Inorganic Chemistry)**

**Contact Hours: 60**

**Full Marks = 30 [** End Semester Exam (24) Internal Assessment (6)**]**

***Time: 6 hours***

**A. Iodo / Iodimetric Titrations (any one) Marks - 12**

(i) Estimation of Cu(II) and K2Cr2O7 using sodium thiosulphate solution (Iodimetrically).

(ii) Estimation of available chlorine in bleaching powder iodometrically.

**B. Inorganic preparations (any one**) **Marks - 8**

(i) Cuprous Chloride, Cu2Cl2

(ii) Preparation of Manganese(III) phosphate, MnPO4.H2O

(iii) Preparation of Aluminium potassium sulphate KAl(SO4)2.12H2O (Potash alum) or Chrome alum.

C. **Viva-voce Marks - 4**

**Reference Books**

**1.** Mendham, J., *A. I. Vogel’s Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(3rd Semester)**

**CHE-CC-T4-302**

**(Organic Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To develop preliminary knowledge on the synthesis, properties of organic compounds of Halogen & oxygen containing Functional groups.

**Expected Learner Outcome: Students will gain an understanding of ---**

i. The prediction of mechanism for organic reactions

ii. How to design synthesis of organic molecule.

iii. The reactivity and stability of organic molecule based on structure

iv. An idea of alcohols, phenols, carbonyl compounds, acids and their derivatives etc

**Unit I: Chemistry of Halogenated Hydrocarbons**

**Part A**

**Alkyl halides**: Methods of preparation including Hunsdiecker Reaction, nucleophilic substitution reactions – SN1, SN2 and SNi 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.

**14 Lectures, Marks - 12**

**Part B**

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

**2 Lectures**, **Marks - 2**

**Unit II: 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 OsO4 ,alkaline KMnO4,

periodic acid and lead tetraacetate Pinacol-Pinacolone rearrangement;

*Trihydric alcohols* : Glycerol /Preparation & Properties .

***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 LiAlH4

**16 Lectures**, **Marks -14**

**Unit III: Carbonyl Compounds:**

**Part A**

Structure, reactivity and preparation;

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α- substitution reactions, Clemmensen, Wolff-Kishner, MPV, LiAlH4, NaBH4, PDC , PCC , SeO2, Pb(OAc )4 & HIO4 .

( Synthetic applications only)

Addition reactions of unsaturated carbonyl compounds: Michael addition.

Unsaturated Aldehydes (Acrolein, Crotonaldehyde, Cinnamaldehyde) Unsaturated Ketone

(MVK) .

**12 Lectures, Marks - 12**

**Part B**

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications

of diethyl malonate and ethyl acetoacetate.

**2 Lectures, Marks - 2**

**Unit IV: Carboxylic Acids and their Derivatives:**

Preparation, physical properties and reactions of monocarboxylic acids (Acidity and factors affecting it): 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, Hofmannbromamide degradation and Curtius rearrangement.

**12 Lectures, Marks - 10**

**Unit V: Sulphur containing compounds:**

Preparation and reactions of thiols, thioethers and sulphonic acids.

**6 Lectures, Marks - 4**

**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. CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(3rd Semester)**

**CHE-CC-P2-302**

**(Organic Chemistry)**

**Contact Hours: 60**

**Full Marks = 30 [** End Semester Exam (24) Internal Assessment (6)**]**

***Time: 6 hours***

1. Functional group tests for alcohols, carbonyl, and carboxylic acid group . **Marks -4**

2. **Organic preparations: (Any Two)**

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. Nitration of any one of the following:

a. Acetanilide/nitrobenzene by conventional method

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

v. Reduction of *p*-nitrobenzaldehyde by sodium borohydride.

vi. Hydrolysis of amides and esters.

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.

**Marks - 8+8=16**

**3**. VIVA **Marks - 4**

**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:QualitativeAnalysis,* University Press (2000)

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(3rd Semester)**

**CHE-CC-T4-303**

**(Physical Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To acquaint students in details on phase equilibria, chemical kinetics,

catalysis and surface chemistry.

**Expected Learner Outcome: Students will gain an understanding of ---**

i. Types of catalysis, Michaelis – Menten mechanism, mechanism of catalysed reaction at solid state.

ii. Steady - state approximation in reaction mechanism.

iii. Concept of phases, phase diagrams for systems of solid- liquid equilibria

involving eutectic, congruent and incongruent mp, solid solution etc

**Unit I: 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 solidliquid, 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, Marks - 20**

**Unit II: 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, Marks - 16**

**Unit III: 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, Marks - 12**

**Unit IV: Surface chemistry**

Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state.

**6 Lectures, Marks - 8**

**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. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).

**6.** Zundhal, S.S*. Chemistry concepts and applications* Cengage India (2011).

**7.** Ball, D. W. *Physical Chemistry* Cengage India (2012).

**8.** Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).

**9.** Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill (2011).

**10.** Metz, C. R*. Physical Chemistry 2nd Ed.,* Tata McGraw-Hill (2009).

**11.** Negi,A.S; Anand,S.C. *A Text book of Physical Chemistry* New Age International Publishers

**12.** Pahari,S *Physical Chemistry Vol I &II* New Central Book Agency (P) Ltd.

**13.** Puri,Sharma,Pathiana *Principles of Physical Chemistry* Vishal Publishing Co.

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(3rd Semester)**

**Course Code: CHE-CC-P2-303**

**(Physical Chemistry)**

**Contact Hours: 60**

**Full Marks = 30 [** End Semester Exam (24) Internal Assessment (6)**]**

***Time: 6 hours***

**A.** Any two experiments of the following

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

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

iii. Study the kinetics of the following reactions.

a. Integrated rate method:

i. Acid hydrolysis of methyl acetate with hydrochloric acid.

ii. Saponification of ethyl acetate.

b. Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate.

**Adsorption:**

Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid/oxalic acid on activated charcoal.

**Marks - 10×2=20**

**B. Viva Voce: Marks - 4**

**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.** Yadav, J.B., *Advanced Practical Physical Chemistry 32nd Ed*; Goel Publishing Hour

**SEMESTER-IV**

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(4th Semester)**

**Course Code: CHE-CC-T4-401**

**(Inorganic Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To develop a vivid knowledge on coordination chemistry and its application extended to biological system.

**Expected Learner Outcome: Students will gain an understanding of ---**

i. Predicting metal ion present in biological systems

ii. Use of chelating agents in medicine.

iii. Quantitative aspect of ligand field and MO theory, stability of various oxidation states and emf of transition elements

**Unit I: Coordination Chemistry**

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. Werner’s theory, valance bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10Dq (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.

**26 Lectures, Marks - 25**

**Unit II: 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 and Bsworth diagrams). Difference between the first, second and third transition series. Chemistry of Ti, V, Cr, Mn, Fe and Co in various oxidation states (excuding their metallurgy)

**18 Lectures, Marks - 16**

**Unit III: Lanthanoids and Actinoids**

Electronic configuration, oxidation states, colour, spectral and magnetic properties, Lanthanide contraction, separation of lanthanides (ion-exchange method only)

**6 Lectures, Marks - 5**

**Unit IV: Bioinorganic Chemistry**

Metal ion present in biological systems, classification of elements according to their action in biological system. Geo chemical effect on 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, Marks - 10**

**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.** Cotton, F.A. & Wilkinson,G, *Advanced Inorganic Chemistry*, 5th Ed. Wiley-VCH,1999

**4.** Greenwood, N.N. & Earnshaw A., *Chemistry of Elements*, Butterworth-Heinemann,1977

**5.** Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* 4th Ed., Pearson, 2010

**6.** Atkin, P. *Shriver & Atkins’ Inorganic Chemistry* 5th Ed. Oxford University Press (2010).

**7.** R. Sarkar. General Inorganic Chemistry (Part-2), New Central Book Agency(P) Ltd.

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(4th Semester)**

**Course Code: CHE-CC-P2-401**

 **(Inorganic Chemistry)**

**Contact Hours: 60**

**Full Marks = 30 [** End Semester Exam (24) Internal Assessment (6)**]**

***Time: 6 hours***

**A. Gravimetric Analysis: (any one) Marks - 10**

i. Estimation of nickel(ii) using Dimethylglyoxime

ii. Estimation of copper as CuSCN

iii. Estimation of iron as Fe2O3 by precipitating iron as Fe(OH)3

**B. Inorganic Preparation: (any one) Marks - 6**

i. Tetraamminecopper(II) sulphate

ii. Tetraamminecarbonatocobalt(III) ion

iii. Potassium tris(oxalate)ferrate(III)

C. **Chromatography of metal ions**:

Principles involved in chromatographic seperations. Paper chromatographic separation of following metals **(any one**) **Marks - 4**

**i.** Ni(II) and Co(II)

**ii.** Fe(III) and Al(III)

**D. Viva-voce Marks - 4**

**Reference Book:**

**1.** Mendham, J., A.I.Vogel’s *Quantitative Analysis* 6th Ed., Pearson, 2009 CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(4th Semester)**

**Course Code: CHE-CC-T4-402**

 **(Organic Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To develop the knowledge on the preparation and properties of different classes nitrogen containing compounds. Emphasis is given to heterocyclic compounds of both synthetic and natural origin .

**Expected Learner Outcome: Students will gain an understanding of**

i. Reaction for preparation of Heterocyclic compounds, polynuclear hydrocarbons

ii. Reaction and mechanism of substitution in heterocyclic compounds.

iii. Methods of structure elucidation of terpenoids

**Unit I: Nitrogen Containing Functional Groups**

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

**Amine**s: 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. Diazomethane & Diazoacetic

Ester with synthetic application.

**16 Lectures, Marks - 14**

**Unit II: Polynuclear Aromatic Hydrocarbons**

Preparation and structure elucidation & Reactions of Polynuclear hydrocarbons : naphthalene

phenanthrene and anthracene , and important derivatives of naphthalene and anthracene;.

**12 Lectures, Marks - 12**

**Unit III:**

**Heterocyclic Compound-I**

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,

Derivatives of furan: Furfural and furoic acid.

**Heterocyclic Compound-II**

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

**20 Lectures, Marks - 18**

**Unit IV: 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, Marks - 6**

**Unit V: Terpenes**

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

**6 Lectures, Marks - 6**

**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 Wiley & 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*, Prajati Parakashan (2010).

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(4th Semester)**

**Course Code: CHE-CC-P2-402**

 **(Organic Chemistry)**

**Contact Hours: 60**

**Full Marks = 30 [** End Semester Exam (24) Internal Assessment (6)**]**

***Time :-6 hours***

1. Detection of elements (N, S and Halogens). **Marks - 3**

2. Functional group test for nitro, amine and amide groups. **Marks - 3**

3. Qualitative analysis of unknown organic compounds (alcohols, carboxylic acids, phenols and carbonyl compounds)

**Marks - 14**

**4.** Viva - voce **Marks - 4**

**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).

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(4th Semester)**

**Course Code: CHE-CC-T4-403**

 **(Physical Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To develop the basic knowledge on electrochemistry, various laws governing electro chemical process and their application.

**Expected Learner Outcome: Students will gain an understanding of ---**

i. Quantitative aspects of Faraday’s laws of electrolysis

ii. Application of conductance measurement

iii. Electrical and magnetic properties of atoms and molecules

**Unit I: 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, Marks - 22**

**Unit II: 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 (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) PH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb2O3 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, Marks - 22**

**Unit III: 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, Marks - 12**

**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).

**8.** Negi,A.S; Anand,S.C. *A Text book of Physical Chemistry* New Age International Publishers

**9.** Puri,Sharma,Pathiana *Principles of Physical Chemistry* Vishal Publishing Co.

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(4th Semester)**

**Course Code: CHE-CC-P2-403**

 **(Physical Chemistry)**

**Contact Hours: 60**

**Full Marks = 30 [** End Semester Exam (24) Internal Assessment (6)**]**

***Time: 6 hours***

**Group A : Conductometry Marks - 10**

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:

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

**Group-B : Potentiometry Marks - 10**

I 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

**Viva-voce Marks - 2×2=4**

**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.** Yadav, J.B., *Advanced Practical Physical Chemistry 32nd Ed*; Goel Publishing Hours

**SEMESTER-V**

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(5th Semester)**

**Course Code: CHE-CC-T4-501**

 **(Organic Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To acquire knowledge in organic synthesis, retro synthesis, and to understand biochemistry.

**Expected Learner Outcome: Students will gain an understanding of ---**

i. The chemical basis for biological phenomena and cellular structure.

ii. The chemical properties of amino acids co factors and sugar.

iii. Enzyme kinetics, chemical logic of metabolism

iv. Health, disease and modern medicine are all rooted in biological chemistry.

**Unit I: Nucleic Acids**

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

Structure of DNA (Watson & Model ) and RNA, Genetic Code Biological role of DNA and

RNA, Replication,Transcription and Translation (elementary idea only )

**9 Lectures, Marks - 8**

**Unit II: Amino Acids, Peptides and Proteins**

Amino acids, Peptides and their classification.α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, p*K*a values, isoelectric point and 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, Marks - 10**

**Unit III: 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, Marks - 10**

**Unit IV: Lipids**

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

**8 Lectures, Marks - 8**

**Unit V: Disconnection approach in Organic Synthesis**

Elementary idea about disconnection, Synthon and Synthetic equivalent, Functional group interconversion (FGI), Functional group addition (FGA )., simple examples off retrosynthesis of C-C bond formation (Corey House, Grignard, aldol condensation).. Retrosynthesis of monofunctionalised and Bi-functionalized (1,1 and 1,2) compounds.

**10 Lectures, Marks - 10**

**Unit VI: Pharmaceutical Compounds: Structure and Importance**

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Antacids : Ranitidine; Antibacterial: Providone—Iodine Solution, Synthesis and mode of action of Suphanilamides and other Sulphadrugs (sulphapyridine, sulphathiazole) Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C.

**8 Lectures, Marks - 10**

**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’sIllustrated Biochemistry. XXVIII edition. Lange Medical Bookselectrophoresis;/ McGraw-Hil

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(5th Semester)**

**Course Code: CHE-CC-P2-501**

 **(Organic Chemistry)**

**Contact Hours: 60**

**Full Marks = 30 [** End Semester Exam (24) Internal Assessment (6)**]**

***Time: 6 hours***

**Any Two Marks 10+10 =20**

1. Estimation of glycine by Sorenson’s formalin method.

2. Study of the titration curve of glycine.

3. Estimation of proteins by Lowry’s method.

4. Study of the action of salivary amylase on starch at optimum conditions.

5. Effect of temperature on the action of salivary amylase.

6. Saponification value of an oil or a fat.

7. Determination of Iodine number of an oil/ fat.

8. Isolation and characterization of DNA from onion/ cauliflower/peas.

**Viva-voce Marks - 4**

**Reference Books:**

**1.** Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.

**2.** Arthur, I. V. *Quantitative Organic Analysis,* Pearson.

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(5th Semester)**

**Course Code: CHE-CC-T4-502**

 **(Physical Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To make the students familiar with the various aspects of photo chemistry and quantum chemistry.

**Expected Learner Outcome: Students will gain an understanding of**

i. The difference between classical and quantum mechanics

ii. Qualitative treatment of hydrogen atom and hydrogen like ions.

iii. How to interpret spectra

iv. Role of photochemical reaction in biochemical processes

**Unit I: Quantum Chemistry**

Background of quantum mechanics, 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. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution. Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

**24 Lectures, Marks-22**

**Unit II: 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. 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.

**24 Lectures, Marks-22**

**Unit III: 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 photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

**12 Lectures, Marks-12**

**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).

**6.** Sen,B.K. Quantum Chemistry including Spectroscopy Kalyani Publishers

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(5th Semester)**

**Course Code: CHE-CC-P2-502**

 **(Physical Chemistry)**

**Contact Hours: 60**

**Full Marks = 30 [** End Semester Exam (24) Internal Assessment (6)**]**

***Time: 6 hours***

**Group A: UV/Visible spectroscopy Marks-10**

I. Study the 200-500 nm absorbance spectra of KMnO4 and K2Cr2O7 (in 0.1 M H2SO4) and λ determine the max values. Calculate the energies of the two transitions in different units (J molecule-1, kJ mol-1, cm-1, eV).

II. Study the pH-dependence of the U V-Vis spectrum (200-500 nm) of K2Cr2O7.

III. 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.

**Group B: Colorimetry Marks-10**

**I.** Verify Lambert-Beer’s law and determine the concentration of CuSO4/KMnO4/K2Cr2O7 in a solution of unknown concentration

II. Determine the concentrations of KMnO4 and K2Cr2O7 in a mixture.

III. Study the kinetics of iodination of propanone in acidic medium.

IV. Determine the amount of iron present in a sample using 1,10-phenathroline.

V. Determine the dissociation constant of an indicator (phenolphthalein/ methyl red)*.*

VI**.** Determine phosphate concentration in a soft drink

VII. Analysis of the given vibration-rotation spectrum of HCl(g)

**Viva Voce Marks-4**

**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.** Yadav, J.B., *Advanced Practical Physical Chemistry 32nd Ed*; Goel Publishing Hour

**SEMESTER-VI**

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(6th Semester)**

**Course Code: CHE-CC-T4-601**

 **(Inorganic Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To make familiar with various aspects of knowledge on organometalic chemistry, its application and Inorganic Reaction Mechanism.

**Expected Learner Outcome: Students will gain an understanding of**

i. Basic principles involved in analysis of anions, cations solubility product, common ion effect etc

ii. Inorganic reaction mechanism

iii. Use of Wilkinson’s catalyst in industrial process of hydrozenation of alkene, gas synthesis by metel carbonyl

iv. Hapacity of organic ligands, 18 electron rule, Zeise’s salt etc

**Unit I: 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, Marks-10**

**Unit II: 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. π-acceptor behavior of CO(MO diagram of CO to be discussed), synergic effect and use of IR data to eplain extent of back bonding.

**Zeise’s salt**: preparation and structure, evidences 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 multicentre bonding in these compounds. Role of triethylaluminium in polymerization of ethane (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, Marks - 20**

**Unit III: 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, Marks - 16**

**Unit IV: Catalysis by Organometallic Compounds**

Study of the following industrial processes and their mechanism

1. Alkene hydrogenation (Wilkinson’s Catalyst)

2. Hydroformylation (Co salts)

3. Wacker Process

4. Synthetic Gasoline (Fisher Tropsch reaction)

5. Synthesis gas by metal carbonyl complexes

**10 Lectures, Marks - 10**

**Reference Books:**

**1.** Vogel, A. I. Qualitative Inorganic Analysis, Longman, 1972.

**2.** Svehla, G. Vogel's Qualitative Inorganic Analysis, 7th Ed., Prentice Hall.

**3.** Cotton, F. A. G.; Wilkinson & Gaus, P. L. Basic Inorganic Chemistry 3rd Ed.; Wiley India,

**4.** Huheey, J. E.; Keiter, E. A. & Keiter, R. L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.

**5.** Sharpe, A. G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005

**6.** Douglas, B. E.; McDaniel, D. H. & Alexander, J. J. Concepts and Models in Inorganic Chemistry 3rd Ed., John Wiley and Sons, NY, 1994.

**7.** Greenwood, N. N. & Earnshaw, A. Chemistry of the Elements, Elsevier 2nd Ed, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).

**8.** Lee, J. D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008.

**9.** Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.

**10.** Shriver, D. D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.

**11.** Basolo, F. & Person, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.

**12.** Purcell, K. F. & Kotz, J. C., Inorganic Chemistry, W. B. Saunders Co. 1977

**13.** Miessler, G. L. & Donald, A. Tarr, Inorganic Chemistry 4th Ed., Pearson, 2010.

**14.** Collman, James P. et al. Principles and Applications of Organotransition Metal Chemistry. Mill Valley, CA: University Science Books, 1987.

**15.** Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals. New York, NY: John Wiley, 2000.

**16.** E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.

**17.** P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.

**18.** B.K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut. CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(6th Semester)**

**Course Code: CHE-CC-P2-601**

 **(Inorganic Chemistry)**

**Contact Hours: 60**

**Full Marks = 30 [** End Semester Exam (24) Internal Assessment (6)**]**

***Time: 6 hours***

**A. Qualitative Inorganic Analysis: Marks - 4×5 = 20**

Qualitative analysis of mixtures containing 2 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

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 e.g., BaSO4, SrSO4, PbSO4, CaF2 or Al2O3 or combination of anions e.g. CO32- and SO32-,NO2- and NO3

-, Cl- and Br-, Cl- and I-, B- rand I-, NO3- and Br-, NO3- and I-.

***Spot tests should be done whenever possible*.**

B**. Viva - voce Marks 4**

**Reference Books:**

**1.** Vogel’s Qualitative Inorganic Analysis, Revised by G. Svehla.

**2.** Marr & Rockett Inorganic Preparations.

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY

(Honours)

**(6th Semester)**

**Course Code: CHE-CC-T4-602**

 **(Organic Chemistry)**

**Contact Hours: 60**

**Full Marks = 70 [**End Semester Exam (56) + Internal Assessment (14)]

**Objective of the Course:** To acquaint students on application of Spectroscopy (UV – visible, IR and NMR), carbohydrates, dyes and polymers.

**Expected Learner Outcome: Students will gain an understanding of :**

i. Application of UV, IR, NMR spectroscopy, mass spectra in organic molecules

ii. Biological importance of carbohydrates

iii. Biodegradable polymer, colour and constitution of dyes and applications of different dyes.

**Unit I: 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.

Mass spectrometry: Basic principles

Applications of IR, UV, NMR and Mass for identification of simple organic molecules.

**24 Lectures, Marks - 26**

**Unit II: 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; Assecnding and descending in monosaccharide; Interconversions of aldoses and ketoses; Killiani- Fischer synthesis and Ruff degradation;

**16 Lectures, Marks - 10**

**Unit III: 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, Marks - 10**

**Unit IV: Polymers**

Introduction and classification of polymers;

Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; 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; Biodegradable polymers with examples.

**12 Lectures, Marks - 10**

**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

CBCS: B. Sc. (Honours) with CHEMISTRY

**CORE COURSE**

CHEMISTRY PRACTICAL

(Honours)

**(6th Semester)**

**Course Code: CHE-CC-P2-602**

 **(Organic Chemistry)**

**Contact Hours: 60**

**Full Marks = 30 [** End Semester Exam (24) Internal Assessment (6)**]**

***Time: 6 hours***

**1.** 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.

**Marks - 14**

***Any one-*** **Marks - 6**

2. Extraction of caffeine from tea leaves.

3. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.

4. Identification of simple organic compounds by IR spectroscopy and NMR Spectroscopy (Spectra to be provided).

5.Viva-voce **Marks - 4**

**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).