B.Sc. (Honours) in Chemistry
Under the Framework of Honours School System
OUTLINES OF TESTS

OBJECTIVE OF THE COURSE
To teach the fundamental concepts of Chemistry and their applications at undergraduate level, which will enable to impart comprehensive knowledge in chemistry and its societal applications through a 3 year programme. The syllabi of B.Sc. (Honours) in Chemistry under the framework of honours school system are selected and arranged in such a manner that due importance is given to requisite intellectual and laboratory skills according to UGC module for CHOICE BASED CREDIT SYSTEM (CBCS) pertaining to B.Sc. Honours (Chemistry).

Semester I

CORE COURSE (CHEMISTRY)

Theory Papers:
- Core Course-1 (C 1): Inorganic Chemistry-I 100 Marks (4 credits)
- Core Course-2 (C 2): Physical Chemistry-I 100 Marks (4 credits)

Practicals:
- Core Course-1 Practical (C 1 Lab): Inorganic Chemistry-I 50 Marks (2 credits)
- Core Course-2 Practical (C 2 Lab): Physical Chemistry-I 50 Marks (2 credits)

GENERIC ELECTIVE (GE) FOR CHEMISTRY STUDENTS
Each student of Chemistry Department has to opt two Generic Elective Courses from the available options offered by different science, mathematics, computer science and economics departments. However, a student can take only one GE course from one department per semester.

ABILITY ENHANCEMENT COMPULSORY COURSE FOR CHEMISTRY STUDENTS
Each student of Chemistry Department has to opt one Ability Enhancement Compulsory Course of the following:
1. English Communication (2 credits)
2. Environmental Science (2 credits)

GENERIC ELECTIVE (CHEMISTRY)
A student from other disciplines may opt one of the generic electives offered by the Chemistry Departments of Panjab University out of following:
- Generic Elective -1 (GE-1) 100 Marks (4 credits)
- Generic Elective -2 (GE-2) 100 Marks (4 credits)

Practicals:
- Generic Elective -1 Practical (GE-1 Lab) 50 Marks (2 credits)
- Generic Elective -2 Practical (GE-2 Lab) 50 Marks (2 credits)
Semester II
CORE COURSE (CHEMISTRY)

Theory Papers:
Core Course-3 (C 3): Organic Chemistry-I 100 Marks (4 credits)
Core Course-4 (C 4): Physical Chemistry-II 100 Marks (4 credits)

Practicals:
Core Course-3 Practical (C 3 Lab): Organic Chemistry-I 50 Marks (2 credits)
Core Course-2 Practical (C 4 Lab): Physical Chemistry-II 50 Marks (2 credits)

GENERIC ELECTIVE (GE) FOR CHEMISTRY STUDENTS
Each student of Chemistry Department has to opt two Generic Elective Courses from the available options offered by different science, mathematics, computer science and economics departments. However, a student can take only one GE course from one department per semester.

ABILITY ENHANCEMENT COMPULSORY COURSE FOR CHEMISTRY STUDENTS
Each student of Chemistry Department has to opt one Ability Enhancement Compulsory Course of the following:
1. English Communication (2 credits)
2. Environmental Science (2 credits)

GENERIC ELECTIVE (CHEMISTRY)

Theory Papers:
A student from other disciplines may opt one of the generic electives offered by the Chemistry Departments of Panjab University out of following:
Generic Elective -3 (GE-3) 100 Marks (4 credits)
Generic Elective -4 (GE-4) 100 Marks (4 credits)

Practicals:
Generic Elective -3 Practical (GE-3 Lab) 50 Marks (2 credits)
Generic Elective -4 Practical (GE-4 Lab) 50 Marks (2 credits)

Semester III
CORE COURSE (CHEMISTRY)

Theory Papers:
Core Course-5 (C 5): Inorganic Chemistry-II 100 Marks (4 credits)
Core Course-6 (C 6): Organic Chemistry-II 100 Marks (4 credits)
Core Course-7 (C 7): Physical Chemistry-III 100 Marks (4 credits)

Practicals:
Core Course-5 Practical (C 5 Lab): Inorganic Chemistry-II 50 Marks (2 credits)
Core Course-6 Practical (C 6 Lab): Organic Chemistry-II 50 Marks (2 credits)
Core Course-7 Practical (C 7 Lab): Physical Chemistry-III 50 Marks (2 credits)

SKILL ENHANCEMENT COURSES
Each student of Chemistry Department has to opt one Skill Enhancement Compulsory Course of the following:
1. CHE-SEC1: IT Skills for Chemists  50 Marks (2 credits)
2. CHE-SEC1: Basic Analytical Chemistry  50 Marks (2 credits)

**GENERIC ELECTIVE (GE) FOR CHEMISTRY STUDENTS**
Each student of Chemistry Department has to opt one Generic Elective Course from the available options offered by different science, mathematics, computer science and economics departments. However, a student can take only one GE course from one department per semester.

**GENERIC ELECTIVE (CHEMISTRY)**

**Theory Papers:**
A student from other disciplines may opt following generic elective offered by the Chemistry Departments of Panjab University out of:
Generic Elective -5 (GE-5)  100 Marks (4 credits)

**Practicals:**
Generic Elective -5 Practical (GE-5 Lab)  50 Marks (2 credits)

**Semester IV**

**CORE COURSE (CHEMISTRY)**

**Theory Papers:**
Core Course-8 (C 8):  Inorganic Chemistry-III  100 Marks (4 credits)
Core Course-9 (C 9):  Organic Chemistry-III  100 Marks (4 credits)
Core Course-10 (C 10):  Physical Chemistry-IV  100 Marks (4 credits)

**Practicals:**
Core Course-8 Practical (C 8 Lab):  Inorganic Chemistry-III  50 Marks (2 credits)
Core Course-9 Practical (C 9 Lab):  Organic Chemistry-III  50 Marks (2 credits)
Core Course-10 Practical (C 10 Lab): Physical Chemistry-IV  50 Marks (2 credits)

**SKILL ENHANCEMENT COURSES**
Each student of Chemistry Department has to opt one Skill Enhancement Compulsory Course of the following:
1. CHE-SEC2: Analytical Clinical Biochemistry  50 Marks (2 credits)
2. CHE-SEC2: Chemical Technology & Society  50 Marks (2 credits)

**GENERIC ELECTIVE (GE) FOR CHEMISTRY STUDENTS**
Each student of Chemistry Department has to opt one Generic Elective Course from the available options offered by different science, mathematics, computer science and economics departments. However, a student can take only one GE course from one department per semester.

**GENERIC ELECTIVE (CHEMISTRY)**

**Theory Papers:**
A student from other disciplines may opt following generic elective offered by the Chemistry Departments of Panjab University out of:
Generic Elective -6 (GE-6)  100 Marks (4 credits)

**Practicals:**
EVALUATION
1. There shall be one Mid Term Examination of 20% Marks in each semester.
2. End-semester examination will be of 80% of total marks.
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% marks. The final examination will be of 80% marks.

Pattern of end-semester question paper
(i) Nine questions in all with equal weightage. The candidate will be asked to attempt five questions
(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
(iii) The remaining eight questions will have Four Units comprising two questions from each Unit.
(iv) Students will attempt one question from each unit and the compulsory question.
PREAMBLE

The B.Sc. (Honours) in Chemistry under the framework of honours school system is a three year, six semester programme of the Chemistry department of PU. The Department of Chemistry was founded by Dr. S. S. Bhatnagar at Lahore in 1925. It is one of the prestigious departments of Panjab University with highly qualified and competent faculty members, whose work has been internationally recognized. Several faculty members are recipients of awards and honours, such as Shanti Swarup Bhatnagar, Jawaharlal Nehru fellowship, Raman and Palit awards. Many faculty members are bestowed with F.N.A., F.A.Sc., F.N.A.Sc., Young Scientist award as well as Visiting Professorship from India and abroad. The department has been selected by the UGC first for COSIST, and then for Special Assistant Programme (SAP) and now it is the Centre for Advanced Studies in Chemistry (CAS) for the last 20 years. The Department of Science and Technology (DST), Government of India has awarded FIST LEVEL-II status to this department.

The department has stimulating undergraduate (3-years) and postgraduate (2-years) teaching programmes in terms if BSc. (Hons.) and MSc (Hons.) programmes besides a vibrant research programme leading to PhD. Frequent symposia, summer schools, refresher and orientation courses are organized for the benefit of University, College and School teachers as well as talented students.

The department has good instrumental facilities such as high resolution 300 MHz NMR, FT-IR, UV-Visible Spectrophotometer, Polarimeter, Photocorrelation Spectrometer, HPLC, Microwave synthesizer etc and good computer facilities for carrying out advanced research. These facilities are often utilized by many Science Department of the Panjab University as well as other Universities, Industries and Institutes in the region. The library of the chemistry department is perhaps one of the best libraries in the subject in Northern India with an excellent collection of books, research journals and monographs.

The department is well known for its research activities and has very well equipped research laboratories. The main areas of research include: Main Group Elements Chemistry, Coordination Chemistry, synthetic Inorganic Chemistry, Organometallic Chemistry, Silicon Chemistry, Non-aqueous solution chemistry, Synthetic Organic Chemistry, Development of New reactions, Photochemistry, Nano-chemistry, Colloidal Chemistry (micelles and microemulsions), Thermodynamics of liquid mixtures as well as electrolyte solutions, Protein Chemistry and Theoretical Chemistry (quantum fluid dynamics, stochastic resonance)
## COURSE STRUCTURE

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<tr>
<th>SEMESTER I</th>
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<tr>
<td><strong>C1</strong> CHE-C1: Inorganic Chemistry-I</td>
<td><strong>C3</strong> CHE-C3: Organic Chemistry-I</td>
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<tr>
<td><strong>C2</strong> CHE-C2: Physical Chemistry-I</td>
<td><strong>C4</strong> CHE-C4: Physical Chemistry-II</td>
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<tr>
<td><strong>AECC1</strong> CHE-AECC1: English</td>
<td><strong>AECC2</strong> CHE-AECC2: Environmental Science</td>
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<th>SEMESTER III</th>
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<td><strong>C5</strong> CHE-C5: Inorganic Chemistry-II</td>
<td><strong>C8</strong> CHE-C8: Inorganic Chemistry-III</td>
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<td><strong>C6</strong> CHE-C6: Organic Chemistry-II</td>
<td><strong>C9</strong> CHE-C9: Organic Chemistry-III</td>
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<td><strong>C7</strong> CHE-C7: Physical Chemistry-III</td>
<td><strong>C10</strong> CHE-C10: Physical Chemistry-IV</td>
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<td><strong>SEC1</strong></td>
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<td><strong>C11</strong> CHE-C11: Organic Chemistry-IV</td>
<td><strong>C13</strong> CHE-C13: Inorganic Chemistry-IV</td>
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<td><strong>C12</strong> CHE-C12: Physical Chemistry-V</td>
<td><strong>C14</strong> CHE-C14: Organic Chemistry-V</td>
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**C**: Core Courses; **GE**: General Elective; **AECC**: Ability Enhancement Compulsory Courses; **SEC**: Skill Enhancement Courses; **DSE**: Discipline Specific Elective

*: GE subjects are to be selected by the students from the pool of GE Subjects offered by various Departments of the University.
SKILL ENHANCEMENT COURSES (any one per semester in semesters 3-4)**
1. CHE-SEC1: IT Skills for Chemists   OR
   CHE-SEC1: Basic Analytical Chemistry
2. CHE-SEC2: Analytical Clinical Biochemistry   OR
   CHE-SEC2: Chemical Technology & Society

DISCIPLINE CENTRIC SUBJECTS (any two per semester in semesters 5-6)**
1. CHE-DSE 1: Applications of Computers in Chemistry
2. CHE-DSE 2: Analytical Methods in Chemistry
3. CHE-DSE 3: Polymer Chemistry
4. CHE-DSE 4: Research Methodology for Chemistry
5. CHE-DSE 5: Green Chemistry
6. CHE-DSE 6: Industrial Chemicals & Environment
7. CHE-DSE 7: Instrumental Methods of Analysis
8. CHE-DSE 8: Dissertation

**Courses under these will be offered only if a minimum of 10 students opt for the same

GENERIC ELECTIVE SUBJECTS (Offered by Chemistry Department) for students of other departments

I-Semester
CHE-GE 1: Atomic structure, bonding, general organic chemistry & aliphatic hydrocarbons   OR
CHE-GE 2: Chemical energetics, equilibria & functional organic chemistry-I

II-Semester
CHE-GE 3: Solutions, phase equilibria, conductance, electrochemistry & functional group organic chemistry-II   OR
CHE-GE 4: Transition metal & coordination chemistry, states of matter & chemical kinetics

III-Semester
CHE-GE 5: Molecules of life

IV-Semester
CHE-GE 6: Chemistry of Main Group Elements, Theories of Acids & Bases

Department will run a particular Generic Elective Course only if the minimum number of students opting for that course is 10.
B.Sc. (Honours) in Chemistry

Under the Framework of Honours School System

1\textsuperscript{st} and 2\textsuperscript{nd} Year

Semester I, II, III and IV
Objective: (The objective of the Inorganic Chemistry is to acquaint the student with the basic phenomenon/concepts of atomic structure and the correlation between structure and properties of materials via chemical bonding.)

UNIT-1: Atomic Structure (15 Lectures);

UNIT-2: Periodicity of Elements (15 Lectures);
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 and 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-Jaffe’s electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson’s electron density ratio.

UNIT-3: Chemical Bonding (15 Lectures);
(i) 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. (ii) 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 $N_2$, $O_2$, $C_2$, $B_2$, $F_2$, $CO$, $NO$, and their ions; $HCl$, $BeF_2$, $CO_2$, (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 ($\sigma$ and $\pi$ bond approach) and bond lengths.

UNIT-4: Chemical Bonding (15 Lectures);
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. 

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

**CHE -C1 Lab: (INORGANIC CHEMISTRY-I)** 
**PRACTICALS** 

**Total Lectures : 60**  
**Credits : 2** 

**A) Titrimetric Analysis**  
(i) Calibration and use of apparatus  
(ii) Preparation of solutions of different Molarity/Normality of titrants  

**B) Acid-Base Titrations**  
(i) Estimation of carbonate and hydroxide present together in mixture.  
(ii) Estimation of carbonate and bicarbonate present together in a mixture.  
(iii) Estimation of free alkali present in different soaps/detergents  

**C) Oxidation-Reduction Titrimetry**  
(i) Estimation of Fe(II) and oxalic acid using standardized KMnO₄ solution.  
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.  
(iii) Estimation of Fe(II) with K₂Cr₂O₇ using internal (diphenylamine, anthranilic acid) and external indicator.  

**SUGGESTED READING**  
Objective: (The objective of the Physical Chemistry is to acquaint the student with the basic phenomenon/concepts of equation of state and properties of liquids and solids. In this module students will learn about chemical equilibrium, its types and the factors affecting the state of equilibrium. In this the lesson you will learn about the equilibria involving ionic species. The equilibria involving acids and bases are critically important for a wide variety of reactions. The use of buffer solutions for pH control is of significance in living systems, agriculture and industrial processes.)

UNIT-1; Gaseous state (15 Lectures);
Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; deduce gas laws and ideal gas equation from 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 $\sigma$ from $\eta$; 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. Van der Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici) and virial equation of state.

UNIT-2: Liquification of Gas & Liquid state (15 Lectures)
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.
Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; density, refractive index, 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.

UNIT-3: Solid state (15 Lectures);
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. Defects in crystals. Glasses and liquid crystals.
UNIT-4: Ionic equilibria (15 Lectures);
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.

CHE -C1 Lab: (PHYSICAL CHEMISTRY-I)
PRACTICALS

Total Lectures : 60 Credits : 2

1. Surface tension measurements.
a. Determine the surface tension by (i) drop number (ii) drop weight 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.

3. Density and refractive index measurements
a. Determination of density and refractive index viscosity of organic solvents at room temperature.

4. 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.

SUGGESTED READING
Objective: (To teach the fundamental concepts of Chemistry and their applications. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to the requisite intellectual understanding of atomic structure, bonding, general organic chemistry & aliphatic hydrocarbons and laboratory skills)

UNIT-1: Atomic Structure (15 Lectures);  
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 $\psi$ and $\psi^2$, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (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.

UNIT-2: Chemical Bonding and Molecular Structure (15 Lectures);  
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.

UNIT-3: Fundamentals of Organic Chemistry (15 Lectures);

UNIT-4: Aliphatic Hydrocarbons (15 Lectures);
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, oxymercuration-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.

Reference Books:
CHE-GE1 LAB: (Atomic structure, bonding, general organic chemistry & aliphatic hydrocarbons)

PRACTICALS

Total Lectures : 60                                                                                                   Credits : 2

Section A: Inorganic Chemistry - Volumetric Analysis
1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with KMnO₄.
3. Estimation of water of crystallization in Mohr’s salt by titrating with KMnO₄.
4. Estimation of Fe (II) ions by titrating it with K₂Cr₂O₇ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using Na₂S₂O₃.

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

Reference Books:
Objective: To teach the fundamental concepts of Chemistry and their applications. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to the requisite intellectual understanding of Chemical energetics, equilibria & functional organic chemistry and laboratory skills.

UNIT-1: Chemical Energetics (15 Lectures);

UNIT-2: Chemical Equilibrium & Ionic Equilibria (15 Lectures);
Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between $\Delta G$ and $\Delta G^\circ$, Le Chatelier’s principle. Relationships between $K_p$, $K_c$ and $K_x$ for reactions involving ideal gases.

UNIT-3: Aromatic hydrocarbons, Alkyl and Aryl Halides (15 Lectures);
Organic Chemistry: Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.
Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN$_1$, SN$_2$ and SN$_i$) reactions. Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson’s ether synthesis: Elimination vs substitution.
UNIT-4: Alcohols, Phenols and Ethers (15 Lectures);


Ethers (aliphatic and aromatic): Cleavage of ethers with HI.


Reference Books:
- Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
CHE-GE2 LAB: (Chemical energetics, equilibria & functional organic chemistry-I)

PRACTICALS

Total Lectures : 60

Credits : 2

Section A: Physical Chemistry

Thermochemistry
1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO₃, NH₄Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ∆H.

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.

a) Preparation of buffer solutions:
   (i) Sodium acetate-acetic acid
   (ii) Ammonium chloride-ammonium hydroxide

b) Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed.
Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
(a) Bromination of Phenol/Aniline
(b) Benzoylation of amines/phenols
(c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

Reference Books
Objective: (The objective of the Organic Chemistry is to acquaint the student with the basic phenomenon/concepts of stereochemistry of organic compounds and mechanistic aspects of organic reactions. The course is adequated with basic knowledge of hydrocarbons ranging from alkanes to arenes chemistry so they will understand the method of formations and reactions of compounds)

UNIT-1: Structure, Bonding and Mechanism of Organic Reactions: (15 Lectures);


UNIT-2: Alkanes and Cycloalkanes: (15 Lectures);
Stereochemistry of Organic Compounds-II : Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivative.
Cycloalkanes – nomenclature, methods of formation, chemical reactions, Baeyer’s strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring; banana bonds.

UNIT-3: Alkenes, Cycloalkenes, Dienes (15 Lectures);

UNIT-4: Alkynes, Arenes and Aromaticity (15 Lectures)

Reference Books:
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
1. **Calibration of Thermometer**
   80-82° (Naphthalene), 113-114° (acetanilide).
   132.5-133° (Urea), 100° (distilled Water)

2. **Determination of melting point**
   - Naphthalene 80-82°, Benzoic acid 121.5-122°
   - Urea, 132.5-133°, Succinic acid 184-185°
   - Cinnamic acid 132.5-133°, Salicylic acid 157-5-158°
   - Acetanilide 113-5-114°, m-Dinitrobenzene 90°
   - p-Dichlorobenzene 52°. Aspirin 135°.

3. **Determination of boiling points**
   - Ethanol 78°, Cyclohexane 81.4°, Toluene 110.6°, Benzne 80°.

4. **Mixed melting point determination**
   Urea-Cinnamic acid mixture of various compositions (1:4,1:1,4:1)

5. **Distillation**
   - Simple distillation of ethanol-water mixture using water condenser
   - Distillation of nitrobenzene and aniline using air condenser.

6. **Crystallization**
   - Concept of induction of crystallization
   - Phthalic acid from hot water (using fluted filter paper and stemless funnel)
   - Acetanilide from boiling water
   - Naphthalene from ethanol
   - Benzoic acid from water.

7. **Decolorisation and crystallization using charcoal**
   - Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration.
   - Crystallization and decolorisation of impure naphthalene (100g of naphthalene mixed with 0.3g of Congo Red using 1g decolorising carbon) from ethanol.

8. **Sublimation (Simple and Vacuum)**
   - Camphor, Naphthalene, Phthalic acid and Succinic acid.

9. **Extraction: The separatory funnel, drying agent:**
   - Isolation of caffeine from tea leaves

10. **Steam distillation**
    - Purification of aniline/nitrobenzene by steam distillation.

**Reference Books**
CHE –C4: (PHYSICAL CHEMISTRY- II: Chemical Thermodynamics and its Applications)

THEORY

Total Lectures : 60  
Credits : 4

Objective: (To develop and systematically upgrade their knowledge of concepts of thermodynamics and to be able to identify and describe energy exchange processes. The student with the knowledge of the thermodynamics will understand and explain scientifically the application of the subject to a wide variety of topics in science and engineering, especially physical chemistry, chemical engineering and mechanical engineering.)

UNIT-1: Chemical Thermodynamics (15 Lectures);
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.

UNIT-2: Thermochemistry, Second and Third law of thermodynamics (15 Lectures);
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.

UNIT-3: Free Energy functions and Systems of Variable Composition (15 Lectures);
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.
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.

UNIT-4: Chemical Equilibrium, Solutions and Colligative Properties (15 Lectures);
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 $K_p$, $K_c$ and $K_x$. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

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

Reference Books

**CHE –C4: (PHYSICAL CHEMISTRY- II: Chemical Thermodynamics and its Applications)**

**PRACTICAL**

**Total Lectures : 60**

**Thermochemistry**
(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.
(d) Determination of heat of solution of salts.
(e) Determination of Lattice energy (Born-Haber cycle).
(f) Determination of enthalpy of hydration of copper sulphate.
(g) Study of the solubility of benzoic acid in water and determination of $\Delta H$.

**Reference Books**
Semester II

CHE-GE3: (Solutions, phase equilibria, conductance, electrochemistry & functional group organic chemistry-II )

THEORY

Lectures 60  Credits: 4

Objective: (To teach the fundamental concepts of Chemistry and their applications. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to the requisite intellectual understanding of Solutions, phase equilibria, conductance, electrochemistry & functional group organic chemistry and laboratory skills)

UNIT-1: Solutions and Phase Equilibria (15 Lectures);

Phase Equilibria: 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, FeCl3-H2O and Na-K only).

UNIT-2: Electrochemistry (15 Lectures);


UNIT-3: Organic Chemistry (15 Lectures);
Organic Chemistry: Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.
Carboxylic acid derivatives (aliphatic): (Upto 5 carbons) Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion.


Diazonium salts: Preparation: from aromatic amines. Reactions: conversion to benzene, phenol, dyes.

UNIT-4: Amino Acids, Peptides, Proteins and Carbohydrates: (15 Lectures);


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:
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
Section A: Physical Chemistry

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

\[ \text{I}_2(\text{aq}) + \text{I}^{-}(\text{aq}) \rightarrow \text{I}^{3-}(\text{aq}) \]
\[ \text{Cu}^{2+}(\text{aq}) + x\text{NH}_2(\text{aq}) \rightarrow [\text{Cu(NH}_3]_{x}^2+ \]

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
1. Determination of cell constant
2. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
3. Perform the following conductometric titrations:
   a. Strong acid vs. strong base
   b. Weak acid vs. strong base

Potentiometry
1. Perform the following potentiometric titrations:
   i. Strong acid vs. strong base
   ii. Weak acid vs. strong base
   iii. 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 1. Separation of amino acids by paper chromatography
2. Determination of the concentration of glycine solution by formylation method.
3. Titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. Differentiation between a reducing and a nonreducing sugar.

Reference Books:
CHE-GE4: (Transition metal & coordination chemistry, states of matter & chemical kinetics)

THEORY

Lectures 60 Credits: 4

Objective: (To teach the fundamental concepts of Chemistry and their applications. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to the requisite intellectual understanding of transition metal & coordination chemistry, states of matter & chemical kinetics and laboratory skills)

UNIT-1: Transition Elements (3d series) (15 Lectures);
General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.
Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

UNIT-2: Coordination Chemistry and Crystal Field Theory (15 Lectures);
Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

UNIT-3: Kinetic Theory of Gases and Liquids (15 Lectures);
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).

UNIT-4: Solids and Chemical Kinetics (15 Lectures);

Reference Books:

CHE-GE4: (Transition metal & coordination chemistry, states of matter & chemical kinetics)

**PRACTICAL**

**Section A: Inorganic Chemistry**

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

*Cations : NH⁺⁴, Pb⁺², Bi⁺³, Cu⁺², Cd⁺², Fe⁺³, Al⁺³, Co⁺², Ni⁺², Mn⁺², Ba⁺², Sr⁺², Ca⁺², K⁺*

*Anions : CO₃⁻², S⁻², SO₃⁻², S₂O₃⁻², CH₃COO⁻, Cl⁻, Br⁻, I⁻, NO₃⁻, SO₄⁻², PO₄³⁻, BO₃⁻³, C₂O₄⁻², F⁻*

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically.
2. Estimation of (i) Mg⁺² or (ii) Zn⁺² by complexometric titrations using EDTA.
3. Estimation of total hardness of a given sample of water by complexometric titration.

**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.
3. Initial rate method: Iodide-persulphate reaction
4. Integrated rate method:
c. Acid hydrolysis of methyl acetate with hydrochloric acid.
d. Saponification of ethyl acetate.
e. Compare the strengths of HCl and H$_2$SO$_4$ by studying kinetics of hydrolysis of methyl acetate

**Reference Books:**
OBJECTIVE: The objective of the Inorganic Chemistry is to acquant the student with the general principle of Metallurgy and to explain certain key introductory concepts in inorganic chemistry i.e. acid, bases and inorganic polymers. In addition, the syllabus contents are duly arranged in such a manner so that due importance is given to the understanding of main group elements, and laboratory skills.

UNIT-1: General Principles of Metallurgy & Acids and Bases (15 Lectures)

UNIT-2: Chemistry of s and p Block Elements-I (15 Lectures)

UNIT-3: Chemistry of s and p Block Elements-II (15 Lectures)
Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, boron hydrides (diborane), carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogenes and basic properties of halogens.

UNIT-4: Noble Gases & Inorganic Polymers (15 Lectures)
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). Inorganic Polymers: Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes, phosphazenes and triphosphazenes.
Reference Books:

**CHE –C5 Lab: (INORGANIC CHEMISTRY-II)**

**PRACTICALS**

**Total Lectures: 60**

**Credits : 2**

(A) Iodo/Iodimetric Titrations
(i) Estimation of Cu(II) and K₂Cr₂O₇ using sodium thiosulphate solution (Iodimetrically).
(ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically
(iii) Estimation of available chlorine in bleaching powder iodometrically.

(B) Inorganic preparations
(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.

**Reference Books:**
CHE–C6: (ORGANIC CHEMISTRY-II: Halogenated Hydrocarbons & Functional Groups)

Total Lectures : 60                         Credits : 4

Objective: (The objective of the Organic Chemistry is to acquaint the student with the halogenated hydrocarbons and their comparative studies. The course is adequate with basic knowledge of alcohols, phenols, ethers, carbonyl compounds, carboxylic acids & their derivatives and thiols chemistry so they will understand the method of formations and reactions of compounds)

Instructions for the Paper Setters and Examiners:
Question paper will have four sections. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Unit-I: Chemistry of Halogenated Hydrocarbons: (15 Lectures)
Alkyl halides: Methods of preparation, nucleophilic substitution reactions – SN\textsuperscript{1}, SN\textsuperscript{2} and SN\textsuperscript{i} mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.
Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; S\textsubscript{N}Ar, 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.

Unit-II: Alcohols, Phenols, Ethers and Epoxides: (15 Lectures)
Alcohols: preparation, properties and relative reactivity of 1\textdegree, 2\textdegree, 3\textdegree alcohols, Bouvaelt-BlancReduction; 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\textsubscript{4}

Unit-III: Carbonyl Compounds: (15 Lectures)
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, \(\alpha\)-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH\textsubscript{4}, NaBH\textsubscript{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.

**Unit-IV Carboxylic Acids & their Derivatives & Sulphur containing compounds: (15 Lectures)**

*Carboxylic Acids & 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 substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmannbromamide degradation and Curtius rearrangement.

*Sulphur containing compounds*: Preparation and reactions of thiols, thioethers and sulphonic acids.

**Reference Books:**


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**CHE –C6 Lab: (ORGANIC CHEMISTRY-II) PRACTICALS**

**Total Lectures: 60**

**Credits : 2**

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. Benzoylation 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, pcesol) 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)
   v. Nitration of any one of the following:
      a. Acetanilide/nitrobenzene by conventional method
      b. Salicylic acid by green approach (using ceric ammonium nitrate).
vi. Selective reduction of *meta* dinitrobenzene to *m*-nitroaniline.
vii. Reduction of *p*-nitrobenzaldehyde by sodium borohydride.
viii. Hydrolysis of amides and esters.
ix. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
x. S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
xi. Aldol condensation using either conventional or green method.
xii. 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**
Objective: (The objective of the course is to give the students insight into the basics of chemistry in everyday life through the in-depth study of topics like concepts of phases, components and degrees of freedom, binary solutions, azeotropes, steam distillation, Nernst Distribution Law, Determination of rate laws of reactions, parallel reactions. Temperature dependence of reaction rates, Physiosorption, Chemisorption. The course will make a better understanding and designing of different research problems based on the study of catalysis and mechanism of catalyzed reactions. The students will be made to practically analyse the theoretical concepts through various practical problems like determination of critical solution temperature and composition of two component system and effect of impurities on them, construction of phase diagrams using cooling curves, study of kinetics of reactions, verification of different adsorption isotherms.)

UNIT-1: Phase Equilibria (15 Lectures)
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.

UNIT-2: Phase Equilibria (15 Lectures)
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.

UNIT-3: Chemical Kinetics (15 Lectures)
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.

UNIT-4: Catalysis & Surface chemistry (15 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.


Reference Books:

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CHE –C7 Lab: (PHYSICAL CHEMISTRY-III)

PRACTICALS

Total Lectures : 60                                                                                         Credits : 2

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) $I_2(aq) + I^{-} \rightarrow I^3(aq)^{2+}$
   (ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$

V. Study the kinetics of the following reactions.
   1. Initial rate method: Iodide-persulphate reaction
   2. Integrated rate method:
      a. Acid hydrolysis of methyl acetate with hydrochloric acid.
      b. Saponification of ethyl acetate.
   3. Compare the strengths of HCl and H$_2$SO$_4$ 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:
Total Lectures: 30

Objective: (The objective of the IT Skills for Chemists is to acquaint the student with the basic understanding of the Mathematics, Computer programming, HANDS ON & Handling numeric data and Numeric modeling, Statistical analysis & Presentation for various chemistry subjects).

UNIT-1: Mathematics (8 Lectures)
Fundamentals, mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, interconversion of units, constants and variables, equation of a straight line, plotting graphs.
Algebraic operations on real scalar variables (e.g. manipulation of van der Waals equation in different forms). Roots of quadratic equations analytically and iteratively (e.g. pH of a weak acid). Numerical methods of finding roots (Newton-Raphson, binary –bisection, e.g. pH of a weak acid not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions).
Differential calculus: The tangent line and the derivative of a function, numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).
Numerical integration (Trapezoidal and Simpson’s rule, e.g. entropy/enthalpy change from heat capacity data).

UNIT-2: Computer programming (8 Lectures)
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.
BASIC programs for curve fitting, numerical differentiation and integration (Trapezoidal rule, Simpson’s rule), finding roots (quadratic formula, iterative, Newton-Raphson method).

UNIT-3: HANDS ON & Handling numeric data (7 Lectures)
Introductory writing activities: Introduction to word processor and structure drawing (ChemSketch) software. Incorporating chemical structures, chemical equations, expressions from chemistry (e.g. Maxwell-Boltzmann distribution law, Bragg’s law, van der Waals equation, etc.) into word processing documents.
Handling numeric data: Spreadsheet software (Excel), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs. Incorporating tables and graphs into word processing documents. Simple calculations, plotting graphs using a spreadsheet (Planck’s distribution law, radial distribution curves for hydrogenic orbitals, gas kinetic theory- Maxwell-Boltzmann distribution curves as function of temperature
and molecular weight), spectral data, pressure-volume curves of van der Waals gas (van der Waals isotherms), data from phase equilibria studies. Graphical solution of equations.

UNIT-4: Numeric modeling, Statistical analysis & Presentation (7 Lectures)
Numeric modelling: Simulation of pH metric titration curves. Excel functions LINEST and Least Squares. Numerical curve fitting, linear regression (rate constants from concentration time data, molar extinction coefficients from absorbance data), numerical differentiation (e.g. handling data from potentiometric and pH metric titrations, pKa of weak acid), integration (e.g. entropy/enthalpy change from heat capacity data).
Statistical analysis: Gaussian distribution and Errors in measurements and their effect on data sets. Descriptive statistics using Excel. Statistical significance testing: The \( t \) test. The \( F \) test.
Presentation: Presentation graphics

Reference Books:
CHE-SEC1: BASIC ANALYTICAL CHEMISTRY
THEORY

Total Lectures: 30  Credits: 2

Objective: (The objective of the Basic Analytical Chemistry is to acquaint the student with the basic understanding of the Analytical Chemistry and Analysis of soil, water & food products).

UNIT-1: (7 Lectures)
Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.
Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators
a. Determination of pH of soil samples.
b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

UNIT-2: (7 Lectures)
Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.
a. Determination of pH, acidity and alkalinity of a water sample.
b. Determination of dissolved oxygen (DO) of a water sample.
Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration.
a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
b. Analysis of preservatives and colouring matter.

UNIT-3 (8 Lectures)
Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.
a. Paper chromatographic separation of mixture of metal ion (Fe$^{3+}$ and Al$^{3+}$).
b. To compare paint samples by TLC method.
Ion-exchange: Column, ion-exchange chromatography etc.
Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

UNIT-4 (7 Lectures)
Analysis of cosmetics: Major and minor constituents and their function
a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Suggested Applications (Any one):  
a. To study the use of phenolphthalein in trap cases.  
b. To analyze arson accelerants.  
c. To carry out analysis of gasoline.

Suggested Instrumental demonstrations:
a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drinks.

Reference Books:
GE5: MOLECULES OF LIFE
THEORY

Total Lectures : 60                                                                                       Credits : 4

Course Objectives: The course will provide foundational knowledge of the chemistry of life. It investigates the modern science of biological molecules, which are subject of study in chemistry, biology, and medicine. The focus will be in understanding the major molecular components of the cell i.e., carbohydrates, proteins, nucleic acids, lipids, enzymes etc. viz-à-viz role of chemical principles in understanding their structure and function. It will also help in understanding the action of therapeutic drugs on a molecular level and source of energy in biosystems.

Unit-1: Carbohydrates and Lipids
Carbohydrates: Classification of carbohydrates, reducing and non-reducing sugars, General properties of glucose and fructose, their open chain structure. Epimers, mutarotation and anomers.
Determination of configuration of Glucose (Fischer proof).
Lipids: Introduction to lipids, classification.
Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

(15 Lectures)

Unit-2: Amino Acids, Peptides and Proteins
Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins.
Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C-terminal amino acid (by thiohydantoin).
Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

(14 Lectures)

Unit-3: Nucleic Acids
Components of nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

(13 Lectures)

Unit-4: Enzymes, correlation with drug action and Concept of Energy in Biosystems
Enzymes, correlation with drug action: Mechanism of enzyme action, 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 and Noncompetitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure–activity relationships of drug molecules.

Concept of Energy in Biosystems: Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of
cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of Carbohydrate- Glycolysis, Fermentation, Krebs Cycle.

(18 Lectures)

**Recommended Texts:**

**GE5: MOLECULES OF LIFE**

**PRACTICAL**

**Lectures 60**

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. To determine the saponification value of an oil/fat.
5. To determine the iodine value of an oil/fat
6. Differentiate between a reducing/ nonreducing sugar.
7. Extraction of DNA from onion/cauliflower

**Credits: 2**

**Recommended Texts:**

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OBJECTIVE: (To teach the fundamental concepts of Chemistry and their applications. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to the requisite intellectual understanding of coordination chemistry, transition metal & Bio inorganic chemistry)

UNIT-1 (15 Lectures)
Coordination Chemistry-I
IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers, Werner’s theory, Effective Atomic numbers, Stability of complexes, Factors affecting stability of the complexes (Chelate effect), Labile and inert complexes.
Valence bond theory (inner and outer orbital complexes), Electroneutrality principle and back bonding.

UNIT-2 (15 Lectures)
Coordination Chemistry-II
Crystal field theory, CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt).
The splitting of d-orbitals in different fields (octahedral, tetrahedral, tetragonally distorted octahedral, square planar, trigonal bipyramidal), Consequences and applications of orbital splitting, crystal field stabilization energy magnetic properties, measurement of 10 Dq (Δo), Factors affecting extent of splitting and spectrochemical series, colour of transition metal complexes. Structural effect of crystal field splitting; ionic radii, Jahn Teller effect in octahedral and tetrahedral complexes.
Qualitative aspect of Ligand field and MO Theory.

UNIT-3 (15 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)

UNIT-4
Lanthanoids and Actinoids:
Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

**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.

**Reference Books:**

**CHEMISTRY-C 8 LAB**

**PRACTICAL**

**Lectures 60**

**Credits: 2**

**Gravimetric Analysis:**
i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN
iii. Estimation of iron as Fe$_2$O$_3$ 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$_2$O
ii. *Cis* and *trans* K[Cr(C$_2$O$_4$)$_2$. (H$_2$O)$_2$] 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 Book:**
Objective: (The objective of the Organic Chemistry is to acquaint the student with the heterocyclic chemistry and concepts of stereochemistry of organic compounds. The course is adequate with basic knowledge of nitrogen containing functional groups, heterocyclic & polynuclear compounds, fats, oils, detergents and stereochemical principles so they will understand the method of formations and reactions of compounds)

Instructions for the Paper Setters and Examiners:
Question paper will have four sections. Examiner will set a total of nine questions comprising two questions from each unit and one compulsory question of short answer type covering the whole syllabus. The students will attempt one question from each unit and the compulsory question. All questions may carry equal marks, unless specified.

Unit-I: Nitrogen Containing Functional Groups: (15 Lectures)
Preparation and important reactions of nitro 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.

Unit-II: Heterocyclic Compounds: (15 Lectures)
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 furic acid.

Unit-III:Polynuclear Hydrocarbons and Fats, Oils & Detergents: (15 Lectures)
Polynuclear Hydrocarbons:Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons. Fats, Oils and Detergents:Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils. Saponification value, iodine value, acid value. Soaps, synthetic detergents, alkyl and aryl sulphonates. (15 Lectures)
Unit-IV: Stereochemical Principles; conformation, steric and stereoelectronic effects: (15 Lectures)
Enantiomeric relationships, Diastereomeric relationships, Dynamic stereochemistry, Prochiral relationships, Conformations of Acyclic molecules, cyclohexane derivatives, Rings other than six membered. Conformational effects on reactivity, angle strain and its effects on reactivity. Relationship between ring size and facility of ring closure. Torsional strain and related stereo electronic effects.
*Free radical reactions:* Generation and characterization, characteristics of reaction mechanisms involving and electron transfer reactions.

**Reference Books:**
- Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

CHE–C9: (ORGANIC CHEMISTRY-III: Heterocyclic Chemistry & Stereochemical Principles)

**PRACTICAL**

Total Lectures : 60  
Credits : 2

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**
CHE –C10: (PHYSICAL CHEMISTRY-IV: Conductance, Electrochemistry, Electric & Magnetic Properties)

THEORY

Total Lectures : 60  
Credits : 4

Objective: (The course covers basic ideas of electrostatics, dipole moments, diamagnetism, paramagnetism, concepts of conductivity, equivalent and molar conductivity, Kolrausch Law, Ionic velocities, and various applications of conductance measurements such as ionic product of water, conductometric titrations, hydrolysis constants of salts. The course intends to impart basic knowledge of electrochemistry and its application in industrial and metallurgical processes covering all the important topics such as Faraday’s laws of electrolysis, Chemical cells, EMF of cell and its measurement, Application of EMF measurements in determining (i) free energy, enthalpy, and entropy of a cell reaction (ii) equilibrium constants and (iii) pH values using different electrodes. The practical course includes conductometric and potentiometric titrations of different acids and bases and practical determination of cell constant, equivalent conductance, degree of dissociation and dissociation constant of weak acid.)

UNIT-1: Conductance (15 Lectures)
Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods.

UNIT-2: Conductance & Electrochemistry (15 Lectures)
Conductance: 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.
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,

UNIT-3: Electrochemistry (15 Lectures)
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/Sb$_2$O$_3$ 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).

UNIT-4: Electrical & Magnetic Properties of Atoms and Molecules (15 Lectures)
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.

Reference Books:

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CHE –C10 Lab: (PHYSICAL CHEMISTRY-IV)
PRACTICALS

Total Lectures : 60  Credits : 2

Conductometry
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

Potentiometry
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

Reference Books:

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Objective: (The objective of the Analytical clinical biochemistry is to acquaint the student with the basic understanding of the structures, properties and functions of carbohydrates, lipids, proteins, hormones, DNA & RNA, blood and urine analysis).

Unit-I: Carbohydrates and Proteins: (8 Lectures)
Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysachharides.
Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins.

Unit-II: Enzymes and Lipids: (7 Lectures)
Enzymes: Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in “Green Chemistry” and Chemical Industry.
Lipids: Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. Lipoproteins.

Unit-III: Hormones and DNA & RNA: (7 Lectures)
Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.

Unit-IV: Blood/ urine analysis: (8 Lectures)
Biochemistry of disease: A diagnostic approach by blood/ urine analysis.

Practicals
Identification and estimation of the following:
1. Carbohydrates – qualitative and quantitative.
2. Lipids – qualitative.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Determination of cholesterol using Liebermann-Burchard reaction.
7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids

Reference Books:
CHE-SEC2: Chemical Technology & Society

Total Lectures: 30                                                                                                       Credits : 2

Objective: (The objective of the Chemical Technology & Society is to acquaint the student with the basic understanding of the Chemical Technology & exploration of societal and technological issues from a chemical perspective).

UNIT-1: Chemical Technology (7 Lectures)
Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption.

UNIT-2: Chemical Technology (8 Lectures)
An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.

UNIT-3: Society (7 Lectures)
Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants).

UNIT-4: Society (8 Lectures)
Energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission; materials like plastics and polymers and their natural analogues, proteins and nucleic acids, and molecular reactivity and interconversions from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs.

Reference Book:
CHE-GE 6: Chemistry of Main Group Elements, Theories of Acids & Bases

THEORY

Total Lectures : 60

Credits : 4

Objective: (The objective of the Chemistry of Main Group Elements, Theories of Acids & Bases is to acquaint the student with the basic understanding of the Acids and Bases & General Principles of Metallurgy, s- and p-Block Elements, and Noble gases & Inorganic Polymers)

UNIT-1: Acids and Bases & General Principles of Metallurgy (15 Lectures)
Acids and Bases: Brønsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

UNIT-2: s- and p-Block Elements (15 Lectures)
Periodicity in s- and p-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electron gain enthalpy, electronegativity (Pauling scale).
General characteristics of s-block metals like density, melting and boiling points, flame colour and reducing nature.
Oxidation states of s- and p-block elements, inert-pair effect, diagonal relationships and anomalous behaviour of first member of each group. Allotropy in C, P and S.
Complex forming tendency of s block elements and a preliminary idea of crown ethers and cryptates, structures of basic beryllium acetate, salicylaldehyde/ acetylacetonato complexes of Group 1 metals.
Solutions of alkali metals in liquid ammonia and their properties. Common features, such as ease of formation, solubility and stability of oxides, peroxides, superoxides, sulphates and carbonates of s-block metals.

UNIT-3: p-Block Elements (15 Lectures)
Structure, bonding and properties (acidic/ basic nature, oxidizing/ reducing nature and hydrolysis of the following compounds and their applications in industrial and environmental chemistry wherever applicable:
A brief idea of pseudohalides

UNIT-4: Noble gases & Inorganic Polymers (15 Lectures)
Noble gases: Rationalization of inertness of noble gases, clathrates, preparation and properties of XeF2, XeF4 and XeF6 ,bonding in these compounds using VBT and shapes of noble gas compounds using VSEPR Theory

**Recommended texts:**

**CHE-GE 6: Chemistry of Main Group Elements, Theories of Acids & Bases**

**PRACTICAL**

**Lectures 60**

1. Iodometric estimation of potassium dichromate and copper sulphate
2. Iodimetric estimation of antimony in tartaremetric
3. Estimation of amount of available chlorine in bleaching powder and household bleaches
4. Estimation of iodine in iodized salts.
5. Iodimetric estimation of ascorbic acid in fruit juices.
7. Gravimetric estimation of sulphate as barium sulphate.
8. Gravimetric estimation of aluminium as oximato complex
9. Preparation of the following: potash alum, chrome alum, tetraamminecopper(II) sulphate monohydrate, potassium trioxalatoferrate(III) (any two, including one double salt and one complex).

**Recommended Texts:**