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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hr.</th>
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BS: 1st Year (Semester-I)

Course Title: Biochemistry-I  Cr. Hr. 2
Course Code: CHEM-1101

1. Thermodynamics in Life

2. Aqueous solutions as medium of life.
Role of hybridization towards geometry and shape of water molecules, Water as a solvent, Dissociation of water, pH and pH scale, Strengths of Acids and Bases, pH Buffers, pH Indicators, Solubility and solubility Product.

3. Amino acids and Proteins

4. Lipids
Classification. Fatty acids and their properties. Chemistry of glycerides, phospholipids and steroids. Biological significance of lipids. Structure and functions of biological membranes

5. Carbohydrates
Classification of carbohydrates, chemistry and properties of monosaccharide, disaccharides and polysaccharides.
Practical: Biochemistry-I
Course Code: CHEM-1101P

1. Acid hydrolysis of starch
2. Qualitative tests for amino acids
3. Isolation and identification of amino acids from the given sample by paper chromatography
4. Titration curve of amino acids.
5. Qualitative tests for carbohydrates (pentoses, hexoses, reducing and non reducing sugar).
6. Qualitative tests for fats, sterols and phospholipids.
7. Determination of iodine number of fat
8. Determination of acid value of fat

Recommended Books:

BS: 1st Year (Semester-II)
Course Title: Biochemistry-II
Course Code: CHEM-1201

1. Nucleic Acids
Purines and pyrimidines, nucleosides and nucleotides, Structures and functions of RNA and DNA.

2. Enzymes
Chemical nature, nomenclature and classification, Catalysis and enzyme kinetics, Enzyme activity, Effect of different factors on enzyme activity, Coenzymes and immobilized enzymes.

3. Vitamins
Introduction, classification, chemistry and biological significances of vitamins.
4. Bioenergetics and Biological oxidation
Introduction, high energy molecules, biological oxidations, oxidative phosphorylation, glycolysis and citric acid cycle.

5. Evolution of Biomolecules
Different theories of evolution of biomolecules, evolution of complex living systems.

Practical: Biochemistry-II  Cr. Hr. 1
Course Code: CHEM-1201P
1. Assay of catalase isolated from potato
2. Extraction and estimation of amylase from germinating seeds
3. Determination of Km and Vmax of Amylase
4. Isolation of DNA
5. Estimation of Na\(^+\) ions in blood/urine
6. Estimation of K\(^+\) in blood/urine
7. Estimation of glucose in blood/urine sample using quantitative Benedict’s reagent
8. Estimation of protein in egg by Lowry’s method

Recommended Books
Theory

Practicals
BS: 2nd Year (Semester-III)

Course Title: Organic Chemistry-I     Cr. Hr. 2
Course Code: CHEM-2101

1. Basic Concepts in Chemical Bonding
Concept of hybridization leading to bond angles, bond energies and geometry of some organic molecules; inductive effect; dipole moment; Localized and delocalized bonding; resonance, resonance energy, rules of resonance, resonance effect, steric inhibition of resonance; hyperconjugation; tautomerism; hydrogen bonding and its significance in living system.

2. Chemistry of the Hydroxyl Group and Ethers
Physical properties of alcohols, preparation of alcohols by Hydration of alkenes, Hydrolysis of alkyl halides, Grignard reagents and Reduction of carbonyl compounds along with mechanism. Reactions of alcohols with detailed mechanism
Physical properties of phenol, Preparation of phenol and reactions with a special focus on mechanisms. Open chain and cyclic ethers, their preparation, properties and reactions.

3. Chemistry of Carbonyl Compounds
Structure and reactivity of the carbonyl group; preparation and reactions of aldehydes and ketones with a special emphasis on mechanisms.

4. Chemistry of Carboxylic Acids and Their Derivatives
Physical properties of carboxylic acids, effect of substitution and structure on the strengths of acidity of carboxylic acids. Preparation and reactions of carboxylic acids and their derivatives i.e. esters, amides, acid halides and acid anhydrides along with mechanisms.

Practical: Organic Chemistry-I     Cr. Hr. 1
Course Code: CHEM-2101P

1. Basic Experimental Techniques
Determination of melting, mixed melting and boiling point, Hand on practice on distillation, solvent extraction, crystallization

2. Preparation of Organic Compounds
Preparation of following organic compounds.
a) Aspirin
b) Benzoic acid
c) Benzyl alcohol
d) Iodoform
e) Ethylbenzoate
f) Butyl chloride
Recommended Books

Theory

Practicals

BS: 2nd Year (Semester-IV)
Course Title: Organic Chemistry-II Cr. Hr. 2
Course Code: CHEM-2201

1. Chemistry of Amino Group
2. Structure and Reactivity
Concepts of acids and bases; scale of acidity and basicity; \( pK_a \) values; predicting acid/base reactions from \( pK_a \) values; the effect of structure on the strengths of acids and bases, field effects, resonance effects, steric effects, hydrogen bonding effects and hybridization effects; the effect of the medium on the strengths of acids and bases; the Hammett and Taft’s equations- applications and limitations.

3. Aliphatic Nucleophilic Substitution Reactions:
Mechanisms and study of \( S_N1 \), \( S_N2 \), \( S_{Ni} \), \( S_{N1}' \), \( S_{N2}' \) mechanisms; Neighbouring group participation: Intramolecular displacement by neighbouring oxygen, nitrogen, sulphur and halogen; The effects of the substrate structure, entering group, leaving group and reaction medium on the mechanisms and rates of substitution reactions.

4. Elimination Reactions:
Study of E1, E1cB and E2 mechanisms; Saytzeff and Hofmann Rules; The effects of the substrate structure, attacking base, leaving group and the reaction medium on the rates and mechanisms of elimination reactions; competition between elimination and substitution reactions.

Books Recommended:

Practical: Organic Chemistry-II Cr. Hr. 1
Course Code: CHEM-2201P

Qualitative Organic Analysis
Systematic identification of following organic compounds via preliminary tests, detection of elements, allocation of functional group, test for functional group and confirmation by solid derivative preparation/ melting point determination.

i-Cinnamic acid ii-Urea iii-Thiourea iv-Benzoic acid
v-Phenol vi-Catechol vii-Resorcinol viii-Phloroglucinol
ix-Naphthalene x-Anthracene xi-Phenanthrene xii-\( \alpha \)-Naphthol
xiii-\( \beta \)-Napthol xiv-Starch xv-Oxalic acid
BS: 2\textsuperscript{nd} Year (Semester-VI)

Course Title: Analytical Chemistry-I  
Course Code: CHEM-2202  
Cr. Hr. 3

1. Fundamentals of Chemometrics: Sampling, stoichiometric calculations, experimental errors, correlation coefficient, arithmetic mean, median, mode, standard deviation, relative standard deviation, confidence limit, Gaussian distribution, least square method, statistical tests, quality assurance and calibration methods.


3. Titrimetry and Gravimetry: Titration based on acid - base reactions, titration based on complexation reactions, titration based on redox reactions, precipitation reactions and Gravimetric analysis.

Practical: Analytical Chemistry-I  
Course Code: CHEM-2202 P  
Cr. Hr. 1

Course Title: Analytical Chemistry-I (Practical)  
Course Code: CHEM-2202  
Cr. Hr. 1

2. A statistical evaluation of spectrometric absorption data including linear regression analysis.
3. Graphing with MS Excel and constructing a calibration curve from given analytical data.
4. Finding of $[\text{OH}^-]$ ion when $[\text{H}^+]$ is known
5. Determination of hardness of water using EDTA.
6. Determination of chloride in tap water Sample.
7. Estimation of copper, arsenic, hydrogen peroxide and vitamin C using iodometry.
8. Percentage determination of barium in barium nitrate by gravimetric method.
11. Determinations of cation in a mixture by complexometric titrations.
12. Study the effect of common ions on solubility of sparingly soluble salts
   (AgCl / PbSO4).

Books Recommended:

   2003.
   Reinhold Company. (1972)

BS: 3rd Year (Semester-V)
Course Title: Physical Chemistry-I Cr. Hr. 3
Course Code: CHEM-3101

1. Physical States of Matter:
   Ideal and real gases, equations of state, critical phenomenon, critical constants,
   collision diameter, mean free path and collision number. Physical properties of
   liquids: surface tension, viscosity, refractive index, dipole moment etc. and their
   applications. Brief account of interactions among the molecules in liquids.
   Packing of atoms. Unit cells and crystal systems. Methods of crystal structure
   analysis (powder and single crystal XRD) and Bragg’s diffraction law.

2. Solution Chemistry:
   Ideal and non-ideal solutions. Concentration units and their inter-convension.
   Raoult’s law and its applications. Molecular interactions in solutions and ionic
   strength. Thermodynamic derivations of Colligative properties; lowering of vapour
   pressure, elevation of boiling point, depression of freezing point, osmotic
   pressure. Abnormal colligative properties; degree of association and dissociation
   of solutes. Osmotic pressure and its measurement. Fractional distillation and
   concept of azeotropic mixture.

3. Chemical Kinetics:
   Rate of reactions and Rate law. Derivations of zero, first, and second order
   reactions with same and different initial concentration of reactants, equations of
   half life periods. Integration, half life, initial rate, and graphical methods for the
   determination of reaction order and its rate constant. Different techniques for the
measurements of order of reactions. Derivation of Arrhenius equation and measurements of its parameters.

4. Chemical Equilibrium:
Dynamic equilibrium, Free enthalpy and chemical affinity. Equilibrium constant in different concentration units, Kc, Kp, Kn, and Kx and their relationships. Pressure and temperature dependence of equilibrium constant and degree of dissociation.

5. Chemical Thermodynamics:
Thermodynamic functions: internal energy, enthalpy, entropy, free energy and feasibility of reactions. Heat capacity at constant pressure (Cp) and constant volume (Cv) and their relationship. Effect of temperature over enthalpy change and internal energy change. Relations between thermodynamic functions. Isothermal, adiabatic, isobaric and isochoric processes. Second and third law of thermodynamics.

Practical: Physical Chemistry-I
Course Code: CHEM-3101P

1. Determination of viscosity and paraochor values of liquids.
2. Determination of percent composition of liquid solutions viscometrically.
3. Determination of refractive index and molar refractivity.
4. Determination of percent composition of liquid solutions by refractive index measurements.
5. Determination of molecular weight of a compound by elevation of boiling point (ebullioscopic method).
6. Determination of molecular weight of a compound by lowering of freezing point (cryoscopic method).

Books Recommended
Theory:


Practical:

BS: 3rd Year (Semester-V)
Course Title: Inorganic Chemistry-I Cr. Hr. 3
Course Code: CHEM-3102

1. The Periodic Law and Periodicity
   Development of Periodic Table; Classification of elements based on s, p, d and f orbitals, group trends and periodic properties in s, p, d and f block elements, i.e., atomic radii, ionic radii, ionization potential, electron affinities, electronagerties and redox potential.
2. **Principles of Chemical Bonding**
   Types of chemical bonding; ionic bonding; the localized bond approach: VB theory, hybridization and resonance; the delocalized approach to bonding: molecular orbital theory as applied to diatomic and polyatomic molecules, three center bonds, bonding theory of metals and intermetallic compounds; conductors, insulators and semiconductors; bonding in electron deficient compounds; hydrogen bonding.

3. **Acids and Bases**
   Concepts of acids and bases including SHAB concept, relative strength of acids and bases, significance of pH, pKa, pKb and buffer solutions. Theory of indicators, solubility, solubility product, common ion effect and their industrial applications.

4. **Chemistry of p-block Elements**
   Chemistry and structure of p-block elements; main emphasis on the chemistry and structure of noble gases and their compounds, chemistry and structure of interhalogens, pseudohalogens and polyhalides. Prediction of shapes of molecules using VSEPR model and hybridization.

**Practical: Inorganic Chemistry-I**

**Course Code: CHEM-3102P**

1. **Preparation and Standardization of Molar solution of HCl, NaOH and KMnO₄.**
2. **Qualitative Analysis**
   a) Determination of strength of NaOH & Na₂CO₃ in the given solution.
   b) Determination of strength of Na₂CO₃ & NaHCO₃ in the given solution, using HCl.
   c) Determination of composition of H₂SO₄ & Oxalic acid in the given solution.
   d) Determination of purity of commercial Pot. Oxalate, using KMnO₄.
   e) Determination of strength of Mohr’s salt in the given solution, by K₂Cr₂O₇ (using internal indicator method).
   f) Determination of % age purity of commercial FeSO₄, by K₂Cr₂O₇ (using external indicator method).
   g) Determination of strength of CuSO₄ solution, Iodometrically, using Na₂S₂O₃.
   h) Determination of strength of K₂Cr₂O₇ solution, Iodometrically.
3. **Preparations of following Inorganic Compounds**
   a) FeSO₄.
   b) Sod. Cobaltinitrite, Na₃[Co(NO₂)₆].
   c) Potash Alum, K₂SO₄.Al₂(SO₄)₃.24H₂O.
   d) Prussian Blue.
Recommended Books:

Practicals

BS: 3rd Year (Semester-V)
Course Title: Organic Chemistry-III
Course Code: CHEM-3103

1. Conformational isomerism:
Conformational analysis of monosubstituted cyclohexanes, disubstituted cyclohexanes and decalin systems.

2. Optical isomerism:
Optical activity, chirality, symmetry elements and optical inactivity, relative and absolute configuration, R, S notation, methods of determining configuration, racemic mixtures and their resolution, asymmetric synthesis, optical activity in biphenyls, allenes and spiro compounds, stereospecific and stereoselective reactions.

3. Geometrical isomerism:
cis- and trans- isomerism in cyclic systems, Z, E convention, Determination of configuration of geometrical isomers.

Practical: Organic Chemistry-III
Course Code: CHEM-3103P
Cr. Hr. 1

1. Synthesis of the following organic compounds.
   i) Benzilic acid
   ii) p-Nitro aniline
   iii) Phenacetin
   iv) p-Bromoaniline.
   v) Benzil

2. Estimation of following groups.
   a) amino
   b) hydroxyl
   c) amido
   d) carbonyl
   e) carboxyl group

3. Determination of Saponification value and acid value in oil.

Books Recommended
(Latest available editions of the following books are recommended)

1. **Separation Methods**: Principle of solvent extraction; The distribution coefficient, distribution ratio, The percentage extracted, solvent extraction of metals, analytical separations, multiple batch extraction, counter current distribution, solid-phase extraction, solvent extraction by flow injection method. Introduction to chromatographic Methods; principles of chromatography, classification of chromatographic techniques, over view of paper, thin layer, column, ion exchange chromatography and electrophoresis.

2. **Spectrophotometry**: Fundamentals; Properties of light and its interaction with matter, relation between frequency, velocity and wave number, Lambert-Beer’s law and its limitations. Single beam and double beam spectrophotometers, lamps and lasers as sources of light, monochromators, detectors; photomultiplier tube, photodiode array, charged coupled device. FT-IR spectroscopy; fourier analysis, interferometry, noise and its control.

**BS: 3rd Year (Semester-V)**

**Course Title: Analytical Chemistry-II (Practical)**  
**Cr. Hr. 1**

**Course Code: CHEM-3104P**

1. Separation of phenol from given organic mixture using solvent extraction.
2. Separation of given mixture of cations using Paper Chromatography.
3. Analysis of the composition of a mixture of nitro anilines by TLC.
5. Separation of amino acids using paper/thin layer chromatography.
6. Deionization and softening of water using ion exchange chromatography.
7. Determination of $\lambda_{\text{max}}$ of KMnO$_4$ and K$_2$Cr$_2$O$_7$ solutions and verification of Beer-Lambert’s law.
8. Determination of stoichiometry of a metal complex by visible spectrometry.
9. Determination of aspirin and caffeine in a proprietary analgesic by double beam UV-Vis. spectrometer.
10. Quantification of iron in a given sample by using single beam spectrophotometer.
11. A study of characteristics infrared absorption frequencies.

**Books Recommended:**


BS: 3rd Year (Semester-V)
Course Title: Environmental Chemistry Cr. Hr. 3
Course Code: CHEM-3105

Recommended Books
5. Pakistan Environmental Pollution Act 1997.
7. S. K. Banerji, Environmental Chemistry, Tata Publisher, Delhi.
8. Staneley E. Manahan, Environmental Chemistry, Brooks, California.

BS: 3rd Year (Semester-VI)
Course Title: Physical Chemistry-II Cr. Hr. 3
Course Code: CHEM-3201
1. Electrochemistry:
Spontaneous reactions and electrode potential, electrochemical cell, types of concentration cells, electrolysis with different examples of electrolytes, liquid junction potential electron transfer reactions, rate of charge transfer reaction and Butler-Volmer equation. Latimer Diagram, Frost Diagram, cell Potential and thermodynamics, and Nernst Equation. Voltammetry, fuel cells. Corrosion and its prevention. Fuel cell and hydrogen economy.
2. Conductometry:

3. Quantum Chemistry and Spectroscopy:

4. Group Theory:
Symmetry operations. properties of groups, matrices, transformation of matrices, character tables.

Practical: Physical Chemistry-II
Course Code: CHEM-3201P

Cr. Hr. 1

1. Determination of molecular weight of a polymer by viscosity method
2. Determination of specific and molar conductivities of strong and weak electrolytes
3. Precipitation value of electrolytes
4. Measurement of IR spectra of simple compound and their interpretation
5. Measurement of cyclic voltammogram of an organic compound and its interpretation
6. Determination of dipole moment of an organic liquid
7. Determination of percentage composition of $\text{KMnO}_4 / \text{K}_2\text{Cr}_2\text{O}_7$ in a given solution by spectrophotometry.
8. Stoichiometry of a complex in solution by Job’s method
9. Evaluation of $pK_a$ value of an indicator by spectrometric method

Recommended Books

Theory
2. G. W. King, “Spectroscopy and Molecular Structure”, Rinehart and Winston (1964)

Practical:

BS: 3rd Year (Semester-VI)
Course Title: Inorganic Chemistry-II       Cr. Hr. 3
Course Code: CHEM-3202

1. Chemistry of Coordination Compounds
   Historical background of coordination compounds, geometry of complexes having coordination number 2 to 9, nomenclature, theories of coordination compounds; Werner's theory, valence bond theory, crystal field and; molecular orbital theory; Jahn-Teller theorem; magnetic properties; spectrochemical series, isomerism and stereochemistry, stability constants, techniques for studying complexes, applications of coordination compounds.

2. Non Aqueous Solvents
   Classification of solvents, types of reactions in solvents, effect of physical and chemical properties of solvent, detailed study of liq. NH₃, liq. H₂SO₄, liq HF, and liq. SO₂, BrF₃ and reaction in molten salts system.

Practical: Inorganic Chemistry-II       Cr. Hr. 1
Course Code: CHEM-3202P
1. **Precipitation Titrations.**
   a) Determination of strength of NaCl given solution by AgNO₃ using Fluoresceine as indicator.
   b) Determination of % age purity of KBr using Fluoresceine as indicator.
   c) Determination of % composition of mixture of KI & KNO₃ using Eosceine as indicator.

2. **Complexometric Titrations**
   a) Determination of strength of MgSO₄ solution using Eriochrome Black-T as Indicator.
   b) Determination of % age purity of ZnSO₄ solution using Eriochrome Black-T as Indicator.
   c) Determination of Total Hardness of water sample.

3. **Chromatographic Separations**
   a) Separation of Ni²⁺ & Co²⁺ ions in a mixture by paper chromatography.
   b) Separation of Ni²⁺ & Cu²⁺ ions in a mixture by paper chromatography.
   c) Separation of Cu²⁺ & Cd²⁺ ions in a mixture by paper chromatography.

4. **Preparations of following Inorganic Complexes**
   a) Tetra ammine Cu (II) Sulphate.
   b) Pot. Trioxalato Chromate (III).
   c) Pot. Trioxalato Aluminate (III).
   d) Cis- dioxalato diaqua Chromate (III).

**Recommended Books**

**Theory:**


Practicals:

BS: 3rd Year (Semester-VI)
Course Title: Organic Chemistry-IV Cr. Hr. 2
Course Code: CHEM-3203

1. Electrophilic Aromatic Substitution:
Aromaticity i.e. description of aromatic, anti-aromatic and non aromatic systems on the basis of Hückel rules; mechanisms of electrophilic aromatic substitutions; orientation and reactivity; electrophilic substitution reactions, i.e. nitration, halogenation, sulfonation, Friedel-Crafts reactions, diazo-coupling, formylation and carboxylation.

2. Aromatic Nucleophilic Substitution:
Mechanisms: Study of S_NAr mechanism, S_N1 mechanism, Benzyne Mechanism, S_{RN1} Mechanism, SN (ANRORC) Mechanism, Vicarious nucleophilic substitution. The effects of substrate structure, leaving group and the attacking nucleophile on the rates of substitution reactions.

3. Multistep Synthesis:
Designing of multistep synthesis of following molecules: benzyl mercaptan from benzene, phenylacetic acid from benzene, p-chlorobenzyl alcohol from benzene, p-chloro styrene from benzene, stilbene from toluene, m-bromoaniline from benzene, p-toluidine from benzene, p-bromobenzoic acid from p-bromoaniline, 1,3,5-tribromobenzene from benzene, p-cresol from benzene, cinnamic acid from benzene, benzamide from aniline, α-bromobenzoic acid from p-nitrotoluene, 1,4-naphthoquinone from naphthalene, anthranilic acid from naphthalene.

Practical: Organic Chemistry-IV Cr. Hr. 1
Course Code: CHEM-3203P

Mixture Analysis:
Separation and identification of the two component mixture by various physical and chemical methods.

i) Benzoic acid + Naphthalene
ii) Cinnamic acid + Anthracene
iii) α-Naphthol + Phenanthrene
iv) Succinic acid + Biphenyl
v) β-Naphthol + Naphthalene
vi) Resorcinol + Acenaphthene
vii) Urea + Cinnamic acid
viii) Salicylic acid + Thiourea

Books Recommended
(Latest available editions of the following books are recommended)


BS: 3rd Year (Semester-VI)
Course Title: General Applied Chemistry Cr. Hr. 2
Course Code: CHEM-3204
1. Unit operations
2. Water treatment
3. Oil, Soap and Detergents
4. Paper Industry
5. Sugar Industry
6. Fertilizers
BS: 3rd Year (Semester-VI)
Course Title: General Applied Chemistry Practical Cr. Hr. 1
Course Code: CHEM-3204P

1. Determination of iodine value of the given oil.
2. Determination of acid value of the given oil.
3. To find out the percentage purity of fatty acid.
4. Preparation of gum sample.
5. Preparation of liquid detergent or liquid soap.

Recommended Books
1. Roger’s Industrial Chemistry. Von Norstand Co. N. Y.
2. Reigel’s Handbook of industrial chemistry. Von Norstand Reeinhold Co. N. Y.

BS: 3rd Year (Semester-VI)
Course Title: Polymer Chemistry Cr. Hr. 3
Course Code: CHEM-3205

1. Introduction

2. Synthesis
   Synthesis of step growth polymerization, chain growth polymerization; free radical & co-polymerization, ionic-polymerization & co-polymerization, co-ordination polymerization.

3. Polymerization Techniques
   Bulk, solution, suspension and emulsion polymerization.

4. Manufacturing & Applications
   Manufacturing of polyester, polyamides or Nylon, formation of phenol formaldehyde, polyethylene and polyvinyl resins, rubber, Teflon & PVC.

5. Characterization
   Thermodynamics of solutions, measurement of molecular weight, analysis techniques of polymers. Spectroscopic and thermal.

6. Degradation
   Stability and Environmental issues.
RECOMMENDED BOOKS:

2. Cowie, “Physics and Chemistry of Polymers”.

BS 4th Year

In the fourth year the student would take two compulsory courses “Organic spectroscopy” in semester VII and “Separation Techniques” in semester VIII along with two specialized courses in each semester in one of the following fields: Physical / Organic/ Inorganic/ Analytical/ Biochemistry/ Applied Chemistry.

BS: 4th Year (Semester-VII)
Course Title: Organic Spectroscopy (Compulsory) Cr. Hr. 3
Course Code: CHEM-4101

1. Introduction

2. Ultraviolet/Visible Spectroscopy

3. Infrared Spectroscopy
4. Nuclear Magnetic Resonance

5. Mass Spectrometry

NOTE: Emphasis should be on identification of organic Compounds using these techniques.

Practical: Organic Spectroscopy (Compulsory) Cr. Hr. 1
Course Code: CHEM-4101P

1. Spectrophotometric Analysis
Assay of following commercial drugs using spectrophotometer:

<table>
<thead>
<tr>
<th>Drug</th>
<th>Possible source</th>
</tr>
</thead>
<tbody>
<tr>
<td>i). Ofloxacin</td>
<td>(Oflobid tablets, 200 mg, 400 mg)</td>
</tr>
<tr>
<td>ii). Pantoprazole sodium</td>
<td>(Zopent tablets, 20 mg, 40 mg)</td>
</tr>
<tr>
<td>iii). Cetirizine dihydrochloride</td>
<td>(Ronex tablets, 10 mg)</td>
</tr>
<tr>
<td>iv). Levocetirizine dihydrochloride</td>
<td>(Leozin tablets, 5 mg)</td>
</tr>
<tr>
<td>v). Ciprofloxacin.HCl</td>
<td>(Hiflox tablets, 750 mg)</td>
</tr>
<tr>
<td>vi). Esomeprazole magnesium</td>
<td>(Esoird capsules, 20 mg)</td>
</tr>
<tr>
<td>vii). Enrofloxacin</td>
<td>(Avifloxacin OS liquid)</td>
</tr>
</tbody>
</table>

2. Interpretation of spectra
Sample handling and interpretation of UV, IR, 1H-NMR and GC-MS spectra for the structure elucidation of organic molecules.

RECOMMENDED BOOKS:


BS: 4th Year (Semester-VIII)
Course Title: Separation Techniques (Compulsory) Cr. Hr. 3
Course Code: CHEM-4201

General principles and classifications of chromatographic techniques, the chromatographic processes, rate theory of chromatography, van-Deemter equation and its significance in evaluating column efficiency.

Gas Chromatography:
General principle, separation process, sample preparation, sample injection, detectors and method development.

HPLC:
General principle, separation process, sample preparation, sample injection, detectors and method development for normal phase and reverse phase separation, isocratic and gradient elution.

Capillary electrophoresis:
Theory and principle of CE, Mobility, electro-osmotic floe separation by CE, instrumentation. Sample injection and detection, modes of operation, applications.
BS: 4th Year (Semester-VIII)

Course Title: Separation Techniques (Practical)     Cr. Hr. 1
Course Code: CHEM-4201P

1. Quantitative analysis of Amoxicillin trihydrate in Augmentin tablets by HPLC.
2. Quantitative analysis of Cephradine in Velocef tablets by HPLC.
4. The characterization of peppermint oils by gas chromatography and the identification of oils used in consumer products.
5. GC analysis of alcohol content in beverages.
6. HPLC analysis of sugar content in foods and beverages.
7. Determination of caffeine and coffee in cola drinks by internal standard addition by HPLC.

Recommended Books:


SPECIALIZATION IN ANALYTICAL CHEMISTRY

BS: 4th Year (Semester-VII)

Course Title: Paper-I (Electro-analytical Techniques)     Cr. Hr. 3
Course Code: CHEM-4102

2. Coulometry and Electrogravimetry; Basic electrochemistry, principle, instrumentation of coulometry. Principle, instrumentation electrogravimetry.
Consequences of electrogravimetry, Ohmic drop, activation over potential, concentration and gas polarization, basic difference and merits/demerits of coulometry and electrogravimetry.

3. Voltammetry and Polarography: Basic principle, voltammogram, polarizable and non-polarizable electrodes, solid electrodes, their scope and limitations, cyclic voltammetry, anodic stripping voltammetry, voltammetric equation. Basic concept of polarography and interpretation of various polarographic curves, measurement of decomposition potential, diffusion and limiting currents, derivation of Ilkovic equation, logarithmic analysis of polarographic wave, advantages and limitation of dropping mercury electrode.

BS: 4th Year (Semester-VII)

Course Title: Paper-II (Atomic Spectrometry) Cr. Hr. 3
Course Code: CHEM-4103

1. Flame Photometry: Origin and classification of atomic spectroscopic methods; origin of atomic spectrum, position of the signal, intensity of the signal, spectral line width, principle of flame photometry; fate of the sample in the flame, flame and its characteristics; instrumentation for flame photometry. Merits and limitations.
3. Atomic Absorption Spectrophotometry: Principle of atomic absorption spectrophotometry; concentration dependence of absorption, quantitative methodology, instrumentation for atomic absorption spectrophotometry; radiation sources, atomizers; flames, graphite furnaces and electrochemical atomisers, monochromators, detectors, handling background absorption. Interferences in atomic absorption spectrophotometry, sample handling in atomic absorption spectrophotometry, preparation of the sample, use of organic solvents, microwave, digestion, sample introduction methods, applications of atomic absorption spectrophotometry.
4. Atomic Emission Spectrophotometry: Introduction, principle of atomic emission spectrometry; atomic emission spectrometry using plasma sources, plasma and its characteristics; inductively coupled plasma, direct current plasma, microwave induced plasma, choice of argon as plasma gas, instrumentation for ICP-MS.
BS: 4th Year (Semester-VII)

Course Title: Analytical Chemistry Paper-III (Thermal Methods of Analysis)  Cr. Hr. 3
Course Code: CHEM-4104

1. Thermogravimetric Methods of Analysis (TGA): Introduction, instrumentation, sources of error in TGA, interpretation of TG curve, Factors affecting TG curve, applications of thermogravimetric analysis.

Course Title: Analytical Chemistry Practical-I
Course Code: CHEM-4105P  Cr. Hr. 1

1. Estimation of Na K and Ca using flame photometry.
2. Quantification of iron in soil by atomic absorption spectrophotometry.
3. Percentage determination of Ni in steel sample using atomic absorption spectrophotometer.
4. Separation of hydrocarbons using GC/HPLC.
5. To determine pKa Values for the given samples of weak acids by potentiometric method.
7. Preparation of buffer solutions of definite pH.
8. Electrogravimetric determination of copper in given samples.
9. Study of thermal decomposition of copper sulfate pentahydrate and calcium oxalate monohydrate

BS: 4th Year (Semester-VIII)

Course Title: Paper-IV (Luminescence, ESR and LASER Spectroscopic Techniques)  Cr. Hr. 3
Course Code: CHEM-4202
1. **Luminescence Spectrophotometry**: Introduction, origin of fluorescence and phosphorescence spectra; Jablonski diagram, activation, deactivation, fluorescence spectrum, fluorescent and phosphorescent species; photoluminescence and structure, factors affecting fluorescence and phosphorescence, fluorescence quenching; quantum yield, instrumentation for fluorescence measurement; sources, wavelength selectors, sampling, detectors, read out devices, instrumentation for phosphorescence measurement; sampling, recording procedure, applications of fluorescence and phosphorescence.

2. **ESR and Mössbauer spectroscopy**: Angular momentum, spin properties and magnetic resonance, EPR spectra of the hydrogen atoms, EPR spectra of paramagnetic organic species (free radicals, biradicals and triplet states), principles and applications of Mössbauer spectroscopy.

3. **Laser spectroscopy**: Laser-induced breakdown spectroscopy, LIBS system for modern science, material characterization and their analysis.

**BS: 4th Year (Semester-VIII)**

**Course Title**: Paper-V (Radio analytical Techniques)  
**Cr. Hr. 3**  
**Course Code**: CHEM-4203

Fundamentals of radioactivity, radiotracer techniques; choice of radiotracers, factors affecting choice of radiotracers, isotope dilution analysis (IDA); principle and equation, instrumentation, applications, advantages and limitations, sub stoichiometric isotope dilution analysis (SIDA), activation analysis (AA); principle of NAA, neutron sources, interferences, sensitivity and detection limits, classification, instrumentation, applications, advantages and limitations, comparison of NAA and IDA with other methods, radiometric titrations (RT); procedure, advantages and limitations, radio chromatography and radioimmunoassay.

**BS: 4th Year (Semester-VIII)**

**Course Title**: Paper-VI (Applied Analytical Chemistry)  
**Cr. Hr. 3**  
**Course Code**: CHEM-4204

1. Analysis of food products
Introduction to food analysis, sampling of food, general methods of analysis. Analysis of milk, butter, wheat flour, meat, beverages, tea, coca, honey and soft drinks.

2. **Pharmaceutical Analysis**
   Classification of drugs, clinical tests for analysis of different pharmaceuticals, introduction to US and British pharmacopeia.

3. **Forensic Analysis:**
   Classification and analysis of narcotics & dangerous drugs, examination of crime scene evidences, fingerprint, skeletal material to provide scientific opinion for legal.

**Course Title: Analytical Chemistry Practical-II**

**Course Code: CHEM-4205P**

1. Determination of fat content in milk
2. Quantification of Proteins
3. Determination of cholesterol in food
4. Quantification of reducing sugars and total sugars
5. Water analysis for drinking purpose
6. Determination of caffeine
7. Determination of heavy metals in food items
8. Determination of citric acid in juices
9. Determination of ascorbic acid in fruit juices
10. Evaluation of Rancidity of edible oil [Acid value]
11. Evaluation of Iodine value of edible oils
12. Evaluation of Ester value of edible oils
14. Extraction of DNA from Saliva, Cheek cells and blood.
15. Detection of Saliva by α-amylase activity.
16. Finger print analysis by AgNO₃, iodine vapour method.
17. Spot test/TLC of arsons and explosive (i.e. picric acid, nitrobenzenes and nitrotoluene)
18. Calibration and validation of HPLC system as per requirements of British or US pharmacopoeia.
19. Analysis of the binary mixture of pharmaceutical dosage by HPLC and statistical evaluation of data (RSD, CV, precision, accuracy, LOD, LOQ, resolution, Tailing factor).
Recommended Books:
39. Melvin and Kelvin "Electrophoresis" Analytical Chemistry by Open Learning, Published by John Wiley and Sons.
42. Reiger, P.H. "Electrochemistry", Prentice Hall N.J, 1987
45. Stock and Rice, Chromatographic methods, Chapman and Hall, 1967
SPECIALIZATION IN APPLIED CHEMISTRY

BS: 4th Year (Semester-VII)
Course Title: Applied Chemistry paper-A, (paper-I)
Course Code: CHEM-4106 Cr. Hr. 3

1. Common Industrial Unit Operations
   Elementary treatment of general unit operations commonly used in industries such as size reduction, screening, enrichment, filtration, distillation and crystallization Chemical unit processes like nitration, halogenation, sulfonation, oxidation and hydrolysis with appropriate technical examples.

2. Basic Chemical Industries
   Raw materials, chemical processes involved: flow sheet diagrams with all the important parameters concerning the manufacture of sulfuric acid, hydrochloric acid, caustic soda, washing soda, phthalic anhydride.

BS: 4th Year (Semester-VII)
Course Title: Applied Chemistry paper-B, (paper-II)
Course Code: CHEM-4107 Cr. Hr. 3

1. Cement Industry
   Raw materials used for cement manufacturing used, dry process, wet process, chemistry involved in hydration of cement, setting of cement, setting time.

2. Glass Industry

BS: 4th Year (Semester-VII)
Course Title: Applied Chemistry paper-C, (paper-III)
Course Code: CHEM-4108 Cr. Hr. 3

1. Soap Industry
   Processes involved in soap manufacturing, methods used for manufacturing laundry detergents. Recovery of glycerin. Detergent or surface active agents, cationic anionic and non-ionic agents.

2. Water Softening and Scale Removing
   Water hardness, its measurement and removal, methods used for water softening including ion-exchange, distillation and precipitation.
3. Paper and Pulp
Raw materials. Preparation of paper by acid sulfide and krafts process. Different types of papers and uses.

Course Title: Applied Chemistry Practical-I
Course Code: CHEM-4109P     Cr. Hr. 1

1. Water hardness by complexometry.
2. Determination of magnesium and aluminum by EDTA titration.
3. Analysis of caustic soda and soda ash in mixtures.
4. Analysis of Lithium in industrial effluents, barium in ores, potassium by in soil samples.
6. Preparations: Calcium gluconate, detergents, cosmetics and vanishing creams.
8. Analysis of Steel and Industrial Alloys.

BS: 4th Year (Semester-VIII)
Course Title: Applied Chemistry paper-D, (paper-IV)
Course Code: CHEM-4206     Cr. Hr. 3

1. Synthetic Fibers
Introduction and classification. Preparation properties and application of Nylon, Dacron, Polyesters, Rayon and Cuprammonium Rayon.

2. Dyes and Pigments
Introduction and application methods of Acid Dyes, Basic dyes, Vat Dyes, Ractive Dyes, Azodyes, Pigment Dyes.

3. Adhesives
Introduction, Preparation and applications of Amino plasts. Polyesters, cellulosic, silicones, Polyurethanes.

BS: 4th Year (Semester-VIII)
Course Title: Applied Chemistry paper-E, (paper-V)
Course Code: CHEM-4207     Cr. Hr. 3
1. **Quality Control in Industries**
Different methods for quality control in industries. Milk composition and different types of milk, butter, cheese etc.

2. **Explosives**
Classification. Various types and their composition. Preparation of TNT, Trinitroglycerine, cellulose trinitrate, Smokeless powder and Black powder.

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**BS: 4th Year (Semester-VIII)**

**Course Title: Applied Chemistry paper-F, (paper-VI)**

**Course Code: CHEM-4208**

Cr. Hr. 3

1. **Plant Protection and Modeling Chemicals / Insecticides**
Preparation and properties of insecticides. Applications for plant protection. Their side-effects and poisoning effects.

2. **Petroleum and Petrochemicals**
Composition, Refining. Testing, Extraction from rocks, Types of minerals associated with petroleum. Climates indicating zones, Various Petrochemicals.

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**Course Title: Applied Chemistry Practical-II**

**Course Code: CHEM-4209P**

Cr. Hr. 1

2. Extraction and characterization of essential oils from fragment plants.
3. Preparation and characterization of Nylon.
5. Analysis of effluents from tanneries.
7. Analysis of dolomite.
9. Assay of Aspirin and vitamin C.

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**Books Recommended**

SPECIALIZATION IN BIOCHEMISTRY

BS: 4th Year (Semester-VII)
Course Title: Biochemistry paper-A, (paper-I)
Course Code: CHEM-4110       Cr. Hr. 3

1. Carbohydrate metabolism
   Carbohydrate metabolism, pentose phosphate pathway, uronic acid pathway, 
   gluconeogenesis, glycogenesis and glycogenolysis. Regulation of carbohydrate 
   metabolism. Photosynthesis.

2. Lipid metabolism
   Lipid metabolism, biosynthesis of fatty acids, glycerides, phospholipids and 
   ketone bodies. Degradation and biosynthesis of sterols and bile acids. 
   Regulations of lipid metabolism.

BS: 4th Year (Semester-VII)
Course Title: Biochemistry paper-B, (paper-II)
Course Code: CHEM-4111       Cr. Hr. 3

1. Protein metabolism
   Protein metabolism and biosynthesis of amino acids. deamination and 
   transamination, urea cycle, metabolic disorders, creatine & creatinine synthesis.

2. Metabolism of Nucleic acids
   Metabolism of nucleic acids biosynthesis and degredation of purines, 
   pyrimidines, nucleosides and nucleotides.

BS: 4th Year (Semester-VII)
Course Title: Biochemistry paper-C, (paper-III)
Course Code: CHEM-4112       Cr. Hr. 3
1. **Physical techniques in biochemistry**
Physical techniques in biochemistry, gel filtration, ion-exchange and affinity chromatography, isoelectric focussing, centrifugation, ultrafiltration Isotopic labelling, Immunoblotting, ELISA and spectrometry.

2. **Chemotherapy**
Chemotherapy antimalarials, sulfonamides and some commonly used antibiotics. Mechanism of drug resistance

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**Course Title: Biochemistry Practical-I**

**Course Code: CHEM-4113P**

<table>
<thead>
<tr>
<th>Cr. Hr. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Analysis of normal and abnormal constituents in urine.</td>
</tr>
<tr>
<td>2. Analysis of organic and inorganic constituents of blood.</td>
</tr>
<tr>
<td>3. Estimation of different vitamins.</td>
</tr>
<tr>
<td>4. Separation of sub-cellular fractions in cells.</td>
</tr>
<tr>
<td>5. Gel filtration, ion-exchange, paper and thin layer chromatography of proteins.</td>
</tr>
<tr>
<td>6. Gel filtration, ion-exchange chromatography and HPLC.</td>
</tr>
<tr>
<td>7. Enzymes: Purification and kinetic studies of invertase, lactic dehydrogenase and peroxidase.</td>
</tr>
<tr>
<td>8. Electrophoresis of plasma proteins, polyacrylamide gel electrophoresis.</td>
</tr>
<tr>
<td>9. Agarose electrophoresis of DNA.</td>
</tr>
</tbody>
</table>

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**Course Title: Biochemistry paper-D, (paper-IV)**

**Course Code: CHEM-4210**

<table>
<thead>
<tr>
<th>Cr. Hr. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Immunology</td>
</tr>
</tbody>
</table>
Immunology, chemistry of immunoglobulins, myeloma and hybridoma immunoglobulins. Immune system and its abnormalities, allergy and inflammation, complement system, peripheral leucocytes and macrophages.

2. **Microbiology**
Microbiology microbial cultivation, metabolism and genetics. Bacteria, fungi, protozoa and algae. Medical and industrial microbiology.

3. **Molecular biology**
Molecular biology Replication, transcription and translation. Regulation of gene expression. DNA synthesis and sequencing. Genetic code, plasmids, bacteriophages and cosmids. Mutagenesis, Methods and applications of recombinant DNA.
BS: 4th Year (Semester-VIII)
Course Title: Biochemistry paper-E, (paper-V)
Course Code: CHEM-4211       Cr. Hr. 3

1. Composition of blood
Composition of blood blood plasma, serum proteins, red blood cells, white blood cells, plateletes, structure and function of haemoglobin. Coagulation and its mechanism.

2. Body Fluids
Biochemistry of urine and lymphatic fluids.

3. Physiological Chemistry
Structure and functions of liver lungs, muscle, connective tissue, kidney, heart, nerve conduction and sensory systems.

4. Hormones
Chemistry, functions and metabolism of thyroid, adrenal, pancreatic, steroid and growth hormones, hormonal regulation of metabolism.

BS: 4th Year (Semester-VIII)
Course Title: Biochemistry paper-F, (paper-VI)
Course Code: CHEM-4212       Cr. Hr. 3

1. Enzymes Kinetics
Kinetic of single substrate reactions, substrate specify enzyme inhibition, multi-substrate reactions, multi-enzyme systems.

2. Vitamins:
structure, physiological functions, deficiency diseases and recommended dietary allowances of vitamin A, D, E, K, B complex and C.

3. Nutrition
Nutritional importance of carbohydrates, fats and proteins. Balance diet. micro-nutrients and their functions. Role of nutrition in growth, development and disease.

Course Title: Biochemistry Practical -II
Course Code: CHEM-4213P       Cr. Hr. 1
1. Dialysis, ultra filtration and lyophilization.
2. Cultivation of microorganisms in laboratory using solid and liquid culture media, test tube, petri plate and shake flask cultures, isoleitia of pure culture, study of physical characteristics of microorganism, bacterial growth curve, preservation of microbial strains
3. Enzymes, including preparation and kinetic studies of Invertase, Lactic dehydrogenase and peroxidases.
4. Estimation of different Vitamins, isolation and characterization of proteins in food materials.

Recommended Books

Theory

Practicals


SPECIALIZATION IN INORGANIC CHEMISTRY

BS: 4th Year (Semester-VII)

Course Title: Inorganic Chemistry paper-A, (paper-I)

Course Code: CHEM-4114 Cr. Hr. 3

1. **Chemistry of f-Block Elements**
   (i) Lanthanides: Electronic structure and position in the periodic table, Lanthanide’s contraction, oxidation states, spectral and magnetic properties, general characteristics, occurrence, extraction and general principles of separation, complexes and uses.
   (ii) Actinides: Electronic structure and position in the periodic table, oxidation states, general characteristics, half life and decay law.

2. **Π -Acceptor Complexes**
   Mononuclear and polynuclear metal carbonyls: the eighteen electron rule as applied to metal carbonyls; rationalization of molecular structure; evaluation of structures based on spectroscopic evidences; chemistry of metal carbonyls and their derivatives (nitosyls, halides and hydrides

Recommended Books

Theory

BS: 4th Year (Semester-VII)
Course Title: Inorganic Chemistry paper-B, (paper-II)
Course Code: CHEM-4115       Cr. Hr. 3

1. Periodic Anomalies and Bonding in Electron deficient Compounds
First- and second- row anomalies; the use of d- orbitals by non-metals; reactivity and d- orbital participation; pπ-dπ bonds; the use of p- orbitals in π- bonding; periodic anomalies of non-metals and post-transition metals. Multicenter bonding in electron deficient molecules, three centre two electron bond (3c-2e) and three-center, four-electron (3c-4e) bond model.

2. Kinetics and Reaction Mechanism of Inorganic Reactions
Classification of reaction mechanisms; rate laws; steady state approximation; inert and labile complexes; substitution reactions; octahedral complexes: acid hydrolysis, acid catalyzed aquation, anation reactions, base hydrolysis, attack on ligands, steric effects of inert ligands; square planar complexes: nucleophilic reactivity, trans-effect, cis-effect, effect of leaving group, mechanism of substitution, racemization reactions.

3. Electron Transfer Reactions
Electron transfer reactions in co-ordination compounds, mechanism of electron transfer reactions, outer sphere or tunneling mechanism, inner sphere or ligand bridge mechanism, factors effecting the rate of electron transfer reactions, two electrons transfer reactions, complementary or non complementary electron transfer reactions, oxidation reduction reactions of metal ions.

RECOMMENDED BOOKS

BS: 4th Year (Semester-VII)
Course Title: Inorganic Chemistry paper-C, (paper-III)
Course Code: CHEM-4116       Cr. Hr. 3

1. Organic Reagents Used in Inorganic Analysis
Types of reagents, specificity and sensitivity of the reagents, methods of application with specific examples, complexometric and gravimetric methods involving various reagents, chelates and chelate-effect.

2. Corrosion
Corrosion, different types of corrosion. Different theories of corrosion, safety measures for corrosion (corrosion Control) prospects in Pakistan to control the corrosion.

Recommended Books:
1. Emeleus and Sharpe., “Modern Aspects of Inorganic Chemistry”.
Course Title: Inorganic Chemistry Practical-I
Course Code: CHEM-4117P     Cr. Hr. 1

1. Use of some Organic Reagents for Gravimetric Estimation.
   (a) 8-Hydroxyquinoline Al (III) and Fe (III)
   (b) Nitron

2. Use of Some Organic Reagents for The Estimation of Various Elements
   (a) Salicylaldoxime: Ni (II) in the presence of Cu (II)
   (b) Anthranilic acid: Co(II) and Zn(II)

3. Inorganic Synthesis:
   Preparation of at least six inorganic compounds / complexes in a pure state and
determination of their state of purity.

4. Conductometry
   (i) Titration of strong acid and weak acid with a strong base.
   (ii) Precipitation titration involving AgNO₃ and KCl.
   (iii) Determination of dissociation constant Ka for acetic acid

5. Potentiometry
   (i) Determination of \( K_{1} \), \( K_{2} \), \( K_{3} \), and \( K_{4} \) for \( H_{3}PO_{4} \)
   (ii) Determination of chloride in the presence of iodide and evaluation of \( K_{sp} \) of
        AgI and AgCl

Books Recommended
Practical

initely

BS: 4th Year (Semester-VIII)
Course Title: Inorganic Chemistry paper-D, (paper-IV)
Course Code: CHEM-4214     Cr. Hr. 3
1. **Nuclear Chemistry**
   Introduction, Structure of nucleus, radioactivity and radioactive series, artificial radioactivity, Determination of half life, nuclear fission and fusion reaction, energetic nuclear reactions, Application of radioisotopes.

2. **Spectroscopic Methods of Analysis**
   Flame Spectrometry (AAS & FES), Basic principles, instrumentation and applications.

**Recommended Books:**

2. Elton L. R. B. “Introductory Nuclear Theory” The English Language Book Society and Sir ISAAC Pitman & Sons, Ltd. (1959)
5. Harvey B. G. “Nuclear Physics and Chemistry” Prentice-Hall, Inc. (19690
7. Christian G.D “Analytical Chemistry”

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**BS: 4th Year (Semester-VIII)**

**Course Title:** Inorganic Chemistry paper-E, (paper-V)

**Course Code:** CHEM-4215  
**Cr. Hr.** 3

**1. Symmetry and Group Theory**
Symmetry and symmetry operations. Point groups. Properties of group, Non-degenerate representation, matrices, transformation of matrices, Degenerate representation, character tables and their applications in chemical bonding and molecular vibration.

**RECOMMENDED BOOKS (THEORY)**

5. Alan Vincent “Molecular symmetry and Group theory” John Wiley and Sons
BS: 4th Year (Semester-VIII)
Course Title: Inorganic Chemistry paper-F, (paper-VI)
Course Code: CHEM-4216       Cr. Hr. 3

1. Chemistry of Organometallics
   History and introduction to organometallic compounds, types of bonding.
   Transition metals; single, double and triple bonds to carbon (compound types,
   acyls, alkylidene complexes and alkylidyne complexes), delocalized hydrocarbon
   systems (alkenes, olefins, allyl and butadienes), alkyne complexes, cyclic \( \pi \)-
   complexes (five- and six- member rings).

2. Organometallic Compounds in Homogenous Catalytic Reactions
   Homogenous catalytic hydrogenation, dimerization, oligomerization,
   polymerization, oxidation, hydrosilation, hydroformylation of olefins. Catalytic
   polymerization of acetylenes, insertion reactions, use of organometallic
   compounds in organic synthesis.

RECOMMENDED BOOKS
   1995.
   Inorganic Chemistry” by John Willey and Sons, 1994.

Course Title: Inorganic Chemistry Practical-II
Course Code: CHEM-4217P       Cr. Hr. 1

   a) Estimation of Ba\(^{2+}\) as BaSO\(_4\).
b) Estimation of Ni$^{2+}$ as in the given solution by DMG.
c) Estimation of Pb$^{2+}$ as PbSO$_4$.

2. Complexometric Titrations
   a) Determination of Mg$^{2+}$ and Zn$^{2+}$ ions by EDTA (Direct titration).
b) Determination of Ni$^{2+}$ ions by EDTA (Back titration).
c) Determination of Ca$^{2+}$ and Zn$^{2+}$ ions by EDTA (Masking Method).

3. Conductometry
   a) Titration of strong Acid with strong Base.
   b) Titration of weak Acid with strong Base.
   c) Titration of strong Acid with weak Base.

4. Use of some organic reagents for estimation of various metal ions.
   a) Anthranilic acid ( Cd$^{2+}$, Zn$^{2+}$, Co$^{2+}$).
   b) 8-Hydroxyquinoline ( Al$^{3+}$, Fe$^{3+}$).
   c) Nitron ( NO$_3^-$).

5. Inorganic preparations of metal complexes
   a) Sod. Trioxalato Ferrate (III).
   b) [Cr(en)$_3$]Cl$_3$
   c) Trans isomer K[Cr(C$_2$O$_4$)$_2$(H$_2$O)$_2$]2H$_2$O.

6. Potentiometry
   a) Titration of strong Acid with strong Base.
   b) Titration of strong Acid with weak Base.

Books Recommended
Practical
1. Reactive Intermediates
Introduction, Structure, Generation, Detection, Reactions, Mechanisms, and Synthetic applications of:
   a. Carbenes
   b. Nitrenes
   c. Benzynes
   d. Free radicals

2. Methods of Determining Reaction Mechanisms

3. Protective Groups
Introduction, role of protective groups in organic synthesis. Protection of hydroxyl, amino, carboxylic and aldehyde group and their applications. Compatibility of different protective groups.

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BS: 4th Year (Semester-VII)
Course Title: Organic Chemistry B, (paper-II)
Course Code: CHEM-4119 Cr. Hr. 3

1. Heterocyclic Compounds

2. Molecular Rearrangements
Reaction mechanism involving molecular rearrangements, classification of molecular rearrangements, migratory aptitude and stereochemical implications
Mechanism of molecular rearrangements involving:
   (a). Carbon to Carbon migration.
   (b). Carbon to Nitrogen migration.
   (c). Carbon to Oxygen migration.
   (d). Electrocyclic and Sigmatropic Rearrangements.

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BS: 4th Year (Semester-VII)
Course Title: Organic Chemistry C, (paper-III)
Course Code: CHEM-4120 Cr. Hr. 3

1. Polymers

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2. Photochemistry

Course Title: Organic Chemistry Practical-I
Course Code: CHEM-4121P Cr. Hr. 1

1. Organic Preparations
Preparations of:
  a). Methyl Orange  b). Sulphanilic acid  c). meta-Dinitrobenzene

2. Qualitative and Preparative Chromatography
   a) Thin layer chromatography
   b) Paper chromatography
   c) High performance liquid chromatography

3. Analysis of Three Component Mixtures
Separation and identification of the components by Solvent extraction methods and chemical methods, using IR, UV and NMR techniques.

BS: 4th Year (Semester-VIII)
Course Title: Organic Chemistry D, (paper-IV)
Course Code: CHEM-4218 Cr. Hr. 3

1. Introduction to natural products
Introduction of primary and secondary metabolites and their varied sources, General classification of natural products, Historical and recent use of natural products in medicines.

2. Alkaloids

3. Terpenoids
Introduction, classification, isolation and general methods of structure determination. Chemistry of Citral, α-Pinene, Camphor and their biosynthesis.

4. Steroids
Introduction, stereochemistry of Steroids, Chemistry of Cholesterol and Bile Acids. Biosynthesis of cholesterol.

5. Flavonoids
Structure and synthesis of Flavones, Flavonol, Quercetin. Biosynthesis of Falvonoids.

**BS: 4th Year (Semester-VIII)**

**Course Title: Organic Chemistry E, (paper-V)**

**Course Code: CHEM-4219 Cr. Hr. 3**

1. Modern Organic Synthesis

2. Oxidation
Introduction. Oxidation of saturated hydrocarbons, olefinic double bonds, aromatic rings, systems containing oxygen. such as alcohols, aldehydes, ketones and dicarbonyl compounds oxidative decarboxylation of acids. Oxidation of systems containing nitrogen such as amine, hydrazines and hydrazons.

3. Reduction
Introduction. Reduction of cycloalkanes, alkenes, conjugated olefine, alkynes and aromatic rings. Hydrogenolysis. Reduction of benzylic and allylic systems, aldehydes and ketones, Reduction of systems. Containing nitrogen such as imines, oximes and nitro compounds.

**BS: 4th Year (Semester-VIII)**

**Course Title: Organic Chemistry F, (paper-VI)**

**Course Code: CHEM-4219 Cr. Hr. 3**

**Named Organic Reactions**

1. Cannizzaro reaction
2. Perkin reaction
3. Michael reaction
4. Claisen-Schmidt reaction
5. Darzens Glycidic Ester reaction
6. Stobbe reaction
7. Mannich reaction
8. Wittig reaction
9. Ene reaction
10. Reformatsky reaction
11. Diels-Alder reaction.

Course Title: Organic Chemistry Practical-II
Course Code: CHEM-4221P
Cr. Hr. 1

1. Isolation of Natural Products
   Isolation of Natural Products from the following;
   1. Red Pepper
   2. Turmeric
   3. Piperine from Black Pepper
   4. Caffeine from tea
   5. Separation of plant pigments by TLC
   6. Separation of plant pigments by paper chromatography
   7. Cholesterol from gall stone, brain and egg
   8. Lactose from milk
   9. Oil from orange peels

2. Analysis of Commercial Drugs
   Analysis of the following commercial drugs using HPLC and Titration methods:

   vii). Neomycin viii). Chloropromazine

Books Recommended:


SPECIALIZATION IN PHYSICAL CHEMISTRY

BS: 4th Year (Semester-VII)

Course Title: Physical Chemistry-A (paper-I) Cr. Hr. 3
Course Code: CHEM-4122

1. Symmetry Operations

2. Molecular Spectroscopy

BS: 4th Year (Semester-VII)

Course Title: Physical Chemistry-B (paper-II) Cr. Hr. 3
Course Code: CHEM-4123

1. Photochemical reactions

1. Quantum Chemistry

BS: 4th Year (Semester-VII)

Course Title: Physical Chemistry-C (paper-III) Cr. Hr. 3
Course Code: CHEM-4124

1. Solid State Chemistry

Course Title: Physical Chemistry practical-I  
Course Code: CHEM-4125P

1. Determination of percentage composition of $\text{KMnO}_4 / \text{K}_2\text{Cr}_2\text{O}_7$ in a given solution by spectrophotometry.
2. Evaluation of pKa value of an indicator by spectrometric method.
3. Measurement of IR spectra of simple compound and their interpretation
5. Study of multistep reactions.
6. Evaluation of energy of activation.
7. Sugar analysis and inversion studies by polarimetry.

BS: 4th Year (Semester-VIII)
Course Title: Physical Chemistry-D (paper-IV)  
Course Code: CHEM-4222  Cr. Hr. 3

1. Surface and Catalytic Chemistry

2. Polymer Chemistry

BS: 4th Year (Semester-VIII)
Course Title: Physical Chemistry-E (paper-V)  
Course Code: CHEM-4223  Cr. Hr. 3

1. Chemical Kinetics

2. Statistical Thermodynamics

BS: 4th Year (Semester-VIII)
Course Title: Physical Chemistry-F (paper-VI)
Course Code: CHEM-4224 Cr. Hr. 3

1. Nuclear Chemistry

2. Theories of Electrolytes

Course Title: Physical Chemistry Practical-II
Course Code: CHEM-4225P Cr. Hr. 1

1. Determination of free energy changes, standard free energies.
2. Verification of Kohlrausch law.
3. Study of temperature dependence of electrode potentials
5. Determination of molecular weight of a polymer by viscosity method.
8. Stoichiometry of a complex in solution by Job’s method.

Recommended Books
5. Banwell C.N., Fundamentals of Molecular Spectroscopy” 3rd Ed., , New Delhi,
40. Wallace S. and Brey JR., “Physical Method For Determining Molecular Geometry”