

UNIVERSITY OF PYAY  
DEPARTMENT OF CHEMISTRY  
SYLLABUS FOR BSc, MSc DEGREE COURSES FOR CHEMISTRY  
(2019–2020)

BSc FIRST YEAR

SEMESTER I

Chem 1101

Fundamental Chemistry I

**Chapter 1 The Electronic Structure of Atom and Periodic Properties**

- The Electronic Structure of Atom
  - Electrical Nature of Matter
  - Origins of the Quantum Theory
  - The Quantum Mechanical Nature of Atom
  - Quantum Numbers and Atomic Orbital
  - Multi-electron Atoms
- Periodic Properties
  - Periodic Table
  - The Periodic Properties of Elements

**Chapter 2 The Properties of Gases and Solutions**

- The Properties of Gases
  - General Characteristics of Gases
  - Parameters of a Gas
  - The Gas Laws
  - Kinetic Molecular Theory of gases
  - Kinetic gas equation in terms of kinetic energy
  - Deduction of gas laws from the kinetic gas equation
  - Distribution of molecular velocities
  - Different kinds of velocities
  - Deviation from ideal behaviour
  - Explanation of deviations–van der Waals equation
- The Properties of Solutions
  - Intermolecular forces (IMFs)
  - The solution
  - Solution and its concentration
  - Solutions of solids in solids
  - Solutions of solids in liquids
  - Solutions of gases in gases
  - Solutions of gases in liquids
  - Solutions of liquids in liquids
  - Surface tension
  - Viscosity
  - Refractive index

**Chapter 3 Aliphatic Compounds I**

- Aliphatic Compounds
- Aliphatic Hydrocarbons
- Important Functional Groups in Organic Compounds
- Monohydric Alcohols

**Chem 1001 General Chemistry I (for Zool/Bot/Geol /Nuclear Physics /Math/Marine Science/Geog/ Sports Studies)****Chapter 1 The Electronic Structure of Atom and Periodic Properties**

- The Electronic Structure of Atom
  - Electrical Nature of Matter
  - Quantum Numbers and Atomic Orbitals
  - Multi-electron Atoms
- Periodic Properties
  - Periodic Table
  - The Periodic Properties of Elements
- Chemical Bonds
  - Parameters of Molecular Structure
  - Ionic Bond
  - Covalent Bond
  - Bond Polarity
  - Metallic Bonding

**Chapter 2 Aliphatic Compounds I**

- Aliphatic Compounds
- Aliphatic Hydrocarbons
- Important Functional Groups in Organic Compounds
- Monohydric Alcohols
- Ethers
- Aldehydes and Ketones

**BSc FIRST YEAR****SEMESTER II****Chem 1102                  Fundamental Chemistry II****Chapter 1 Chemical Bonds**

- Parameters of Molecular Structure
- Ionic Bond
- Covalent Bond
- Bond Polarity
- Multiple Bonds
- Multicenter Bonds
- Metallic Bonding

**Chapter 2 Metals and Metalloids**

- General trends in main group chemistry
- Hydrogen
- Group (IA) The alkali metals
- Group (IIA) The alkaline earths
- Group (IIIA) Elements
- Group (IVA) Elements
- Metallic contaminants

**Chapter 3 General Properties of Aqueous Solutions**

- Solutions of Liquids in Liquids
- Vapour Pressure of Liquid-Liquid Solutions
- Vapour Pressure of Mixtures of Non-Miscible Liquids
- Colligative Properties
- Colligative Properties of Electrolyte
- Concept of Activity and Activity Coefficient
- Reactions in the Aqueous Solutions
- Galvanic Cell

**Chapter 4 Aliphatic Compounds II**

- Ethers
- Aldehydes and Ketones

**Chem 1002    General Chemistry II (for Zool/Bot/Geol /Nuclear Physics /Math/Marine Science/Geog/ Sports Studies)****Chapter 1 The Properties of Gases**

- The General Properties of Gases
- Kinetic Molecular Theory of Gases
- Distribution of Molecular Velocities
- Specific Heat Ratio of Gases

**Chapter 2 The Properties of Solutions**

- The General Properties of Solutions
- Solutions of Solids in Solids

- Solutions of Solids in Liquids
- Solutions of Gases in Gases
- Solutions of Gases in Liquids
- Solutions of Liquids in Liquids
- Colligative Properties
- Colligative Properties of Electrolytes
- Concept of Activity and Activity Coefficient
- Surface Tension
- Viscosity
- Refractive Index

### **Chapter 3 Aliphatic Compounds II**

- Carboxylic Acids (Monocarboxylic Acids)
- Functional Derivatives of Carboxylic Acids
- Esters
- Amides
- Amines (Monoamines)

**Chem 2101 Inorganic Chemistry I****Chapter 1 Non-Metallic Elements**

- The elements of Group (VA)
- The elements of Group (VIA)
- Group (VIIA) The halogens
- Group (VIIIA) The noble gases
- Non-metallic contaminants

**Chapter 2 Chemical Bonding**

- Valence Shell Electron Pair Repulsion (VSEPR) Theory
- Valence Bond (VB) Theory
- AB<sub>2</sub> Molecules (Linear molecules)
- AB<sub>3</sub> Molecules (Trigonal planar molecules)
- AB<sub>4</sub> Molecules (Tetrahedral molecules)
- AB<sub>5</sub> Molecules (Trigonal bipyramidal molecules)
- AB<sub>6</sub> Molecules (Octahedral molecules)
- Partial Ionic Character of Covalent Bonds

**Chapter 3 Molecular Orbitals in Chemical Bonding**

- Molecular Orbitals
- MO Energy Level Diagrams
- Bond Order and Bond Stability
- Homonuclear Diatomic Molecules
- Heteronuclear Diatomic Molecules
- Delocalization and the Shapes of Molecular Orbitals

**Chapter 4 The Transition Metals**

- Members and Configurations
- Characteristic Properties
- Oxidation States and Compound Formation
- 3d Transition Series Elements
- 4d and 5d-Transition Series Elements
- Complex Ion Formation
- Chromium
- Manganese
- Iron
- Cobalt
- Nickel

**Chem 2102                  Physical Chemistry I****Chapter 1 Basic Concepts of Thermodynamics**

- Thermodynamic Terms and Basic Concepts
- Types of Thermodynamic Systems
- Intensive and Extensive Properties
- State of a System
- Thermodynamic Processes
- Nature of Heat and Work
- Isothermal Reversible Expansion Work of an Ideal Gas
- Isothermal Irreversible Expansion Work of an Ideal Gas
- Maximum Work Done in Reversible Expansion
- Internal Energy
- First law of Thermodynamics
- Enthalpy of a System
- Molar Heat Capacities
- Joule–Thomson Effect
- Adiabatic Expansion of an Ideal Gas
- Spontaneous Process
- Some Useful Definitions
- The Carnot Cycle
- Derivation of Entropy from Carnot Cycle
- Entropy Change in an Irreversible Process
- Entropy Change for an Ideal Gas
- Entropy Change Accompanying Change of Phase
- Free Energy Function ( $G$ ) and Work Function ( $A$ )
- Conditions of Equilibrium and Criterion for a Spontaneous Process
- The Clapeyron Equation
- VAN'T HOFF Isotherm
- Zeroth Law of Thermodynamics

**Chapter 2 Thermodynamics**

- Partial Molar Quantities
- Chemical Potential or Partial Molar Free Energy
- Fugacity, Activity, Activity Coefficient
- Gibbs–Duhem Equation
- Variation of Chemical Potential with Temperature, Pressure
- Phase Equilibrium for multi–component System
- Gibbs Adsorption Equation

**Chem 2103            Organic Chemistry I****Chapter 1 Aliphatic Compounds III**

- Carboxylic Acids (Monocarboxylic Acids)
- Functional Derivatives of Carboxylic Acids
- Esters
- Amides
- Amines(Monoamines)

**Chapter 2 Aromatic Compounds**

- Nature of Aromatic Compounds
- Structure of Benzene
- Aromaticity and Hückel Rule
- Benzene and its Homologues

**Chapter 3 Polyfunctional Compounds**

- Polyhydric alcohols
- Dicarboxylic acids
- Hydroxy acids
- Keto acids
- Keto esters
- Diesters

**Chem 2104 (Elective) Chemistry in Society****Chapter 1 Chemistry and its Importance**

- What is Chemistry?
- Importance of Chemistry

**Chapter 2 Chemistry and Energy**

- Sources of Energy
- Non-Renewable Resources
- Renewable Resources

**Chapter 3 Chemistry in Agriculture**

- Soil
- Nutrients
- Fertilizer
- Major and Minor Elements in Fertilizers
- Fertilizer Needs
- Hunger Signs in Plants
- Fertilizer Label
- Protecting Food Crops

**Chapter 4 Chemistry of Food**

- Chemicals in the Body
- Chemicals in the Foods
- Energy Needed for Our Body

- Our Storehouse of Energy
- Energy from Foods
- Minerals in the Diet
- Food Additives

#### **Chapter 5 Chemistry and Medicine**

- Drugs: Up, Down, or Sideways
- Sources of Drugs
- Relating Molecular Structure to Activity
- Stimulants
- Anesthetics: Under and Out
- The Opium Alkaloids: Narcotics
- Antibiotics
- Analgesics

#### **Chapter 6 Chemistry in Household Products**

- Soap and Detergent Chemistry
- Cosmetics

#### **Chapter 7 Chemistry in Textile**

- Some Natural Colored Compounds
- Dyes
- Classification of Dyes
- Types of Dyes
- Purification of Dyes
- Dyeing of Textile

#### **Chapter 8 Chemistry of Building Materials**

- Chemistry of the Earth
- Glass
- Ceramics
- Cement
- Concrete
- Clay
- Wood

#### **Chem 2105 (Elective) Soil Chemistry**

##### **Chapter 1 Introduction**

##### **Chapter 2 Climate and Soil Formation**

- Climate
- Soil Mineral Matter
- Cation Exchange Capacity

##### **Chapter 3 Soil and Land Use**

- Soil Erosion
- Land Use and Land Cover
- Impacts of Soil Loss and Land Cover on Biogeochemical Cycles



**Chem. 2001 Chemistry I (For Geology specialization)****Chapter 1 Transition Metals**

- Members and Configurations
- Characteristic Properties
- Oxidation States and Compound Formation
- 3d Transition Series Elements
- 4d and 5d-Transition Series Elements
- Complex Ion Formation
- Chromium
- Manganese
- Iron
- Cobalt
- Nickel

**Chapter 2 Basic Concepts of Thermodynamics**

- Thermodynamic Terms and Basic Concepts
- Types of Thermodynamic Systems
- Intensive and Extensive Properties
- State of System
- Thermodynamic Processes
- Nature of Heat and Work
- Isothermal Reversible Expansion Work of an Ideal Gas
- Isothermal Irreversible Expansion Work of an Ideal Gas
- Maximum Work Done in Reversible Expansion
- Internal Energy
- First Law of Thermodynamics
- Enthalpy of a System
- Molar Heat Capacities
- Joule-Thomson Effect
- Adiabatic Expansion of an Ideal Gas
- Spontaneous Process
- Some Useful Definitions
- The Carnot Cycle
- Derivation of Entropy from Carnot Cycle
- Entropy Change in an Irreversible Process
- Entropy Change for an Ideal Gas
- Zeroth Law of Thermodynamics

**Chapter 3 Aromatic Compounds**

- Nature of Aromatic Compounds
- Benzene and its Homologues

**Chem. 2002 Organic Chemistry I (For Zoology, Botany and Biotechnology Specialization)****Chapter 1 Aromatic Compounds**

- Nature of Aromatic Compounds
- Structure of Benzene
- Aromaticity and Hückel Rule
- Benzene and its Homologues

**Chapter 2 Natural Products and Heterocyclic Compounds**

- Natural Products and Commercial Medicines
- Phytochemicals of Medicinal Value in Plants
- Heterocyclic Compounds
- Alkaloids

**Chapter 3 Polyfunctional Compounds**

- Polyhydric Alcohols
- Dicarboxylic Acids
- Hydroxy Acids
- Keto Acids
- Keto Esters
- Diesters

**Chem 2003 Soil Chemistry (for Geography Specialization)****Chapter I Introduction****Chapter II Climate and Soil Formation**

- Climate
- Soil Mineral Matter
- Cation Exchange Capacity

**Chapter III Soil and Land Use**

- Soil Erosion
- Land User and Land Cover
- Impacts of Soil Loss and Land Cover on Biogeochemical Cycles

BSc SECOND YEAR

SEMESTER II

Chem 2106 Inorganic Chemistry II

**Chapter 1 Coordination Chemistry**

- Coordination Compounds
- Werner's Coordination Theory
- Electronic Interpretation
- Nomenclature
- Isomerism in Coordination Complexes

**Chapter 2 Structures of Ionic Compounds**

- Close Packing of Spheres
- Interstitial Sites
- Crystals
- Binary Compounds
- Ternary Compounds

Chem 2107 Physical Chemistry II

**Chapter 1 Basic Concepts of Chemical Kinetics**

- Introduction
- Rate or Velocity of a Reaction
- Collision Theory of Reaction Rate
- Factors Affecting the Reaction Rate
- Rate Law and Rate Constant
- Ionic and Molecular Reactions
- Molecularity of a Reaction
- Order of a Reaction
- Reaction of the First Order
- Reactions of the Second Order
- Reactions of the Third Order
- Reversible or Opposing Reactions
- Reaction of Higher Order–Explanation of their Rarity on the Bases of Reaction Mechanism
- Zero Order Reactions
- Determination of the Order of a Reaction
- Disturbing Factors in the Determination of Order

**Chapter 2 Chemical Equilibrium**

- Reversible Processes
- The Law of Mass Action
- The Reaction Quotient
- The Equilibrium Constant
- Thermodynamic Derivation of the Equilibrium Constant
- Relationship between  $K_p$  and  $K_c$
- The Le-Chatelier-Braun Principle

- Types of Chemical Equilibria
- Variation of Equilibrium Constant with Temperature
- Variation of Equilibrium Constant with Pressure

### **Chapter 3 The Phase Rule**

- The Statement
- What is meant by a "Phase"?
- What is meant by "Components"?
- Degrees of Freedom
- Derivation of the Phase Rule
- One Component Systems
- Polymorphism
- Experimental Determination of Transition Point
- The Water System
- The Sulphur System
- Two-Component Systems
- The Silver-Lead System
- The Zinc-Cadmium System
- Potassium Iodide-Water System
- Magnesium-Zinc System
- The Ferric Chloride-Water System
- The Sodium Sulphate-Water System

## **Chem 2108                  Organic Chemistry II**

### **Chapter 1 Isomerism**

- Classification of Isomerism
- Constitutional or Structural Isomerism
- Conformational Isomerism

### **Chapter 2 Natural Products and Heterocyclic Compounds**

- Natural Products and Commercial Medicines
- Phytochemicals of Medicinal Value in Plants
- Heterocyclic Compounds
- Alkaloids

### **Chapter 3 Natural and Synthetic**

#### **Polymers**

- Natural Polymers (Biopolymers)
- Synthetic Polymers
- General Classes of Synthetic Polymer
- Stereochemistry of Polymerization

**Chapter 4 Carbohydrates**

- Nomenclature
- Monosaccharides
- Disaccharides and Polysaccharides

**Chem 2109 (Elective) Water Chemistry****Chapter 1 The Water Molecule**

- Water on the Earth
- Hydrologic (Water) Cycle
- Sources of Water
- Properties of Water
- Water Availability and Use

**Chapter 2 Distribution of Water**

- Water Distribution on Earth
- Methods of Water Distribution
- Systems of Water Supply

**Chapter 3 Quality of Water and Water Analysis**

- Water Chemistry
- Water Quality Standards
- Environmental Water Quality
- Assessment of Water Quality
- Sample Collection and Sample Preservation
- Water Quality Parameters
- Water Analysis
- Data Analysis and Presentation

**Chapter 4 Water Pollution**

- Sources of Water Pollution
- Prevention and Control of Water Pollution
- Water Pollution due to Lead Poisoning

**Chapter 5 Water Treatment Processes**

- Sewage Treatment
- Industrial Water Treatment
- Municipal Sewage Treatment
- Water Softening

**Chapter 6 Wastewater Processing**

- Preliminary Treatment
- Sedimentation
- Biological Filtration

**Chem 2110 (Elective) Atmospheric Chemistry****Chapter 1 Earth's Atmosphere**

- Concentrations of Chemical Species
- Measures of Atmospheric Composition

**Chapter 2 Phenomena in the Outer Layer's of the Atmosphere**

- Geochemical Cycles of Nitrogen, Oxygen and Carbon

**Chapter 3 Depletion of Ozone in the Stratosphere**

- Ozone Air Pollution

**Chapter 4 Volcanoes****Chapter 5 The Green House Effect****Chapter 6 Acid Rain****Chapter 7 Photochemical Smog****Chapter 8 Indoor Pollution****Chem 2004 Chemistry II (For Geology specialization)****Chapter 1 Structures of Ionic Compounds**

- Close Packing of Spheres
- Interstitial Sites
- Crystals
- Binary Compounds
- Ternary Compounds

**Chapter 2 Basic Concepts of Chemical Kinetics**

- Introduction
- Rate or Velocity of a Reaction
- Collision Theory of Reaction Rate
- Factors Affecting the Reaction Rate
- Rate Law and Rate Constant
- Ionic and Molecular Reactions
- Molecularity of a Reaction
- Order of a Reaction
- Reaction of the First Order
- Reactions of the Second Order
- Reactions of the Third Order
- Reversible or Opposing Reactions
- Reaction of Higher Order–Explanation of their Rarity on the Bases of Reaction Mechanism
- Zero Order Reactions
- Determination of the Order of a Reaction
- Disturbing Factors in the Determination of Order

**Chapter 3 Chemical Equilibrium**

- Reversible Process
- Thermodynamic Derivation of the Equilibrium Constant
- The Le-Chatelier-Braun Principle
- Types of Chemical Equilibria
- Variation of Equilibrium Constant with Temperature
- Variation of Equilibrium Constant with Pressure

**Chem 2005 Organic Chemistry II (For Zoology and Botany Specializations)****Chapter 1 Isomerism**

- Classification of Isomerism
- Constitutional Structural Isomerism
- Conformational Isomerism

**Chapter 2 Carbohydrates**

- Nomenclature
- Monosaccharides
- Disaccharides and Polysaccharides
- Formation of Esters and Ethers
- Formation of Glycosides

**Chapter 3 Natural and synthetic polymers**

- General Principle of Polymer Formation
- Polymerization
- Vinyl Polymers
- Structure and Stereochemistry of Polymers

**Chem 2006 Water Chemistry (for Geography Specialization)****Chapter 1 The Water Molecule**

- Water on the Earth
- Hydrologic (Water) Cycle
- Sources of Water
- Properties of Water
- Water Availability and Use

**Chapter 2 Distribution of Water**

- Water Distribution on Earth
- Methods of Water Distribution
- Systems of Water Supply

**Chapter 3 Quality of Water and Water Analysis**

- Water Chemistry
- Water Quality Standards
- Environmental Water Quality
- Assessment of Water Quality
- Sample Collection and Sample Preservation
- Water Quality Parameters

- Water Analysis
- Data Analysis and Presentation

#### Chapter 4 Water Pollution

- Sources of Water Pollution
- Prevention and Control of Water Pollution
- Water Pollution due to Lead Poisoning

#### Chapter 5 Water Treatment Processes

- Sewage Treatment
- Industrial Water Treatment
- Municipal Sewage Treatment
- Water Softening

#### Chapter 6 Wastewater Processing

- Preliminary Treatment
- Sedimentation
- Biological Filtration

BSc THIRD YEAR

SEMESTER I

Chem 3101 Inorganic Chemistry III

#### Chapter 1 Organometallic Chemistry

- Classification
- Bonding and Synthetic Methods
- Thermodynamic and Kinetic Stabilities
- Properties and Reactions
- Catalytic Reactions
- Stoichiometric Reactions (Insertion, Oxidative-Addition)

#### Chapter 2 Complexes of Acceptor $\pi$ Ligands

- Noble Gas Formulation
- Carbon Monoxide Complexes
- Nitric Oxide Complexes
- Donor Complexes of Group VB and Group VIB Ligands
- Cyanide Complexes
- Ligands having Extended  $\pi$  Systems

Chem 3102 Physical Chemistry III

#### Chapter 1 Basic Concepts of Molecular Spectroscopy

- Fundamentals of Molecular Spectroscopy
- Energy of Molecules
- Microwave Spectroscopy
- Infra-red Spectroscopy
- Ultraviolet and Visible Spectroscopy



- Nuclear Magnetic Resonance Spectroscopy
- Electron Spin Resonance Spectroscopy

#### **Chapter 2 Surface Chemistry and Surface Thermodynamics**

- Adsorption on Solid Surfaces
- Liquids on Solids and Liquids
- Surface-Active Agents (Surfactants): Soluble Materials
- Surface-Active Agents: Insoluble Surface Films
- Surface-active Agents: Other Phenomena
- Molecules between Phases
- Pressure Across an Interface
- Spreading of Liquids and Capillary Rise
- Adsorption in Liquid Systems and Surface Films

#### **Chem 3103 Organic Chemistry III**

##### **Chapter 1 Theoretical Concepts of Organic Chemistry**

- Reactants and Reactions
- Types of Reactions
- Factors Influencing a Reaction
- Carbocations
- Carbanions
- Radicals

##### **Chapter 2 Nucleophilic Substitution and Elimination Reactions**

- Nucleophilic Substitution Reactions
- Factors Affecting  $S_N1$  and  $S_N2$  Reactions
- Elimination Reaction
- Competition between Substitution and Elimination

#### **Chem 3104 Analytical Chemistry I**

##### **Chapter 1 Practical Aspects of Chemical Analysis**

- Analysis of Real Samples
- Preparing Samples for Analysis
- Decomposing and Dissolving the Samples

##### **Chapter 2 Treatment of Analytical Data**

- Significant Figures
- Accuracy and Precision
- Types of error in Experimental Data
- Statistical Treatment of Data

**Chapter 3 Gravimetric Analysis**

- General Principles of Gravimetric Analysis
- Stoichiometry of Gravimetric Reaction
- Formation and Properties of Precipitates
- Drying and Ignition of Precipitates
- Organic precipitants
- Solubility Equilibrium

**Chapter 4 Precipitation Titrations**

- Requirements for Precipitation Titrations
- Titration Curve for Precipitation Titrations
- End Points for Argentometric Titrations
- Applications of Standard Silver Nitrate Solutions

**Chem 3105 (Elective) Biochemistry****Chapter 1 Fundamental Concepts**

- Bioelements
- Important Functional Groups in Biomolecules
- The Specific Interactions of Biomolecules Depend on Noncovalent Bonds
- Properties of Water

**Chapter 2 Biomolecules**

- Carbohydrates
- Lipids
- Amino Acids
- Nucleic Acids

**Chapter 3 Enzymes**

- Enzyme Characteristics
- Enzyme Nomenclature and Classification
- Mechanism of Enzyme Action
- Types of Enzyme Action
- Enzyme Catalysts Activity
- Factors that Affect Enzyme Activity
- Enzyme Kinetic
- Enzyme Units
- Enzyme Inhibitor
- Enzyme Parts List

**Chapter 4 Metabolism**

- What is cell?
- Introduction to Metabolism
- Intermediary Metabolism

- Glycolysis
- Citric Acid Cycle

#### **Chapter 5 Molecular Genetics**

- Watson–Crick Double Helix
- Biosynthesis of DNA (Replication)
- Biosynthesis of RNA (Transcription)
- Biosynthesis of Protein (Translation)
- Mutation

### **Chem 3106 (Elective) Instrumental Methods of Analysis**

#### **Chapter 1 Separation Methods**

- Solvent Extraction
- Chromatographic Separation

#### **Chapter 2 Spectroscopic Methods**

- Ultraviolet Spectroscopy
- Fourier Transform Infrared Spectroscopy

### **Chem 3001 Organic Chemistry III (for Zoology and Botany Specializations)**

#### **Chapter 1 Fundamental Concepts of biochemistry**

- Bioelements
- Important Functional Groups in Biomolecules
- The Specific Interactions of Biomolecules Depend on Noncovalent Bonds
- Properties of Water

#### **Chapter 2 Biomolecules**

- Carbohydrates
- Lipids
- Amino Acids
- Nucleic Acids

### **BSc THIRD YEAR**

### **SEMESTER II**

#### **Chem 3107**

#### **Inorganic Chemistry IV**

#### **Chapter 1 Nonaqueous Solvents Systems**

- Classification of Solvents
- General Properties of Ionising Solvents
- Liquid Ammonia as Solvent
- Liquid Sulphur Dioxide as Solvent
- Liquid Hydrogen Fluoride
- Liquid Hydrogen Cyanide
- Acetic Acid (CH<sub>3</sub>COOH)
- Other Non-Aqueous Solvents

**Chapter 2 Theories of the Coordinate Bond in Metal Complexes**

- Valence Bond Theory
- Crystal Field Theory
- Ligand Field Theory (LFT)
- Molecular Orbital Theory
- Stability of Complex Ions

**Chem 3108 Physical Chemistry IV****Chapter 1 Physical Chemistry of Macromolecules**

- Basic Terms and Definitions
- Polymerization Reactions
- Molecular Weight Determination Methods
- Polymer Morphology
- Thermal Properties
- Differential Thermal Analysis and Differential Scanning Calorimetry

**Chapter 2 Quantum Chemistry I**

- Waves and Particles
  - Historical Perspective
  - Electromagnetic Radiation: The Wave Theory
  - Particle Nature of Radiation
  - Spectroscopy
  - The Bohr Theory of the Hydrogen Atom
  - The de Broglie Principle
  - Electron Diffraction
  - Diffraction of Neutral Particles
  - Superposition, Wave Packets and Uncertainty Principle
- The Wave function and the Postulate of Quantum Theory
  - The Schrodinger Equation
  - The Wave function and Probability Density
  - Operators
  - Average Values
  - The Tunneling Phenomenon

**Chem 3109 Organic Chemistry IV****Chapter 1 Stereochemistry**

- Stereoisomers
- Conformational Isomers
- Configurational Isomers
- Prediction of Enantiomerism
- Naming Enantiomers: The R, S System of Nomenclature

- Optical Activity
- Specification of Configuration: More than one Chiral Centre
- Diastereomers
- Meso Compounds
- Separation of Enantiomers: Resolution of a Racemic Modification

## **Chapter 2 Amino acids, Peptides, Proteins and Nucleic Acids**

- The Structures of Amino Acids
- Dipolar Structure of Amino Acids
- Isoelectric Point
- Separation of Amino Acids
- Synthesis of  $\alpha$ -Amino Acids
- Reactions of Amino Acids
- Resolution of Racemic Mixtures of Amino Acids
- Peptides
- Determination of Peptide Structure
- Synthesis of Peptides
- Classification of Proteins
- Protein Structures
- Determination the Primary Structure of a Protein
- Denaturation of Protein
- Nucleic Acids
- The Structure of DNA
- The Structure of RNA
- Hydrolysis of Nucleic Acid

## **Chem 3110 Analytical Chemistry II**

### **Chapter 1 Acid Base Equilibria and Titration**

- Fundamental Concept of Acidity and Basicity
- Equilibrium Calculations for Solutions of Acids and Bases
- Acid-Base Titration
- Titration Curves

### **Chapter 2 Equilibria in Oxidation Reduction Systems**

- Oxidation-Reduction Equilibria
- Half-Reactions
- Fundamentals of Electrochemistry
- Schematic Representation of Electrochemical Cells
- Electrode Potential or Relative Half-Cell Potential
- Effect of Concentration on Electrode Potentials

**Chapter 3 Potentiometric Methods**

- Electrode Systems
- Inert Electrodes
- Measurement of Cell emf
- The Potentiometer
- Potentiometric Titrations
- Reference Electrode
- Indicator Electrodes
- Salt Bridge and Liquid Junction Potentials

**Chem 3111 (Elective) Environmental Chemistry****Chapter 1 Air Pollution**

- The Atmosphere
- Air Pollution
- Radiation Pollution
- Noise Pollution
- Air Pollution Control Technology
- Ambient Air Quality

**Chapter 2 Water Pollution**

- Water Quality Today
- Types and Effects of Water Pollution
- Pollutants
- Prevention and Control of Water Pollution
- Water Legislation

**Chapter 3 Water Use and Management**

- Water Resources
- Major Water Compartments
- Water Availability and Use

**Chapter 4 Solid, Toxic and Hazardous Wastes**

- Solid Waste
- Waste Disposal Methods
- Hazardous and Toxic Wastes

**Chapter 5 Environmental Health and Toxicology**

- Types of Environmental Health Hazards
- Mechanisms for Minimizing Toxic Effects
- Measuring Toxicity
- Risk Assessment and Acceptance
- Establishing Public Policy

**Chapter 6 Environmental Policy, Law and Planning**

- Objectives for Environmental Policy, Law and Planning
- Environmental Policy
- Environmental Laws
- Environmental Planning
- Planning for Water Environment
- Establishment of maximum contamination levels (MCLs)

**Chem 3112 (Elective) Radiation Chemistry****Chapter 1 Interaction of Radiation with Matter and Radiation Measurements**

- Radiation Sources
- Types of Radiation
- Physical Aspects
- Chemical Aspects
- Radiation Chemistry Reactions
- Radiation Measurement

**Chapter 2 Radiation Effects in Solids and Radiation Dosimetry**

- Inorganic Solids
- Organic Solids
- Radiation Dosimetry

**Chapter 3 Applied Radiation Chemistry**

- Radiation Processing
- Radiation Preservation and Sterilization
- Radiation Safety

**Chem 3002 Organic Chemistry IV (for Zoology and Botany Specializations)****Chapter 1 Separation Techniques of Organic Compounds: Solvent Extraction Methods****Chapter 2 Separation Techniques of Organic Compounds: Chromatographic Separation Techniques**

**Chem 4101                      Inorganic Chemistry V****Chapter 1            Stability of Isotopes**

- Nuclear Structure and Stability
- Radioactivity and Nuclear Decay
- Discovery of Isotopes
- Nuclear Reaction
- Nuclear Models
- Analysis of Radioactive Environmental Sample
- Health and Safety Aspects

**Chapter 2            Symmetry and Point Groups**

- Symmetry Operations and Symmetry Elements
- Inverse Operations
- Groups and Their Basic Properties
- Systematic Classification of Molecules into Point Groups
- Matrices

**Chapter 3            Toxicological Effects of Mercury and Arsenic Compounds****-Toxicological Effects of Mercury Compounds**

- Sources of mercury
- Physical and Chemical Properties of Mercury
- Compounds of Mercury
- Health Effects of Mercury
- Risk Assessment for Mercury
- Preventive and Remedial Measures

**-Toxicological Effects of Arsenic Compounds**

- Sources of arsenic
- Physical and Chemical Properties of Arsenic
- Arsenic Compounds
- Health Effects of Arsenic
- Risk Assessment for Arsenic
- Preventive and Remedial Measures



**Chem 4102                      Physical Chemistry V****Chapter 1      Statistical Thermodynamics**

- The Boltzmann Distribution Law
- Gibbs Ensembles
- The Canonical Partition Function and Thermodynamic Properties
- The Electronic Partition Function
- The Translational Partition Function
- The Rotational Partition Function
- The Vibrational Partition Function
- Chemical Equilibrium in Ideal Gas

**Chapter 2      Molecular Spectroscopy**

1. Rotational Spectroscopy
  - Pure rotational spectra
  - Heteronuclear Diatomic Molecules
  - Rigid Rotor in a Plane
  - Rigid Rotors
  - Polyatomic Molecules
  - A survey of Rotational Spectroscopy
2. Vibrational Spectroscopy
  - The Harmonic Oscillator Model
  - Ro-vibrational Spectra of Diatomic Molecules
  - Raman Scattering
  - Effects of Anharmonicity and Nonrigidity
  - Polyatomic Molecules
  - A Survey of Vibrational Spectroscopy

**Chem 4103                      Organic Chemistry V****Chapter 1      Electrophilic Addition to Unsaturated Carbons**

- Halogenation
- Addition of Hypohalous Acids
- Hydrohalogenation
- Hydration
- Epoxidation-Hydroxylation
- Addition of Carbene ( Cycloaddition)
- Addition to Alkenes
- Hydrogenation
- Ozonolysis

**Chapter 2      Electrophilic Aromatic Substitution**

- Halogenation
- Nitration

- Sulfonation
- Alkylation of Aromatic Rings
- Acylation of Aromatic Rings
- Alkylation of Benzene via Acylation- Reduction
- The Diazonium Ion as an Electrophile
- Ipso Substitution
- Reactivity of Aromatic Rings
- The Effect of Substituents on Orientation

### **Chapter 3 Fundamental Concepts of Organic Spectroscopy I**

- Electromagnetic Radiation
- UV Visible Spectroscopy
- FT IR Spectroscopy

## **Chem 4104 Analytical Chemistry III**

### **Chapter 1 Separation by Extraction and Chromatographic Methods: Extraction Analysis**

- The Distribution Coefficient
- The Distribution Ratio
- Multiple Extraction
- The Completeness of Multiple Extractions
- Types of Extraction Procedures
- The Effect of pH and Reagent Concentration on Distribution Ratios
- Chromatography
- Gas Chromatography (GC)
- Liquid Chromatography (LC)
- Ion Chromatography (IC)
- Thin Layer Chromatography (TLC)

### **Chapter 2 Fundamentals of Electrode Processes**

- Introduction to Electrochemistry
- Electrogravimetric Method and Coulometric Methods
- Polarography

## **Chem 4105 Research Methodology**

**Chapter 1** Basic Concept of Research Methodology

**Chapter 2** Literature Survey

**Chapter 3** Research Design

**Chapter 4** Data Collection and Analysis

**Chapter 5** Report Writing and Presentation

<b>Chem 4106</b>	<b>Petroleum Chemistry</b>
<b>Chapter 1</b>	Origin and Nature of Petroleum
<b>Chapter 2</b>	Properties of Hydrocarbon Constituents
<b>Chapter 3</b>	Petrochemicals
<b>Chapter 4</b>	Cracking Processes

**BSc FOURTH YEAR****SEMESTER II****Chem 4107 Inorganic Chemistry VI****Chapter 1 Actinide Elements**

- General Features
- Electronic Structures
- Actinide Contraction
- Oxidation States
- Production and Properties of Actinide Elements in their Compounds
- Radioactivity of Actinides
- Separation of Transuranium Elements
- Production of Transuranium Elements
- Radiation Hazard of Transuranium Elements
- Application of Transuranium Elements

**Chapter 2 Electronic Absorption Spectra of Complexes**

- The Geometry of the Orbitals
- The Vector Model of the Atom
- Term Energy Level Diagrams
- Tanabe–Sugano Diagrams
- Thermodynamic Stability of Complexes
- Kinetic Stability of Complexes
- Optical Activity

**Chem 4108 Physical Chemistry VI****Chapter 1 Electrochemistry: Electrolytes in Solution**

- Specific Conductance
- Molar Conductance
- Conductance in Electrolytic Dissociation
- Colligative Properties and Electrolytic Dissociation
- Electrolysis
- Transference Number
- Ionic Mobilities
- Applications
- Dielectric Effect
- Ionic Strength

- Debye–Huckel Theory
- Activities from the Debye–Huckel Theory
- Activities in more Concentrated Solution

## Chapter 2 Electromotive Forces of Electrochemical Cells

- Electrodes, Cell EMF
- Standard Electrode Potential
- EMF and Activities
- Activities Coefficient EMF's
- Equilibrium Constant from EMF's
- Electrode– Concentration Cell
- Electrolyte–Concentration Cell
- Junction Potential
- Salt Bridge
- Ion Selective Electrode
- Thermodynamic Properties from Cell EMF's

## Chapter 3 Quantum Chemistry II

- 1. The Hydrogen Atom
  - The Schrodinger equation
  - Atomic Orbitals
  - Graphical Presentation of Atomic Orbitals
  - Spin and Fine Structure
- 2. Synthesizing Wave Functions
  - Principle of Superposition
  - The Variation Principle
  - The Secular Determinant
  - Perturbation Theory
  - Qualitative Features of the Approximate Methods

## Chem 4109 Organic Chemistry VI

### Chapter 1 Nucleophilic Addition to Carbonyl Group (Aldehydes and Ketones)

- Reactivity of the Carbonyl Groups
- Cyanide as the Nucleophile
- Oxygen or Sulphur as the Nucleophile
- Hydride as the Nucleophile
- Carbon as the Nucleophile
- Nitrogen as the Nucleophile

### Chapter 2 Nucleophilic Substitution on Carbonyl Group (Carboxylic Acid Family)

- Reactivity in the Carboxylic Acid Family
- Acyl Halides and Anhydrides
- Oxygen or Sulphur as the Nucleophile (Ester and Carboxylic Acids)

- Nitrogen as the Nucleophile
- Carbon as the Nucleophile

### **Chapter 3 Fundamental Concepts of Organic Spectroscopy II**

- NMR Spectroscopy
- Mass Spectrometry

### **Chem 4110 Analytical Chemistry IV**

#### **Chapter 1 Fundamentals of Spectroscopic Techniques and Analysis**

- Absorption of Radiation
- Absorption Spectra
- Atomic Absorption
- Molecular Absorption
- Infrared Absorption
- Absorption of Ultraviolet and Visible Radiation
- Relaxation Process
- Terms Employed in Absorption Spectrometry
- Beer's Law
- Emission of Electromagnetic Radiation

#### **Chapter 2 Complex Formation Equilibria**

- Complex Formation Reactions
- Complex Formation Constants
- The Liebig Titration
- Titrations with Ethylenediamine Tetraacetic Acid
- Metal-EDTA Complexes
- Direct Titration of Calcium with EDTA
- End Point Detection

### **Chem 4111 Introduction to Nanoscience**

**Chapter 1** Basic Concepts of Nanoscience

**Chapter 2** Basic Techniques for Fabrication of Nanomaterials

**Chapter 3** Applications of Nanomaterials

### **Chem 4112 Radiochemistry**

**Chapter 1** Introduction to Radioactivity

**Chapter 2** Production of Radioisotopes

**Chapter 3** Uses of Radioisotope

BSc (Honours) FIRST YEAR

SEMESTER I

Chem 3201 Inorganic Chemistry I

**Chapter 1 Organometallic Chemistry**

- Classification
- Bonding and Synthetic Methods
- Thermodynamic and Kinetic Stabilities
- Properties and Reactions
- Catalytic Reactions
- Stoichiometric Reactions (Insertion, Oxidative-Addition)

**Chapter 2 Complexes of Acceptor  $\pi$  Ligands**

- Noble Gas Formulation
- Carbon Monoxide Complexes
- Nitric Oxide Complexes
- Donor Complexes of Group VB and Group VIB Ligands
- Cyanide Complexes
- Ligands having Extended  $\pi$  Systems

Chem 3202 Physical Chemistry I

**Chapter 1 Basic Concepts of Molecular Spectroscopy**

- Fundamentals of Molecular Spectroscopy
- Energy of Molecules
- Microwave Spectroscopy
- Infra-red Spectroscopy
- Ultraviolet and Visible Spectroscopy
- Nuclear Magnetic Resonance Spectroscopy
- Electron Spin Resonance Spectroscopy

**Chapter 2 Surface Chemistry and Surface Thermodynamics**

- Adsorption on Solid Surfaces
- Liquids on Solids and Liquids
- Surface-Active Agents (Surfactants): Soluble Materials
- Surface-Active Agents: Insoluble Surface Films
- Surface-active Agents: Other Phenomena
- Molecules between Phases
- Pressure Across an Interface
- Spreading of Liquids and Capillary Rise
- Adsorption in Liquid Systems and Surface Films

**Chem 3203                    Organic Chemistry I****Chapter 1      Theoretical Concepts of Organic Chemistry**

- Reactants and Reactions
- Types of Reactions
- Factors Influencing a Reaction
- Carbocations
- Carbanions
- Radicals

**Chapter 2      Nucleophilic Substitution and Elimination Reactions**

- Nucleophilic Substitution Reactions
- Factors Affecting  $S_N1$  and  $S_N2$  Reactions
- Elimination Reaction
- Competition between Substitution and Elimination

**Chem 3204                    Analytical Chemistry I****Chapter 1      Practical Aspects of Chemical Analysis**

- Analysis of Real Samples
- Preparing Samples for Analysis
- Decomposing and Dissolving the Samples

**Chapter 2      Treatment of Analytical Data**

- Significant Figures
- Accuracy and Precision
- Types of error in Experimental Data
- Statistical Treatment of Data

**Chapter 3      Gravimetric Analysis**

- General Principles of Gravimetric Analysis
- Stoichiometry of Gravimetric Reaction
- Formation and Properties of Precipitates
- Drying and Ignition of Precipitates
- Organic precipitants
- Solubility Equilibrium

**Chapter 4      Precipitation Titrations**

- Requirements for Precipitation Titrations
- Titration Curve for Precipitation Titrations
- End Points for Argentometric Titrations
- Applications of Standard Silver Nitrate Solutions

**Chem 3205 (Elective) Biochemistry****Chapter 1      Fundamental Concepts**

- Bioelements
- Important Functional Groups in Biomolecules
- The Specific Interactions of Biomolecules Depend on Noncovalent Bonds
- Properties of Water

**Chapter 2 Biomolecules**

- Carbohydrates
- Lipids
- Amino Acids
- Nucleic Acids

**Chapter 3 Enzymes**

- Enzyme Characteristics
- Enzyme Nomenclature and Classification
- Mechanism of Enzyme Action
- Types of Enzyme Action
- Enzyme Catalysts Activity
- Factors that Affect Enzyme Activity
- Enzyme Kinetic
- Enzyme Units
- Enzyme Inhibitor
- Enzyme Parts List

**Chapter 4 Metabolism**

- What is cell?
- Introduction to Metabolism
- Intermediary Metabolism
- Glycolysis
- Citric Acid Cycle

**Chapter 5 Molecular Genetics**

- Waston–Crick Double Helix
- Biosynthesis of DNA (Replication)
- Biosynthesis of RNA (Transcription)
- Biosynthesis of Protein (Translation)
- Mutation

**Chem 3206 (Elective) Instrumental Methods of Analysis****Chapter 1 Separation Methods**

- Solvent Extraction
- Chromatographic Separation

**Chapter 2 Spectroscopic Methods**

- Ultraviolet Spectroscopy
- Fourier Transform Infrared Spectroscopy



**Chem 3207 Inorganic Chemistry II****Chapter 1 Nonaqueous Solvents Systems**

- Classification of Solvents
- General Properties of Ionising Solvents
- Liquid Ammonia as Solvent
- Liquid Sulphur Dioxide as Solvent
- Liquid Hydrogen Fluoride
- Liquid Hydrogen Cyanide
- Acetic Acid ( $\text{CH}_3\text{COOH}$ )
- Other Non-Aqueous Solvents

**Chapter 2 Theories of the Coordinate Bond in Metal Complexes**

- Valence Bond Theory
- Crystal Field Theory
- Ligand Field Theory (LFT)
- Molecular Orbital Theory
- Stability of Complex Ions

**Chem 3208 Physical Chemistry II****Chapter 1 Physical Chemistry of Macromolecules**

- Basic Terms and Definitions
- Polymerization Reactions
- Molecular Weight Determination Methods
- Polymer Morphology
- Thermal Properties
- Differential Thermal Analysis and Differential Scanning Calorimetry

**Chapter 2 Quantum Chemistry I**

- Waves and Particles
  - Historical Perspective
  - Electromagnetic Radiation: The Wave Theory
  - Particle Nature of Radiation
  - Spectroscopy
  - The Bohr Theory of the Hydrogen Atom
  - The de Broglie Principle
  - Electron Diffraction
  - Diffraction of Neutral Particles
  - Superposition, Wave Packets and Uncertainty Principle
- The Wave function and the Postulate of Quantum Theory
  - The Schrodinger Equation
  - The Wave function and Probability Density

- Operators
- Average Values
- The Tunneling Phenomenon

## Chem 3209                  Organic Chemistry II

### Chapter 1      Stereochemistry

- Stereoisomers
- Conformational Isomers
- Configurational Isomers
- Prediction of Enantiomerism
- Naming Enantiomers: The R, S System of Nomenclature
- Optical Activity
- Specification of Configuration: More than one Chiral Centre
- Diastereomers
- Meso Compounds
- Separation of Enantiomers: Resolution of a Racemic Modification

### Chapter 2      Amino acids, Peptides, Proteins and Nucleic Acids

- The Structures of Amino Acids
- Dipolar Structure of Amino Acids
- Isoelectric Point
- Separation of Amino Acids
- Synthesis of  $\alpha$ -Amino Acids
- Reactions of Amino Acids
- Resolution of Racemic Mixtures of Amino Acids
- Peptides
- Determination of Peptide Structure
- Synthesis of Peptides
- Classification of Proteins
- Protein Structures
- Determination the Primary Structure of a Protein
- Denaturation of Protein
- Nucleic Acids
- The Structure of DNA
- The Structure of RNA
- Hydrolysis of Nucleic Acid

## Chem 3210                  Analytical Chemistry II

### Chapter 1      Acid Base Equilibria and Titration

- Fundamental Concept of Acidity and Basicity
- Equilibrium Calculations for Solutions of Acids and Bases

- Acid-Base Titration
- Titration Curves

### **Chapter 2 Equilibria in Oxidation Reduction Systems**

- Oxidation-Reduction Equilibria
- Half-Reactions
- Fundamentals of Electrochemistry
- Schematic Representation of Electrochemical Cells
- Electrode Potential or Relative Half-Cell Potential
- Effect of Concentration on Electrode Potentials

### **Chapter 3 Potentiometric Methods**

- Electrode Systems
- Inert Electrodes
- Measurement of Cell emf
- The Potentiometer
- Potentiometric Titrations
- Reference Electrode
- Indicator Electrodes
- Salt Bridge and Liquid Junction Potentials

## **Chem 3211 (Elective) Environmental Chemistry**

### **Chapter 1 Air Pollution**

- The Atmosphere
- Air Pollution
- Radiation Pollution
- Noise Pollution
- Air Pollution Control Technology
- Ambient Air Quality

### **Chapter 2 Water Pollution**

- Water Quality Today
- Types and Effects of Water Pollution
- Pollutants
- Prevention and Control of Water Pollution
- Water Legislation

### **Chapter 3 Water Use and Management**

- Water Resources
- Major Water Compartments
- Water Availability and Use

### **Chapter 4 Solid, Toxic and Hazardous Wastes**

- Solid Waste
- Waste Disposal Methods
- Hazardous and Toxic Wastes

**Chapter 5 Environmental Health and Toxicology**

- Types of Environmental Health Hazards
- Mechanisms for Minimizing Toxic Effects
- Measuring Toxicity
- Risk Assessment and Acceptance
- Establishing Public Policy

**Chapter 6 Environmental Policy, Law and Planning**

- Objectives for Environmental Policy, Law and Planning
- Environmental Policy
- Environmental Laws
- Environmental Planning
- Planning for Water Environment
- Establishment of maximum contamination levels (MCLs)

**Chem 3212 (Elective) Radiation Chemistry****Chapter 1 Interaction of Radiation with Matter and Radiation Measurements**

- Radiation Sources
- Types of Radiation
- Physical Aspects
- Chemical Aspects
- Radiation Chemistry Reactions
- Radiation Measurement

**Chapter 2 Radiation Effects in Solids and Radiation Dosimetry**

- Inorganic Solids
- Organic Solids
- Radiation Dosimetry

**Chapter 3 Applied Radiation Chemistry**

- Radiation Processing
- Radiation Preservation and Sterilization
- Radiation Safety

**BSc (Honours) SECOND YEAR****SEMESTER I****Chem 4201 Inorganic Chemistry III****Chapter 1 Stability of Isotopes**

- Nuclear structure and Stability
- Radioactivity and Nuclear Decay
- Discovery of Isotopes
- Nuclear Reaction
- Nuclear Models

- Analysis of Radioactive Environmental Sample
- Health and Safety Aspects

## **Chapter 2 Symmetry and Point Groups**

- Symmetry Operations and Symmetry Elements
- Inverse Operations
- Groups and Their Basic Properties
- Systematic Classification of Molecules into Point Groups
- Matrices

## **Chapter 3 Toxicological Effects of Mercury and Arsenic Compounds**

### **-Toxicological Effects of Mercury Compounds**

- Sources of mercury
- Physical and Chemical Properties of Mercury
- Compounds of Mercury
- Health Effects of Mercury
- Risk Assessment for Mercury
- Preventive and Remedial Measures

### **-Toxicological Effects of Arsenic Compounds**

- Sources of arsenic
- Physical and Chemical Properties of Arsenic
- Arsenic Compounds
- Health Effects of Arsenic
- Risk Assessment for Arsenic
- Preventive and Remedial Measures

## **Chem 4202 Physical Chemistry III**

### **Chapter 1 Statistical Thermodynamics**

- The Boltzmann Distribution Law
- Gibbs Ensembles
- The Canonical Partition Function and Thermodynamic Properties
- The Electronic Partition Function
- The Translational Partition Function
- The Rotational Partition Function
- The Vibrational Partition Function
- Chemical Equilibrium in Ideal Gas

### **Chapter 2 Molecular Spectroscopy**

- Rotational Spectroscopy
  - Pure rotational spectra
  - Heteronuclear Diatomic Molecules

- Rigid Rotor in a Plane
- Rigid Rotors
- Polyatomic Molecules
- A survey of Rotational Spectroscopy
- Vibrational Spectroscopy
  - The Harmonic Oscillator model
  - Ro-vibrational spectra of diatomic molecules
  - Raman Scattering
  - Effects of anharmonicity and nonrigidity
  - Polyatomic molecules
  - A Survey of vibrational spectroscopy

**Chem 4203                      Organic Chemistry III**

**Chapter 1      Electrophilic Addition to Unsaturated Carbons**

- Halogenation
- Addition of Hypohalous Acids
- Hydrohalogenation
- Hydration
- Epoxidation-hydroxylation
- Addition of carbene ( Cycloaddition)
- Addition to Alkenes
- Hydrogenation
- Ozonolysis

**Chapter 2      Electrophilic Aromatic substitution**

- Halogenation
- Nitration
- Sulfonation
- Alkylation of aromatic rings :
- Acylation of aromatic rings:
- Alkylation of benzene via acylation- reduction
- The diazonium ion as an electrophile
- Ipso substitution
- Reactivity of aromatic rings
- The effect of substituents on orientation

**Chapter 3      Fundamental Concepts of Organic Spectroscopy I**

- Electromagnetic Radiation
- UV Visible Spectroscopy
- FT IR Spectroscopy

**Chem 4204 Analytical Chemistry III****Chapter 1 Separation by Extraction and Chromatographic Methods : Extraction Analysis**

- The Distribution Coefficient
- The Distribution Ratio
- Multiple Extraction
- The Completeness of Multiple Extractions
- Types of Extraction Procedures
- The Effect of pH and Reagent Concentration on Distribution Ratios
- Chromatography
- Gas Chromatography (GC)
- Liquid Chromatography (LC)
- Ion Chromatography (IC)
- Thin Layer Chromatography (TLC)

**Chapter 2 Fundamentals of Electrode Processes**

- Introduction to electrochemistry
- Electrogravimetric method and coulometric methods
- Polarography
- 

**Chem 4205 Research Methodology****Chapter 1** Basic Concept of Research Methodology**Chapter 2** Literature Survey**Chapter 3** Research Design**Chapter 4** Data Collection and Analysis**Chapter 5** Report Writing and Presentation**Chem 4206 Petroleum Chemistry****Chapter 1** Origin and Nature of Petroleum**Chapter 2** Properties of Hydrocarbon Constituents**Chapter 3** Petrochemicals**Chapter 4** Cracking Processes**BSc (Honours) SECOND YEAR****SEMESTER II****Chem 4207 Inorganic Chemistry IV****Chapter 1 Actinide Elements**

- General Features
- Electronic Structures
- Actinide Contraction
- Oxidation States

- Production and Properties of Actinide Elements in their Compounds
- Radioactivity of Actinides
- Separation of Transuranium Elements
- Production of Transuranium Elements
- Radiation Hazard of Transuranium Elements
- Application of Transuranium Elements

## **Chapter 2     Electronic Absorption Spectra of Complexes**

- The Geometry of the Orbitals
- The Vector Model of the Atom
- Term Energy Level Diagrams
- Tanabe–Sugano Diagrams
- Thermodynamic Stability of Complexes
- Kinetic Stability of Complexes
- Optical Activity

## **Chem 4208             Physical Chemistry IV**

### **Chapter 1     Electrochemistry : Electrolytes in Solution**

- Specific Conductance
- Molar Conductance
- Conductance in Electrolytic Dissociation
- Colligative Properties and Electrolytic Dissociation
- Electrolysis
- Transference Number
- Ionic Mobilities
- Applications
- Dielectric effect
- Ionic strength
- Debye–Huckel Theory
- Activities from the Debye–Huckel Theory
- Activities in more Concentrated Solution

### **Chapter 2     Electromotive Forces of Electrochemical Cells**

- Electrodes, Cell EMF
- Standard Electrode potential
- EMF and Activities
- Activities Coefficient EMF's
- Equilibrium Constant from EMF's
- Electrode– Concentration cell
- Electrolyte–Concentration cell
- Junction Potential



- Salt Bridge
- Ion Selective Electrode
- Thermodynamic Properties from Cell EMF's

### **Chapter 3 Quantum Chemistry II**

- 1. The Hydrogen Atom
  - The Schrodinger Equation
  - Atomic Orbitals
  - Graphical Presentation of Atomic Orbitals
  - Spin and Fine Structure
- 2. Synthesizing Wave Functions
  - Principle of Superposition
  - The Variation Principle
  - The Secular Determinant
  - Perturbation Theory
  - Qualitative Features of the Approximate Methods

### **Chem 4209 Organic Chemistry IV**

#### **Chapter 1 Nucleophilic Addition to Carbonyl Group (aldehydes and ketones)**

- Reactivity of the Carbonyl Groups
- Cyanide as the Nucleophile
- Oxygen or Sulphur as the Nucleophile
- Hydride as the Nucleophile
- Carbon as the Nucleophile
- Nitrogen as the Nucleophile

#### **Chapter 2 Nucleophilic Substitution on Carbonyl Group (Carboxylic Acid Family)**

- Reactivity in the carboxylic Acid Family
- Acyl Halides and Anhydrides
- Oxygen or Sulphur as the Nucleophile (Ester and Carboxylic Acids)
- Nitrogen as the Nucleophile
- Carbon as the Nucleophile

#### **Chapter 3 Fundamental Concepts of Organic Spectroscopy II**

- NMR Spectroscopy
- Mass Spectrometry

### **Chem 4210 Analytical Chemistry IV**

#### **Chapter 1 Fundamentals of Spectroscopic Techniques and Analysis**

- Absorption of Radiation
- Absorption Spectra
- Atomic Absorption

- Molecular Absorption
- Infrared Absorption
- Absorption of Ultraviolet and Visible Radiation
- Relaxation Process
- Terms employed in Absorption Spectrometry
- Beer's Law
- Emission of Electromagnetic Radiation

#### **Chapter 2     Complex Formation Equilibria**

- Complex Formation Reactions
- Complex Formation Constants
- The Liebig Titration
- Titrations with Ethylenediamine Tetraacetic Acid
- Metal-EDTA Complexes
- Direct Titration of Calcium with EDTA
- End Point Detection

#### **Chem 4211             Introduction to Nanoscience**

**Chapter 1     Basic Concepts of Nanoscience**

**Chapter 2     Basic Techniques for Fabrication of Nanomaterials**

**Chapter 3     Applications of Nanomaterials**

#### **Chem 4212     Radiochemistry**

**Chapter 1     Introduction to Radioactivity**

**Chapter 2     Production of Radioisotopes**

**Chapter 3     Uses of Radioisotope**

**BSc (Honours) THIRD YEAR**

**SEMESTER I**

**MSc (Qualifying)**

#### **Chem 5201             Inorganic Chemistry V**

#### **Chapter 2     Group Theory and its Applications**

- Representation of Groups
- Reducible and Irreducible Representation
- Some Important Reducible Representation
- Group Theory and Vibrational Spectroscopy
- Some Further Aspects of Vibrational Spectroscopy
- Some Applications of Group Theory in Bonding

**Chapter 2 Inorganic Reaction Mechanism**

- Introduction
- Classification
- Dissociation and Addition Reactions
- Free Radical Reactions
- Substitution Reactions
- Oxidation Reduction Reactions

**Chem 5202 Physical Chemistry V****Chapter 1 Chemical Kinetics in Solutions**

- A comparison of Kinetics in Solution and Gas
- Diffusion Control Reactions
- Relaxation Methods
- Proton Transfer and Acid Base Catalysis
- Enzyme Kinetics
- Ionic Reaction in Solution
- Kinetics of Polymerization
- Oscillating Reactions

**Chapter 2 Heterogeneous and Electrochemical Reactions**

- Adsorption and Desorption
- Adsorption Isotherm
- Heterogeneous Catalysis
- Electrode Kinetics

**Chapter 3 Energy Transfer and Photochemistry**

- Interaction of Radiation with Matter
- Radioactive and Non-radioactive Transition in Molecules
- Energy Transfer
- Photochemical Reactions

**Chem 5203 Organic Chemistry V****Chapter 1 Advanced Organic Spectroscopic Techniques**

- <sup>1</sup>H NMR Spectroscopy
- <sup>13</sup>C NMR Spectroscopy
- Mass Spectrometry

**Chapter 2 Advanced Organic Reaction Mechanisms****Chem 5204 Analytical Chemistry V****Chapter 1 Graphical Determination of pH and Chemical Species in Aqueous Solutions**

- Molecular Structure and Acid-Base Strength

- Factors Affecting the Interaction of Acids and Bases with Water
- pH of Aqueous Solution
- Logarithmic Diagram for Acid–Base Equilibria

#### **Chapter 2     Chemical Sensors**

- Introduction
- Definition
- Classification of Chemical Sensors
- Description of Chemical Sensors

#### **Chapter 3     Biosensors**

- Introduction
- Producing Biological Surface
- Achievement of Biotransduction

### **Chem 5205             Nuclear Chemistry I**

#### **Chapter 1     Principles of Radioactive Decay Process**

- Instability of Nuclei
- Alpha Decay
- Spontaneous Fission
- Beta Decay
- Gamma Transition

#### **Chapter 2     Detection of Radioisotopes**

- Ionization Detectors
- Scintillation Detectors
- Photographic Detection Methods
- Nuclear Track Detectors
- Cloud Chambers and Bubble Chambers
- Coincidence and Anticoincidence Measurements

### **Chem 5206             Food and Nutritional Chemistry**

**Chapter 1     Nutrient Requirements in Human**

**Chapter 2     Energy Requirements in Human**

**Chapter 3     Macronutrient and Mineral**

**Chapter 4     Dietary Recommendation**

**Chapter 5     Protein–Calorie Malnutrition**

**Chapter 6     Nutrition and Chronic Diseases**

BSc (Honours) THIRD YEAR

SEMESTER II

MSc (Qualifying)

Chem 5207 Inorganic Chemistry VI

**Chapter 1 Fundamental Aspects of Solid State Chemistry**

- Experimental Evidence on Structure
- Structure and Properties
- Structure and Properties of Transition Metal Oxides

**Chapter 1 Electronic Spectra of Complex Ions**

- Selection Rules and Band Widths
- Spectra of Aqueous Solutions of  $M(H_2O)_6^{n+1}$
- Spectra of Spin-Free  $ML_6^{n+1}$
- Spectra of Spin-Free  $ML_6^{n+1}$
- Spectra of Distorted Octahedral Complexes
- Spectra of Tetrahedral Complexes
- The spectrochemical and Nephelauxetic Series
- Charge Transfer spectra

Chem 5208 Physical Chemistry VI

**Chapter 1 Quantum Chemistry III**

- 1. Atoms: Electronic Structure and Spectra
  - The Lowest Energy Level of the Helium Atom
  - Spin and Antisymmetric Wave Functions
  - Electronic Configurations of Atoms and the Periodic Table
  - Interpretation of Atomic Spectra
- 2. Diatomic Molecule: Bonding and Electronic Spectra
  - Ionic Interactions
  - Separation of Nuclear and Electronic Motion
  - The Hydrogen Molecular Ion
  - Homonuclear Diatomic Molecules
  - Heteronuclear Diatomic Molecules
  - Electronic Spectroscopy

**Chapter 2 Material Science**

- The Geometry of Nanoscale Carbon and Fullerenes
  - Bonding, Dimensionality, Topology, Curvature
  - Energetics, Kinetics
  - Other Rings, Holes
  - Families of Fullerenes: From C<sub>60</sub> to TNTs
  - Reactivity
  - Potential Applications
- Characterization and Properties of Nanomaterials
  - Introduction

- Structural Characterization
- Chemical Characterization
- Physical properties of Nanomaterials
- Electrical Conductivity
- Ferroelectrics and Dielectrics
- Superparamagnetism

## **Chem 5209                  Organic Chemistry VI**

### **Chapter 1      Synthesis of Organic Compounds**

- Multistep Organic Synthesis
- Functional Group Introduction, Removal and Interconversion
- Retrosynthetic Analysis (Disconnections)

### **Chapter 2      Chromatographic Separation Techniques**

- Partition Chromatography
- Thin Layer and Paper Chromatography
- Adsorption Chromatography
- Column Chromatography

### **Chapter 3      Organometallic Compounds**

- Nomenclature
- Carbon-Metal Bonds
- Preparation of Organolithium Compound
- Preparation of Magnesium Compound, Grignard Reagent
- Synthesis of Alcohol using Grignard Reagents
- Synthesis of Alcohol using Organolithium Reagent
- Synthesis of Acetylenic Alcohols
- Retrosynthetic Analysis
- Preparation of Tertiary Alcohol from Esters and Grignard Reagents
- Alkane Synthesis using Organocopper Reagents
- An Organozinc Reagent for Cyclopropane Synthesis
- Carbenes and Carbenoids
- Transition Metal Organometallic Compound

### **Chapter 3      Pericyclic Reactions**

## **Chem 5210                  Analytical Chemistry VI**

### **Chapter 1      Optical Methods: Emission, Absorption, Fluorescence**

- Fundamentals of Spectrophotometry
- Spectroscopic Instruments and Analysis

### **Chapter 2      Continuous Automatic Instrumentation for Process Application**

- Autoanalyzer

- Process Analyzer

### **Chapter 3 An Introduction to Circular Dichroism Spectroscopy**

- Understanding circular dichroism
- Chiral molecules
- Circular dichroism
- Chirality and biology
- CD spectrometer operating principles
- CD spectrometer performance
- CD signatures of structural elements
- CD units and conversion

### **Chem 5211 Nuclear Chemistry II**

#### **Chapter 1 Methods of Production of Isotopes**

- Production of Radioisotopes
- Production of Neutron- Excess Radioisotopes
- Production of Neutron- Deficient Radioisotopes
- Generator Produced Radioisotopes
- Activation Analysis
- Radio Isotopic Purity
- Natural Production of Radioisotopes

#### **Chapter 2 Nuclear Energy**

- Basic Principles of Chain- Reacting System
- Reactors and Their Uses
- Reactor- Associated Problems
- Controlled- Thermonuclear Reactions

### **Chem 5212 Nanochemistry**

#### **Chapter 1 Methods of Nanoparticles Synthesis**

#### **Chapter 2 Characterization and Properties of Nanoparticles**

- XRD, SEM, TEM, FTIR, UV

#### **Chapter 3 Recent Developments in Nanotechnology**

- Nanotech-Enable Sensors and Sensor System

## REFERENCES

**Inorganic Chemistry**

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## For Biotechnology Specialization

Third Year

Semester I

### BT 3103 Chemistry of Biomolecules

#### Chapter 1 Fundamental Concepts

- Bioelements
- Important Functional Groups in Biomolecules
- The Specific Interactions of Biomolecules Depend on Noncovalent Bonds
- Properties of Water

#### Chapter 2 Biomolecules

- Carbohydrates
- Lipids
- Amino Acids
- Nucleic Acids

#### Chapter 3 Enzymes

- Enzyme Characteristics
- Enzyme Nomenclature and Classification
- Mechanism of Enzyme Action
- Enzyme Parts List

#### Chapter 4 Molecular Genetics

- Waston-Crick Double Helix
- Biosynthesis of DNA (Replication)
- Biosynthesis of RNA (Transcription)
- Biosynthesis of Protein (Translation)

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- 1) Berg, J.M., Tymoczko, J. L. and Stryer, L., (2002), "*Biochemistry*", 5<sup>th</sup> edition, W.H. Freeman and Company, New York
- 2) John McMurry, (2000), "*Text Book of Organic Chemistry*", 5<sup>th</sup> Edition, Cornell University

Third Year

Semester II

### BT 3108 Chemistry of Enzymes

- Characteristics of enzymes
- Nomenclature and classification of enzymes

- Mechanism of enzyme Action
- Types of enzyme action
- Enzymes as biological catalysts
- Factors affecting on enzyme activity
- Enzyme kinetics
- Enzyme units
- Enzyme inhibitors

### References

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### Fourth Year

### Semester I

#### BT 4103 Analytical Biochemistry I

Chapter I General Principles of Analytical Biochemistry

Chapter II Spectroscopy I

Chapter III Separation Methods I

### References

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### Fourth Year

### Semester II

#### BT 4108 Analytical Biochemistry II

Chapter I Carbohydrates

Chapter II Lipids

Chapter III Radio isotopes

## References

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## MSc (Qualifying)

### Semester I

- BT 5205 Biochemical Analysis I**
- Chapter I Spectroscopy II
  - Chapter II Separation Methods II
  - Chapter III Enzymes

## MSc (Qualifying)

### Semester II

- BT 5211 Biochemical Analysis II**
- Chapter I Proteins
  - Chapter II Immunological Methods
  - Chapter III Nucleic Acids

## References

- 1) Berg, J.M., Tymoczko, J. L. and Stryer, L., (2002), "*Biochemistry*", 5<sup>th</sup> edition, W.H. Freeman and Company, New York
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## For Environmental Science Specialization

### First Year

### Semester I

#### Chem 1003 General Chemistry

#### Chapter 1 The Electronic Structure of Atom and Periodic Properties

- The Electronic Structure of Atom



- Periodic Properties

**Chapter 2 The Properties of Gases and Solutions**

**Chapter 3 Fundamental Concepts of Organic Compounds**

**Chapter 4 Toxic Waste Materials**

**Second Year**

**Semester I**

**ES 2104 Environmental Chemistry I: Aquatic Chemistry**

**Chapter 1 Fundamentals of Aquatic Chemistry**

- Dissolution / Precipitation Reactions
- Complexation Reaction in Fresh Waters
- Species Distribution in Fresh Waters

**Chapter 2 Case Studies**

- Acidification
- Metals in Water
- Nutrients in Water
- Organic Matter and Organic Chemicals in Water

**Chapter 3 Seawater Composition and Chemistry**

- Major Constituents
- Dissolved Gases
- Nutrients
- Trace Elements

**Third Year**

**Semester I**

**ES 3103/3203 Environmental Chemistry II: Soil Chemistry**

**Chapter I Soil: Its Formation, Constituents and Properties**

- Soil Formation
- Soil Constituents
- Soil Properties

**Chapter II Sources of Soil Contaminants**

**Chapter III Characteristics of Some Major Groups of Soil Contaminants**

**Chapter IV Possible Hazards from Contaminated Soil**

**Chapter V Reclamation of Contaminated Soil**

**Fourth Year**

**Semester I**

**ES 4104/4204 Environmental Chemistry III: Atmospheric Chemistry**

**Chapter 1 Light**

**Chapter 2 Atmospheric Structure**

**Chapter 3 Ozone**

- Introduction to Ozone
- Ozone Catalytic Cycles

**Chapter 4 Chemical Kinetics**

- Pseudo–Steady–State Example
- Arrhenius Equation
- Chapman Reaction Kinetics

Chapter 5 Smog

Chapter 6 Green House Effect

**MSc Qualifying**

**Semester II**

**ES 5211 Environmental Chemistry IV: Environmental Pollution and Management**

**Chapter 1 Carbondioxide Equilibria**

- Pure Rain
- Polluted Rain
- Surface Water

**Chapter 2 Toxic Environmental Compounds**

- Pesticides
- Mercury
- Lead

**Chapter 3 Ecological and Health Effects of Chemical Pollution**

- Health Effects of the Major Air Pollutants
- Effect of Air Pollution on Plants
- Ecological Effects of Acid Deposition
- Hydrocarbons in Marine Environment
- Health Effects of Metal Pollution

**Chapter 4 Managing Environmental Quality**

- Objectives, Standards and Limits
- Legislation to Control and Prevent Pollution
- Pollution Control Agency
- Public and Commercial Pressures to Improve the environment

### References

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**UNIVERSITY OF YANGON**

**DEPARTMENT OF CHEMISTRY**

**Syllabus for MSc Degree Course**

**First Year MSc                      Chemistry Specialization                      SEMESTER I**

**Chem. 611      Inorganic Chemistry**

1. The Transition Elements and the Electronic Structures of their Compounds
2. Inorganic Reaction Mechanisms (Complexes)
3. Selected Topics in Inorganic Chemistry

**Chem. 612      Physical Chemistry**

1. Colloidal, Surface and Catalytic Chemistry
2. Equilibrium Electrochemistry
3. Selected Topics in Physical Chemistry

**Chem. 613      Organic Chemistry**

1. Stereochemistry of Organic Compounds
2. Conformational Analyses
3. Organic Spectroscopy
4. Selected Topics in Organic Chemistry

**Chem. 614      Analytical Chemistry**

1. Electroanalytical Chemistry
2. Selected Topics in Analytical Chemistry

**First Year MSc.                      Chemistry Specialization                      SEMESTER II**

**Chem 621      Inorganic Chemistry and Nuclear Chemistry**

1. Homogeneous and heterogeneous catalytic reactions of organometallic compounds
2. Bioinorganic Chemistry
3. Selected Topics in Inorganic Chemistry & Nuclear Chemistry

**Chem 622      Physical Chemistry**

1. Advanced Quantum Chemistry
2. Chemical Statistics
3. Selected Topics in Physical Chemistry

**Chem 623      Organic Chemistry**

1. Medicinal Chemistry
2. Advanced Heterocyclic Chemistry
3. Organic Polymers

## 4. Selected Topics in Organic Chemistry

- Chem 624 Analytical Chemistry**
1. Environmental Chemistry
  2. Selected Topics in Analytical Chemistry (including Research Methodology)

**Second Year MSc. Chemistry Specialization SEMESTER I**

**Chem 631 Research Outline and Presentation**

**Chem 632 Progress of Research and Presentation**

**Chem 633 Research Progress Report**

**Chem 634 Research Progress Report and Presentation**

**Second Year MSc. Chemistry Specialization SEMESTER II**

**Chem 641 Research and Seminar**

**Chem 642 Thesis and Viva Voce**