DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
Four Year Undergraduate Course Structure:
Subject: Chemistry Semester I NEP (Revised)
For students admitted in session 2023-24 onwards

Semester I						
Paper	**Paper Title**	**Type**	**Credits**	**Internal Assessment**	**University Exam**	**Total Marks**
Paper 1	Inorganic Chemistry 1	Theory (Major/Minor)	4	25	75	100
Paper 2	Chemistry Practical 1	Practical (Major)	4	-	100	100
CC 1	Co-Curriculum 1	From Central Pool	4	25	75	100
P1”	Minor	Minor Theory	4	25	75	100
P1’	Second major subject	Theory	4	25	75	100
P2’	Second major subject	Theory	4	25	75	100
	Total Credits		**24**			**600**

Inorganic Chemistry 1 (Major and Minor)

Semester I **Paper 1** **Credits 4**

Course outcome

Students admitted in B.Sc. Chemistry semester program will gain precise insight into the:

- **CO-1** Structure of atoms and associated important rules, importance of chemistry of elements.
- **CO-2** Ionic, covalent and non-covalent bonding which always play pivotal role in deciding the chemistry and properties of any compound/material.
- **CO-3** Periodic properties of elements and several parameters associated with elements
- **CO-4** Solid state chemistry which forms the basis of the development of targeted crystalline solids inculcating varied defects which induces variety of materials properties viz. piezoelectricity.
- **CO-5** Chemistry of elements belonging to s-block, noble gases and main group.

Unit 1

- **Atomic Structure:**
  - Quantum mechanics-based structure of atom in brief, shapes of s, p and d orbitals, Aufbau and Pauli exclusion principles, Hund's Multiplicity rules. Electronic configurations of the elements, effective nuclear charge.
- **Periodic Properties and Classification based upon electronic configuration:**
  - Diagonal relationship, inert pair effect, atomic and ionic radii, van der waal radii, ionization energy,
- **Electron affinity and electronegativity:**
  - Definition, method of determination, trends in periodic table and applications in predicting and explaining chemical behaviour.

Unit 2

- **Chemical Bonding**
  - Covalent bond: valence bond theory and its limitations, directional characteristic of covalent bond. Hybridization and shapes of simple molecules and ions. Valence Shell Electron Pair Repulsion (VSEPR) theory to simple molecules and ions. Molecular Orbital theory for homonuclear and heteronuclear (CO and NO) diatomic molecules, multi-center bonding in electron deficient molecules, bond strength and the bond energy, % ionic character from dipole moment and electronegativity difference.

- Weak interactions: hydrogen bonding, van der Waals forces.

Unit 3

- **Ionic solid:**
  - ionic structures, radius ratio effect and coordination number, limitation of ratio rule, Lattice defects, Lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarizability of ions. Fajan's rule, Metallic bond free electron, Valence bond and Band theories.
- **s-Block elements:**
  - Comparative study, salient features of hydrides, salvation and complexation tendencies of cations of alkali and alkaline earth matter including their function in biosystems, an introduction to alkyls and aryls of Li & Mg.
- **Noble Gases:**
  - Chemical properties of the noble gases, discovery of $O_2^+PtF_6^-$ and O_2XeF_6.Chemistry of xenon, structure and bonding in xenon compounds.

Unit 4

- **p-Block Elements:**
  - Comparative study (including diagonal relationship) physical and chemical behaviour of group 13-17 elements, compounds like hydrides, oxides, oxyacids and halides ofgroup 13-16, diborane, boronitride α, β forms, Fullerenes, silicates(structural principle) andstructures of oxides and oxyacids of phosphorus and sulphur, interhalogens and polyhalides.

Text Books (Theory Courses):

1. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
2. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
3. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
4. Chemistry for degree students, R. L. Madan

Reference Books:

1. Inorganic Chemistry, J.E. Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
2. Inorganic Chemistry, D.E. Shriver, P W. Atkins and C.H.L. Langford, Oxford.
3. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
4. Concepts of Models of Inorganic Chemistry, B. Douglas, D. McDaniel and J Alexander, John Wiley.
5. Inorganic Chemistry, W.W. Porterfield, Addison - Wesley.
6. Inorganic Chemistry, A.G. Sharpe, ELBS
7. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice- Hall.

Chemistry Practical 1 (Major)

Semester I **Paper 2** **Credits 4**

Course Objective:
Students admitted in B.Sc. Chemistry semester program will gain precise insight into the experiments based on analysis of mixtures.

Course Outcomes:

- **CO-1.** the student will be able to analyse the given mixture and identify anions and cations present.
- **CO-2.** achieve knowledge about different types of reaction.
- **CO-3.** understand various tests to identify the radicals.
- **CO-4.** able to write reactions and structure.
- **CO-5.** acquire the skill to perform the experiment in the real lab once they understand different steps in the procedure.
- **CO-6.** Having expertise in making solutions accurately.
- **CO-7.** To acquired enough knowledge to answer questions based on experiments.

Inorganic Chemistry

- **Qualitative Analyses:**
  - Identification of cations and anions in a mixture of inorganic compounds soluble in water/dilute acids (Macro/semi-micro analysis- cation analysis, separation of ions from group 0-VI, anion analysis). Only six radicals.

Record & Viva

Books Recommended

1. Chemistry Practical by S. Giri, D.N. Bajpai and O.P. Pandey, S. Chand Publication.
2. Practical Chemistry Volume 1-3 by Fateh Bahadur, Vishal Publication
3. Systematic Chemistry Practical, P.C. Kamboj, Vishal Publication

Distribution of Maximum Marks:
The maximum marks in the evaluation of the practical exercises, viva-voce and records of their class-work are given below.

Chemistry Practical 1				
Class	Inorganic Chemistry	Viva	Class Record	Total
B.Sc. Semester I	60	30	10	100

Note: For exempted students, marks of class record will be added to the marks of viva-voce for practical examinations since they do not have the class record.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
Four Year Undergraduate Course Structure:
Subject: Chemistry Semester II NEP (Revised)
For students admitted in session 2023-24 onwards

Semester II						
Paper	**Paper Title**	**Type**	**Credits**	**Internal Assessment**	**Univ Exam**	**Total Marks**
Paper 3	Organic Chemistry 1	Theory (Major/Minor)	4	25	75	100
Paper 4	Chemistry Practical 2	Practical (Major)	4	-	100	100
VC 1	Chemistry Vocational 1	Food Chemistry	4	25	75	100
P2”	Minor	Minor Theory	4	25	75	100
P3’	Second major subject	Theory	4	25	75	100
P4’	Second major subject	Theory	4	25	75	100
	Total Credits		**24**			**600**

Organic Chemistry 1 (Major and Minor)

Semester II **Paper 3** **Credits 4**

Course outcome

Upon successful completion of this course, the student will be able to

- CO-1 Understand different organic compounds with respect to the functional group and thus capable to name the organic compounds as per IUPAC nomenclature.
- CO-2 Understand the basics of chemical reactions i.e. Substrate and Reagent, types of Reagents, Electrophilic and Nucleophilic Homolytic and heterolytic fission. Electron mobility, Inductive effect etc.
- CO-3 Recognize and draw constitutional isomers, stereoisomers, including enantiomers and diasteromers, racemic mixture and meso compounds.
- CO-4. Understand fundamental principles of organic chemistry and predict outcomes and derive mechanism of various types of organic reactions.
- CO-5 Understand various types of reactive intermediates and factors affecting their stability
- CO-6 Understand the nomenclature, synthesis, isomerism and physical properties of alkanes and cycloalkanes.
- CO-7 Understand the concept of Aromaticity of benzenoids & non- benzenoids, the preparation, reactivity & structure of aromatic compounds. CO-8 Learn the preparations, reactivity & stereochemistry of SN1 &SN2 reactions of Halogen compounds.

Unit 1

- **Structure and bonding:**
  - Resonance, electromeric effect, inductive and field effects. Generation, structure, stability and reactions of carbenes, arynes and nitrenes.
- **Stereoisomerism:**
  - **Optical isomerism**: elements of symmetry, molecular chirality, optical activity, stereogenic centres, enantiomers, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythrodiastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configurations. Sequence rules. D, L and R, S nomenclature.
  - **Geometrical isomerism:** determination of configuration of geometric isomers. E, Z system, geometrical isomerism in oximes and alicyclic compounds.
  - Conformational isomerism: conformational analysis of ethane and n-butane and cyclohexane, axial and equatorial bonds, Saw-horse and flying wedge

formulae, Fischer and Newman projections formulae. Difference between conformation and configuration.

Unit 2

- **Alkanes, Alkenes and Alkynes:**
  - **Alkanes and Cycloalkanes:** Methods of formation, physical and chemical properties of alkanes.Baeyer's strain theory and its limitations. Ring strain in (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring and banana bond.
  - **Alkenes:** Methods of formation, physical and chemical properties of alkenes and their relative stabilities.Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes, Structure of allenes and butadiene, methods of formation, chemical reaction – 1, 2 and 1, 4 additions, Diels-Alder reaction.
  - **Alkynes**: Structure and bonding in alkynes. Methods of formation, chemical reactions and acidity of alkynes.

Unit 3

- **Arenes and Aromaticity**:
  - Huckel's rule, Stability and carbon-carbon bond length of benzene, resonance structure, MO picture.
  - Aromatic electrophilic substitution- general pattern of the mechanism, Arrhenium ion intermediate. Mechanism of nitration, halogenation, sulfonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio.
- **Alkyl and Aryl Halides**:
  - Methods of formation and chemical reactions. Mechanism of nucleophilic substitution reactions of alkyl halides, SN2 andSN1 reactions with energy profile diagrams, Methods of formation of aryl halides, nuclear and side chain reactions. Mechanisms of nucleophilic aromatic substitutions.

Unit 4

- **Heterocyclic compounds:**
  - Introduction: Molecular orbital picture and aromatic characteristic of pyrrole, furan, thiophene and pyridine, methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, mechanism of nucleophilic substitution reactions. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles. Preparation and reactions of indols, quinoline and

isoquinoline with special reference to Fisher Indol synthesis, Skraup synthesis and Bischler – Nepieralski synthesis.

- **Organometallic Compounds:**
  - Grignard reagents, formation, structure and chemical reactions.

Text Books (Theory Courses):

1. Organic Chemistry, Vol. I, I.L. Finar, Pearson Education.
2. Organic Chemistry, M.K. Jain, Shoban Lal& Co.
3. Pradeep's Organic Chemistry, S.N. Dhawan, Pradeep Publication.

Reference Books:

1. Organic Chemistry, Morrison and Boyd, Prentice Hall.
2. Organic Chemistry, L.G. Wade Jr. Prentice Hall.
3. Fundamentals of Organic Chemistry, Solomons, John Wiley.
4. Organic Chemistry, Vol. I, II, III S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International)
5. Organic Chemistry, F.A. Carey, Tata McGraw-Hill publishing company
6. Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.

Chemistry Practical 2 (Major)

Semester II **Paper 4** **Credits 4**

Course outcome

Upon successful completion of this course, the student will be able to

- CO 1 Identify, classify, organize, analyze, and draw structures of organic molecules.
- CO 2 Apply the basic rules of organic nomenclature to convert between structures and names.
- CO 3 Recall reagents and predict products for a defined set of organic reactions.
- CO 4 Draw organic structures consistent with the results of specific chemical tests.
- CO 1 Predict the physical properties of organic chemicals based on their structures (e.g. relative boiling point, melting point, and solubility.)
- CO 5 Demonstrate proficiency in organic chemical laboratory techniques. (Chemical tests, extraction, filtration, instrumental analysis, molecular model building)

Organic Chemistry

- Identification of organic compounds
  - Ignition Test
  - Melting Point
  - Solubility
  - Additional Elements (Nitrogen, Halogens, Sulphur)
  - Unsaturation Test
  - Functional Group
  - Preparation of Derivative
  - Melting point of derivative

Record & Viva

Books Recommended

- Chemistry Practical by S. Giri, D.N. Bajpai and O.P. Pandey S. Chand Publication.
- Practical Chemistry Volume 1-3 by Fateh Bahadur, Vishal Publication
- Advanced Physical Chemistry by J.B. Yadav, Goel Publication

Distribution of Maximum Marks:

The maximum marks in the evaluation of the practical exercises, viva-voce and records of their class-work are given below.

Chemistry Practical 2				
Class	Organic Chemistry	Viva	Class Record	Total
B.Sc. Semester II	60	30	10	100

Note: For exempted students, marks of class record will be added to the marks of viva-voce for practical examinations since they do not have the class record.

Food Chemistry (Chemistry Vocational 1)

Semester II **VC 1** **Credits 4**

Course outcome

Students admitted in B.Sc. Chemistry semester program will gain precise insight into the:

- CO-1- Chemistry of water and its significance in foods
- CO-2- Role of each component of food such as carbohydrates, proteins, fats, vitamins and minerals and their interaction.
- CO-3- Functional aspects of various food components and to study their role in food processing.
- CO-4- Enzyme activity in different food systems and their functional importance in preparation of food additives.

Unit 1

- **General**
  - Water molecule, hydrogen bonding, different types of water, physical properties of water, water activity and its role in food processing and storage, industrial and nutritional significance of water.

Unit 2

- **Carbohydrates:**
  - Role of carbohydrates in food industry (sugars starch, cellulose, glucans, hemicellulose, gums, pectic substances). Plant pigments and their role in food industry. Proteins: Major protein systems and factors affecting them, Food proteins derived from milk. egg proteins, meat proteins, fish muscle proteins, oil seed proteins and cereal proteins.

Unit 3

- **Lipids:**
  - Vegetables and animal fats, butter, oleo oil and their use in food processing. Lipid oxidation, factors affecting lipid oxidation, autooxidation, biological significance of auto-oxidized lipids.

Unit 4

- **Enzymes:**
  - Enzyme definition, characteristics, classifications, Factors affecting enzyme catalyze reactions, Enzyme kinetics, Enzyme inhibition, Immobilization of enzymes, Role of Amylase, Protease, Lipase, Pectinase, and Rennet in food processing. Role of enzymes in Baking, Cheese making, fruit juice preparation, and in meat tenderization. Emulsifiers, Antioxidants, Food additives, and Vitamins

References Books

1. Principles of Food Chemistry by John deMan, Springer.
2. Food chemistry by H.K Chopra P.S Panesar, Alpha Science International Ltd.
3. Food chemistry by Owen R. Fennema, CRC Publications.
4. Food Chemistry by Lillian Hoagland Meyer, Reinhoad Publishing Corporation.
5. Food theory and application second edition by Jane Bower, Pearson
6. Spices and Seasonings: A Food Technology Handbook, by Donna R. Tainter, Antony T.Grenis, Wiley
7. Handbook of Herbs and Spices: Volume 3 edited by K.V. Peter Woodhead Publishing

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
Four Year Undergraduate Course Structure:
Subject: Chemistry Semester III NEP (Revised)
For students admitted in session 2023-24 onwards

Semester III						
Paper	**Paper Title**	**Type**	**Credits**	**Internal Assessment**	**Univ Exam**	**Total Marks**
Paper 5	Physical Chemistry 1	Theory (Major/Minor)	4	25	75	100
Paper 6	Chemistry Practical 3	Practical (Major)	4	-	100	100
CC 2	Co-Curriculum 2	From Central Pool	4	25	75	100
P3”	Minor	Minor Theory	4	25	75	100
P5’	Second major subject	Theory	4	25	75	100
P6’	second major subject	Theory	4	25	75	100
	Total Credits		**24**			**600**

Physical Chemistry 1 (Major and Minor)

Semester III **Paper 5** **Credits 4**

Course outcome

- CO-1- Students would gain knowledge regarding the basic of computers and mathematical concepts of log, permutation and combination, differential and integration of some relevant functions.
- CO-2- Student would gain understanding of gaseous state, critical phenomenon, liquid state, solid state, colloidal state and liquid crystals.
- CO-3- It would help students recognize the importance of chemical kinetics and catalysis.

Unit 1

Mathematical Concepts and Computers

- **Mathematical Concepts:**
  - Logarithmic relations, curves scratching, equation of straight line and slopes, tracing of curves, differentiation of simple functions like x, e^x, x^n, sin x, log x; maxima and minima, partial differentiation. Integration of some useful/relevant functions; Permutations and Combinations. Factorials, Probability. Computers: binary numbers and its arithmetic.
- **Gaseous State:**
  - Deviation of gases from ideal behaviour, van der Waals equation of State. Critical phenomenon: PV isotherms of real gases, continuity of states, the isotherms of van der Waals equations, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of states.
- **Molecular velocities:**
  - Qualitative discussion of the Maxwell's distribution of molecular velocities, collision numbers, mean free path and collision diameter

Unit 2

State of Matters: Solid, Liquid and Colloidal State

- **Solid State:**
  - Laws of crystallography, Diffraction: X-ray diffraction by crystals. Derivation of Bragg's equation. Laue's method and powder method, determination of crystal structure of NaCl, KCl and CsCl.
- **Liquid State:**
  - Intermolecular forces, structure of liquids (qualitative description), structural differences between solid, liquid and gases
- **Liquid crystals:**

- Classification, structure of nematic, smectic and cholesteric liquid crystals. Thermography and seven segment cells.

- **Colloidal State:**
  - Solids in liquids (sols): properties- Kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulz law, gold number.
- **Liquids in liquids (emulsions):**
  - Types of emulsions, preparation. Emulsifier.
- **Liquids in solids (gels):**
  - Classification, preparation and properties, inhibition, general applications of colloids.

Unit 3

Chemical Kinetics, Catalysis, Buffer Mixture

- **Chemical Kinetics:**
  - Molecularity and order of reaction, integrated rate expression for- second order, pseudo-order reactions, half-life.
  - Brief outlines of experimental methods of studying chemical kinetics; conductometric, potentiometric, optical methods, polarometry and spectrophotometry
- **Theories of chemical kinetics:**
  - Effect of temperature on rate of reaction. Concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects (no derivation).
- **Catalysis:**
  - Catalysis, classification of catalysis, characteristics of catalysed reactions, Buffers - Mechanism of buffer action, Henderson-Hazel equation. Hydrolysis of salts.

Unit 4

Thermodynamics-1 and Thermochemistry

- **Thermodynamics-1**
  - First Law of Thermodynamics: Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law – Joule Thomson coefficient and inversion temperature. Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.
- **Thermochemistry:**
  - Hess's Law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization.

Bond dissociation energy, effect of temperature on enthalpy of reaction, Kirchhoff s equation.

Text Books (Theory Courses):

1. Physical Chemistry, Puri Sharma & Pathania, Vishal Publishing Co
2. Pradeep's Physical Chemistry Vol II, S.C. Khetrapal, Pradeep Publication.
3. Computers and Common Sense, R. Hunt and Shelly, Prentice Hall.

Reference Books:

1. Physical Chemistry. G.M. Barrow. International Student Edition, McGrawHill
2. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
3. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
4. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd, India
5. Basic Programming with Application, V.K. Jain, Tata McGraw Hill, India
6. Textbook of Physical Chemistry, Samuel Glasstone, Ed 2, Macmillian 1942

Chemistry Practical 3 (Major)

Semester III **Paper 6** **Credits 4**

Course Objective

- Identify the thermodynamic systems and processes, understand the basic principles of phase diagram, solutions and colligative properties, and know how to apply them to explain and interpret the observations in other areas of chemistry and related fields. The course gives basic knowledge necessary for the Physical course based on solutions.

Course Outcome

- CO-1. By interpreting the real gases, the student will be able to solve the problems.
- CO-2. Describes the ideal and real gases.
- CO-3. By interpreting some properties of liquids and solids, the student will be able to solve the problems.
- CO-4. Interpreting the phase equilibrium in simple systems, the student will be able to answer the questions.
- CO-5. Adopt distribution law to explain various phases.
- CO-6. By describing the ideal solution, the student will be able to recognize, use and compare the colligative properties.
- CO-7. Explain various reactions based on kinetics.
- CO-8. describe the kinds of solutions.

Physical Chemistry

- **Chemical Kinetics**
  - To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalysed by hydrogen ions at room temperature.
- **Viscosity, Surface Tension**
  - To determine the percentage composition of a given binary mixture (non interacting systems) by viscosity method.
  - To determine the percentage composition of a given binary mixture (non interacting systems) by surface tension method.
- T**hermochemistry**
  - To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process.
  - To determine the enthalpy of neutralisation of a week acid/weak base versus strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.

- To determine the enthalpy of solution of solid $CaCl_2$ and calculate the lattice energy of $CaCl_2$ from its enthalpy data using Born-Haber cycle.

Record and Viva

Books Recommended

- Chemistry Practical by S. Giri, D.N. Bajpai and O.P. Pandey, S. Chand Publication.
- Practical Chemistry Volume 1-3 by Fateh Bahadur, Vishal Publication
- Advanced Physical Chemistry by J.B. Yadav, Goel Publication

Distribution of Maximum Marks:

The maximum marks in the evaluation of the practical exercises, viva-voce and records of their class-work are given below.

Chemistry Practical 3				
Class	Physical Chemistry	Viva	Class Record	Total
B.Sc. Semester III	60 (35 + 25)	30	10	100

Note: For exempted students, marks of class record will be added to the marks of viva-voce for practical examinations since they do not have the class record.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
Four Year Undergraduate Course Structure:
Subject: Chemistry Semester IV NEP (Revised)
For students admitted in session 2023-24 onwards

Semester IV						
Paper	**Paper Title**	**Type**	**Credits**	**Internal Assessment**	**Univ Exam**	**Total Marks**
Paper 7	Inorganic Chemistry 2	Theory (Major/Minor)	4	25	75	100
Paper 8	Chemistry Practical 4	Practical (Major)	4	-	100	100
VC 1	Chemistry Vocational 2 (VC 2)	Introduction of Household Chemicals, Soaps and Detergents	4	25	75	100
P2”	Minor	Minor Theory	4	25	75	100
P3’	Second major subject	Theory	4	25	75	100
P4’	Second major subject	Theory	4	25	75	100
	Total Credits		**24**			**600**

Inorganic Chemistry 2 (Major and Minor)

Semester IV **Paper 7** **Credits 4**

Course outcome

- **CO-1** Chemistry of transition and inner-transition elements. These insights are important as they help in the rational selection of the cations of these elements for tailor-made syntheses of newer complexes
- **CO-2** Concepts of coordination chemistry and their applications
- **CO-3** Importance of different acid-base concepts which forms the basis of rational ligand designing and coordination complex formation for specific bio-inorganic, materials and optoelectronic applications.
- **CO-4** Importance and different chemical aspects of non-aqueous solvents which now-a-days are gaining importance in varied targeted syntheses of drugs and materials for technological applications

Unit 1

- **Chemistry of Elements of First Transition Series:**
  - Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry.
- **Chemistry of Elements of Second and Third Transition series:**
  - General characteristics, comparative treatment of Zr/Hf, Nb/Ta , Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.

Unit – 2

- **Coordination Compounds:**
  - Werner's coordination theory and its experimental verification, Sidgwick's concept of effective atomic number, EAN concept, Polydentate ligands or chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes, Inner and outer orbital complexes, Limitations of VBT.

Unit 3

- **Chemistry of Lanthanide Elements:**
  - Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, ceric ammonium sulphate and its analytical uses.
- **Chemistry of Actinides:**

- Electronic conformation, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.

Unit 4

- **Oxidation and Reduction:**
  - Electrode potential, electrochemical series and its applications. Principles involved in the extraction of the elements.
- **Acids and Bases:**
  - Arrhenius, Bronsted-Lowry, the Lux-Flood, solvent system and Lewis concept of acids and bases.
- **Non-aqueous Solvents:**
  - Physical properties of a solvent, types of solvents and their general characteristics, Reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2.

Text Books (Theory Courses):

1. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
2. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
3. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
4. Chemistry for degree students, R. L. Madan Publication

Reference Books:

1. Inorganic Chemistry, J.E. Huheey, Ellen A. Keiter, Richard, L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
2. Inorganic Chemistry, D.E. Shriver, P W. Atkins and C.H.L. Langford, Oxford.
3. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
4. Concepts of Models of Inorganic Chemistry, B. Douglas, D. Mc Daniel and J Alexander, John Wiley.
5. Inorganic Chemistry, W.W. Porterfield, Addison - Wesley.
6. Inorganic Chemistry, A.G. Sharpe, ELBS
7. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall

Chemistry Practical 4

Semester IV **Paper 8** **Credits 4**

Course Objective:

- After successful completion of the third semester of under-graduation, students coming in this semester for practical's will be provided knowledge about the experiments based on volumetric and gravimetric.

Course Outcomes:

- **CO-1.** achieve knowledge about different types of redox reactions.
- **CO-2.** able to write reactions and structure.
- **CO-5.** acquire the skill to perform the experiment in the real lab once theyunderstand different steps in the procedure.
- **CO-6.** Having expertise in making solutions accurately.
- **CO-7.** To acquired enough knowledge to answer questions based on experiments.

Inorganic Chemistry Quantitative Analysis:

- **Volumetric Analysis**
  - Determination of acetic acid in commercial vinegar using NaOH
  - Estimation of calcium content in chalk as calcium oxalate by permanganometry
  - Estimation of ferrous ions by dichromate method
  - Estimation of copper using iodometric method.
- **Gravimetric Analysis**
  - Ba as $BaSO_4$ in the given solution of $BaCl_2$
  - Analysis of Ni as $Ni(DMG)_2$

Record & Viva

Books Recommended

(a) Chemistry Practical by S. Giri, D.N. Bajpai and O.P. Pandey, S. ChandPublication.
(b) Practical Chemistry Volume 1-3 by Fateh Bahadur, Vishal Publication
(c) Systematic Chemistry Practical, P.C. Kamboj, Vishal Publication

Distribution of Maximum Marks:

The maximum marks in the evaluation of the practical exercises, viva-voce and records of their class-work are given below.

Chemistry Practical 4				
Class	Inorganic Chemistry	Viva	Class Record	Total
B.Sc. Semester IV	60 (35 + 25)	30	10	100

Note: For exempted students, marks of class record will be added to the marks of viva-voce for practical examinations since they do not have the class record.

Introduction of Household Chemicals, Soaps and Detergents

Semester IV **Chemistry Vocational VC 2** **Credits 4**

Course Outcome

- CO 1 To expose the students to various emerging new areas of Chemistry and apprise them with their prevalent in their future studies and their applications in various spheres of chemical sciences.
- CO 2 To enhance student sense of enthusiasm for chemistry and to involve them in an intellectually stimulating experience of learning in a supportive environment.
- CO3 To enhance practical knowledge
- CO4 To motivate self-employment ability
- CO5 To create self-efficiency

Unit 1

- **Household chemicals**:
  - History of household Industry, Basic Theory of Household Chemicals, and Raw material required for household product, Product manufacture in household industry. Role of household product in day-to-day life.

Unit 2

- **Cleaning agents**:
  - Introduction, synthesis and applications of Natural cleaning agents, cleaning action, Floor cleaner, Toilet Cleaner, Bathroom Cleaner, Kitchen Cleaner

Unit 3

- **Technology of Soap**:
  - Chemistry of soap; Raw material for soap industry and their selection; hard fats yielding and oil yielding soaps; Chemical reactions of soaps; Hard and Soft soaps; Plant and process employed in soap manufacture; Liquid hand wash and liquid dish wash.

Unit 4

- **Detergents and surfactants**:
  - Introduction; Different terms used in detergents; Raw materials for detergents; Washing action of detergents; Types of detergents; Introduction of surfactants; Types of surfactants.

Recommended Books:

1. Small scale industries and house hold industries in developing economy by Shetty M.C.
2. Manufacture of perfume cosmetics and detergents by Giri Raj Prasad .
3. Industrial chemistry by B.K. Sharma
4. Flavours & Essential oils, Industries SBP Board
5. Perfumes soaps & cosmetics by Poucher.

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Semester V						
Paper	**Paper Title**	**Type**	**Credits**	**Internal Assessment**	**Univ Exam**	**Total Marks**
Paper 9	Organic Chemistry 2	Theory	4	25	75	100
Paper10	Physical Chemistry 2	Theory	4	25	75	100
Paper 11 x	Analytical Chemistry	Chemistry Elective 1	4	25	75	100
Paper 11 y	Chemical Energetics and Radiochemistry	Chemistry Elective 2				
IS	Chemistry Internship (Chemistry Practical 5)	Practical	4	-	100	100
P9'	Second major subject	Theory	4	25	75	100
P10'	Second major subject	Theory	4	25	75	100
	Total Credits		**24**			600
Choice will be given to students to opt in which major subject they wish to do internship in semester V and minor project in semester VI						

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For students admitted in session 2023-24 onwards

Organic Chemistry 2

Semester V **Paper 9** **Credits 4**

Course outcome

The completion of this course enables the student to understand the subject initially

- CO-1 The preparation and chemical reactions of Alcohols and Epoxides - Alcohols Dihydric alcohols: (Ethylene Glycol)
- CO-2 Understanding the order of reactivity of different carboxylic acid derivatives and the reactivity of different carboxylic acid derivatives.
- CO-3 Able to recognize structures of acid halides, esters, amides, acid anhydrides.
- CO-4 Able to write down structure of phenol and phenoxide ion and chemical reactions of phenols.
- CO-5 Know the mechanism of named reactions of carbonyl compounds and condensation reactions as well as their use in food and pharmaceuticals.

Unit 1

- **Alcohols and Phenols:**
  - Synthesis, physical and chemical properties of monohydric alcohols, dihydric alcohols (Ethylene glycol) and Trihydric alcohols (glycerol).
  - Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Chemical reactions of phenols.

Unit 2

- **Aldehydes and Ketones:**
  - Synthesis, Physical and chemical properties of aldehydes and ketones. Mechanism of nucleophillic addition to carbonyl group, reactions involving α hydrogens, reduction, oxidation, condensation and Wittig reaction.

Unit 3

- **Carboxylic Acids:**
  - Synthesis, physical and chemical properties of carboxylic acids, acidity of carboxylic acids, effects of substituents on acid strength. Carboxylic acid derivatives (acid chlorides, esters, amides and acid anhydrides): Synthesis, physical and chemical properties.
- **Fats, Oils and Detergents:**
  - Introduction rancidity and analysis of fats and oils (saponification value, iodine value, acid value and Reichert Meissel value). Cleansing action of soaps and detergents.

Unit 4

- **Organic Compounds of Nitrogen:**
  - Mechanisms of nucleophilic substitution in Nitroarenes and their reductions in acidic, neutral and alkaline media.
  - Preparation, physical properties and chemical reactions of amines. Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines.
- **Amino Acids, Proteins and Peptides:**
  - Introduction and classification of amino acids. Acid-base behaviour, isoelectric point and electrophoresis, Preparation, physical properties and chemical reaction of α amino acids. Classification of peptides, geometry and Merrifield solid phase peptide synthesis.
  - General characteristics and colour test of proteins, biological function, denaturation/renaturation of proteins.

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Books Suggested (Theory Courses)

1. Organic Chemistry, Morrison and Boyd, Prentice Hall.
2. Organic Chemistry, L.G. Wade Jr. Prentice Hall
3. Fundamentals of Organic Chemistry Solomons, John Wiley.
4. Organic Chemistry, Vol. I, II, III, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
5. Organic Chemistry, F.A. Carey, Tata McGraw-Hill Publishing Company, Insia
6. Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.
7. Organic Chemistry, Vol. I, II, I.L. Finar

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Subject: Chemistry Semester V NEP (Revised)
For students admitted in session 2023-24 onwards

Physical Chemistry 2

Semester V **Paper 10** **Credits 4**

Course outcome

- CO-1- After the completion of the semester, student will acquire knowledge of first law and second law of thermodynamics, thermochemistry, entropy enthalpy etc.
- CO-2- It will also make them familiar with conductance, equivalent conductance, Kohlrausch's law, Ostwald dilution law, Deby-Huckel Onsagar equation, e.m.f. of cell, types of cell, liquid junction potential, pH and pka, Henderson- Hazel equation etc.

Unit 1

- **Thermodynamics - II**
  - Second law of thermodynamics: statements of second law of thermodynamics, Carnot's cycle and its efficiency, Carnot's theorem. Thermodynamic scale of temperature, Le Chatelier's principle, reaction isotherm and reaction isochore, Clapeyron- Clausius equation and its applications
- **Concept of entropy:**
  - Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, criteria of spontaneity and equilibrium change in ideal gases and mixing of gases.
  - Gibbs and Helmholtz free energy functions and their definitions

Unit 2

- **Electrochemistry-1:**
  - Electrical transport - Kohlrausch's law, weak and strong electrolyte, Arrhenius theory of electrolyte dissociation and its limitations.
  - Ostwald's dilution law its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and its determination by Hittorfs method and moving boundary method.
  - Applications of conductivity measurements: Determination of degree of dissociation, determination of Ka of acids, determination of solubility product of a sparingly soluble salt.

Unit 3

- **Electrochemistry - II:**
  - Types of reversible electrodes- Gas-metal ion, metal-ion, metal- insoluble salt-anion and redox electrodes. Electrode reactions, single electrode potential, standard electrode potential. Reference electrode: standard hydrogen electrode and calomel electrode, Nernst equation, derivation of cell E.M.F., electrochemical series and its significance.

- Electrolytic and Galvanic cells- Reversible and irreversible cells, conventional representation of electrochemical cells.
- EMF of a cell and its measurements- Calculation of cell EMF. Calculation of thermodynamic quantities of cell reactions (G, H and K)

Unit 4

- **Concentration Cell**
  - Concentration cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient. Determination of pH using quinhydrone, calomel and glass electrodes by potentiometric method.
- **Surface Chemistry:**
  - Physical and chemical adsorption, Freundlich and Langmuir adsorption isotherm, multilayer adsorption and BET isotherm (no derivation).

Books Suggested (Theory Courses)

1. Physical Chemistry. G.M. Barrow. International Student Edition, McGraw Hill.
2. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
3. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
4. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.
5. Graduate physical Chemistry, Volume I-III By L.R. Sharma and M.S. Pathania
6. Principles of Physical Chemistry by B.R. Puri, L.P Sharma and M.S. Pathania, Vishal publication, Jallandhar.

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Subject: Chemistry Semester V NEP (Revised)
For students admitted in session 2023-24 onwards

Analytical Chemistry (Chemistry Elective 1)

Semester V **Paper 11X** **Credits 4**

Course Outcome:

- CO 1. Understand the basic of this course and think & develop new ideas and concepts in analytical chemistry.
- CO 2. Know about electroanayltical, thermoanalytical, radiochemical, chromatographic and spectral techniques.
- CO 3. To study concepts and theories behind basic methods and techniques used in analytical chemistry. This theory can be used to solve many rigorous problems of universe.
- CO 4. To prepare the students for further research in analytical methods of chemistry.

Unit 1

- **Electroanalytical Techniques:**
  - **Conductometric**: Discussion of the nature of the curves of acid- base (including mixtures of acids), precipitation and complexometric titrations
  - **Potentiometric**: Different types of electrodes, discussion of the nature of the curves for oxidation-reduction and acid-base titrations, comparision with the conductometric method
  - **Voltametry**: Cyclic voltametry
  - **Polarography**: Dropping mercury electrode and its advantages, polarographically active species, concept of residual, diffusion and limiting current of half wave potential, Ilkovic equation and factors affecting diffusion current

Unit 2

- **Thermoanalytical Methods:**
  - Thermogravimetry: Apparatus, factors affecting TG, Interpretation of TG curves of $CaC_2O_4.H_2O$ and $MgC_2O_4.2H_2O$
  - Differential Thermal Analysis and Differential Scanning Calorimetry: Apparatus, factors affecting DTA and DSC curves with special reference to heating rate, particle size and packing, measurement of heat of transition, heat of reaction and heat of dehydration of salts and metal hydrates.

Unit 3

- **Radiochemical Methods**
  - Isotope method
  - Inverse isotopic dilution
  - Neutron activation technique

Unit 4

- **Chromatographic Method:**
  - Gas Chromatography: GLC and GSC
  - HPLC

- **Spectral Methods:**
  - Nephelometry
  - Turbidimetry
  - Flame Photometry

Reference Books:

1. Fundamentals of Analytical Chemistry: D.A. Skoog, D.M. West and F.J. Holler, 1992,
2. Quantitative Inorganic Analysis, A .I.Vogel, Pearson ,
3. Instrumental Methods of Chemical Analysis: B.K. Sharma, 2011
4. Instrumental Methods of Chemical Analysis: H. Kaur, 2016,
5. Analytical Chemistry, Gary D. Christian, 2007,
6. Instrumental Methods of Analysis: H.H. Willard, L.L. Merrit, Jr. J.A. Dean, 1974

Chemical Energetics and Radiochemistry (Chemistry Elective 2)

Semester V **Paper 11Y** **Credits 4**

Course Outcome:

Student will

- CO 1. Understand the introductory quantum mechanics and concept of third law of thermodynamics, distribution law and phase rule. CO 2. Get introduced to the law of photochemistry and photosensitized
- reactions energy transfer processes.
- CO 3. Study about the dilute solutions and colligative properties.
- CO 4. Get familiar with radiopharmaceuticals and radiochemistry.

Unit 1

- **Introductory Quantum Mechanics:**
  - Plank's radiation law, photoelectric effect, optical activity, polarization (Clausius-Mossotti equation), orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment, temperature method and refractivity method, magnetic properties-paramagnetism, diamagnetism, and ferromagnetism.
- **Thermodynamics - III**
  - Nernst heat theorem, statement and concept of residual entropy. Thermodynamic derivation of Nernst distribution law and its application. Phase rule, derivation Gibbs phase rule and its applications.

Unit 2

- **Photochemistry**
  - Interaction of radiation with matter, difference between thermal and photochemical processes.
  - Laws of photochemistry: Grothus-Drapper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions- energy transfer processes (simple examples).

Unit 3

- **Colligative Properties:**
  - Ideal and non-ideal solutions, methods of expressing concentration of solutions, activity and activity coefficient, Relative lowering of vapour pressure, molecular weight determination, Osmosis, theory of osmotic

pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing point and its thermodynamic relation. Experimental methods of determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

Unit 4

- **Radiochemistry**
  - Natural and induced radioactivity; radioactive decay----α-decay, β-decay, γ-decay; neutron emission, positron emission, electron capture; unit of radioactivity (Curie); half-life period; Geiger-Nuttal rule, radioactive displacement law, radioactive series. Measurement of radioactivity: ionization chamber, Geiger counters, scintillation counters. Applications: energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies, nuclear medicine-99mTc radiopharmaceuticals

Reference Books:

1. Physical Chemistry G.M. Barrow. International Student Edition IMC McGraw Hill.
2. Graduate Physical Chemistry, Volume III L.R. Sharma and M.S. Pathania, 2017.
3. Principles of Physical Chemistry, Volume III, B.R. Puri, L.P. Sharma and M.S. Pathania, Vishal Publications, Jalanadhar.
4. Quantum Chemistry by R.K. Prasad, New Age International Pvt. Ltd.
5. Elements of Physical Chemistry, P.W. Atkins, Oxford University Press
6. Physical Chemistry, R.A. Alberty: Wiley Eastern Ltd.
7. Physical Chemistry through Problems, S.K. Dogra and S. Dogra Wiley Eastern Ltd.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
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Subject: Chemistry Semester V NEP (Revised)
For students admitted in session 2023-24 onwards
Chemistry Internship (Chemistry Practical 5)

Semester V **IS** **Credits 4**

Course Objectives

- The objectives of this course are to acquisition of skills in Inorganic, Organic and Physical Chemistry. To develop the ability to correlate the chemical and physical properties of elements. To establish the link between theory and laboratory practice by conducting laboratory experiments. To acquire expertise in chemistry laboratory in handling of reagents and solvents as well as in analytical techniques.

Course Outcome

After completing the course, the student will be able to: -

- **CO-1** Having acquired knowledge to handle instruments and its calibration.
- **CO-2** Explain the structure and bonding in molecules / ions and predict the structure of molecules / ions.
- **CO-3** Explain selected crystal structures, explain and perform calculations of the lattice enthalpy of ionic compounds.
- **CO-4** Having knowledge of Beer Lamberts law
- **CO-5** To separate compounds chromatographically.
- **CO-6** Able to make solutions accurately to perform conductance experiments.
- **CO-7** To understand making circuit connections and taking observations.

Inorganic Chemistry

- **Synthesis and Analysis**
  - Preparation of potassium trioxalatoferrate (III), $K_3[Fe(C_2O_4)_3]$ and determination of its composition by permagnometry.
  - Preparation of $[CoHg(SCN)_4]$ and estimation of its sulphur content by gravimetric analysis.
  - Preparation of triacetylactonatoaluminium(III) $[Al(acac)_3]$.
  - Preparation of tetraamminecopper(II) sulphate, $[Cu(NH_3)_4]SO_4$
  - Preparation of cis-and trans-dioxalatodiaquachromate(III) ion.
- **Colorimetry**
  - To verify Beer-Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of the given solution.
  - Determination of Fe^{3+} content by thiocyanate method.

Organic Chemistry

- **Mixture Analysis**
  - Organic mixture separation and identification (two components)

Physical Chemistry

- **Electrochemistry**
  - To determine the strength of the given acid conductometrically using standard alkali solution.
  - To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.
  - To determine the ionization constant of a weak acid conductometrically.
- **Molecular Weight Determination**
  - Determination of molecular weight of a non-volatile solute by Rast method/Beckmann freezing point method.
  - Determination of the apparent molecular weight of non-volatile solute at different concentration and determine Van't Hoff factor by ebullioscopy.
- **Colorimetry/Spectrophotometer**
  - Determination pKa values of indicators
  - Determination of Chemical oxygen demand (COD)
  - Determination of Biological oxygen demand (BOD)

- **Record & Viva**

Books Recommended

1. Chemistry Practical by S. Giri, D.N. Bajpai and O.P. Pandey, S. ChandPublication.
2. Practical Chemistry Volume 1-3 by Fateh Bahadur, Vishal Publication
3. Advanced Physical Chemistry by J.B. Yadav, Goel Publication
4. Systematic Chemistry Practical, P.C. Kamboj, Vishal Publication

Distribution of Maximum Marks:

The maximum marks in the evaluation of the practical exercises, viva-voce and records of their class-work are given below.

Internship (Chemistry Practical 5)				
Class	Inorganic/Organic/Physical	Viva	Class Record	Total
B.Sc. Semester V	60	30	10	100

Note:

- ***Experiments from all three branches have to be done in class. In practical examination one experiment has to be allotted to the student through a lottery system.***
- ***For exempted students, marks of class record will be added to the marks of viva-voce for practical examinations since they do not have the class record.***

लखनऊ विश्वविद्यालय
University of Lucknow
(Accredited A++ by NAAC)

Internship Report

On

NAME OF THE TOPIC

NAME OF THE STUDENT

Roll No:

B.Sc. Chemistry Semester-V

Submitted to

NAME OF THE FACULTY MEMBER

Department of Chemistry

NAME OF THE COLLEGE

ADDRESS OF THE COLLEGE

ACKNOWLEDGEMENTS

Font: Arial Font Size: 12 Normal

Name of the Candidate

Contents to be covered

1. **Introduction: 5-10 Pages**

   Title: Font: Arial; Font Size: 13; Bold

   Subtitle: Font: Arial; Font Size: 12; *Italics*

   Content: Font: Arial; Font Size: 12; Normal
2. **Discussion: 5-10 Pages**

   Title: Font: Arial; Font Size: 13; Bold

   Subtitle: Font: Arial; Font Size: 12; *Italics*

   Content: Font: Arial; Font Size: 12; Normal
3. **References**

   Font: Arial; Font size: 11

Reference Style

Reference to a journal publication:

[1] J. van der Geer, J.A.J. Hanraads, R.A. Lupton, The art of writing a scientific article, J. Sci. Commun. 163 (2010) 51–59.

Reference to a journal publication with an article number:

[2] J. van der Geer, J.A.J. Hanraads, R.A. Lupton, 2018. The art of writing a scientific article. Heliyon. 19, e00205.

Reference to a book:

[3] W. Strunk Jr., E.B. White, The Elements of Style, fourth ed., Longman, New York, 2000.

Reference to a chapter in an edited book:

[4] G.R. Mettam, L.B. Adams, How to prepare an electronic version of your article, in: B.S. Jones, R.Z. Smith (Eds.), Introduction to the Electronic Age, E-Publishing Inc., New York, 2009, pp. 281–304.

Reference to a website:

[5] Cancer Research UK, Cancer statistics reports for the UK.

http://www.cancerresearchuk.org/ aboutcancer/statistics/cancerstatsreport/, 2003

(accessed 13 March 2003).

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UNIVERSITY OF LUCKNOW
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Subject: Chemistry Semester VI NEP (Revised)
For Students admitted in 2024-25 onwards

Semester VI

Paper	Paper Title	Type	Credits	Internal Ass. mark	Univ Exam	Total Marks
Paper 11	Inorganic Chemistry	Theory	4	25	75	100
Paper 12	Quantum Mechanics and Spectroscopy (Physico Organic)	Theory	4	25	75	100
Paper 13A	Polymer Chemistry	Chemistry Elective 3	4	25	75	100
Paper 13B	Chemistry of Natural Products	Chemistry Elective 4				
P11'	Second major subject	Theory	4	25	75	100
P12'	Second major subject	Theory	4	25	75	100
	Total Credits		**20**			

Choice will be given to students to opt in which major subject they wish to do internship in semester V and minor project in semester VI

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UNIVERSITY OF LUCKNOW
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Subject: Chemistry Semester VI NEP (Revised)
For Students admitted in 2024-25 onwards
Inorganic Chemistry

Semester VI **Paper 11** **Credits 4**

MM 100 (75 + 25)

Course outcome

After the completion of the semester student will acquire knowledge

- **CO-1** Semi-modern concepts of metal ligand bonding in coordination complexes
- **CO-2** Inorganic polymers viz. silicones which find applications in materials pharmaceutical industries and surgery too. Phosphazenes which in last couple of years had witnessed significant development as emerging smart materials.
- **CO-3** Class-a and class-b donor-acceptors, symbiotic relationship

Unit 1

- **Metal-ligand bonding in Transition Metal Complexes:**
  - Limitation of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors effecting the crystal field parameters. Effect of CFSE on lattice energy, Ionic radii.

Unit 2

- **Magnetic Properties of Transition Metal Complexes:**
  - Types of magnetic behaviour, methods of determining magnetic susceptibility, spin only formula, L-S coupling, spectroscopic ground state. Correlation of μ_S and μ_{eff}values. Orbital contribution to magnetic moments. Application of magnetic moment data for 3d metal complexes.

Unit 3

- **Inorganic Polymers**
  - Silicones and phosphazenes as examples of inorganic polymers. Nature of bonding in triphosphazenes. Pseudohalogens and pseudohalides: Preparation, properties and reactions. Structure and bonding of NO, ligand behaviour of NO. Preparation of nitrosyl complexes, effective atomic number (EAN) as applied to nitrosyls.

Unit 4

- **Hard and Soft Acids and bases (HSAB):**
  - Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid base strength and hardness and softness. Symbiosis,

theoretical basis of hardness and softness. Applications of HSAB principle, limitations of HSAB principle.

Text Books (Theory Courses):

1. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
2. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
3. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
4. Chemistry for degree students, R. L. Madan

Reference Books:

1. Inorganic Chemistry, J.E. Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
2. Inorganic Chemistry, D.E. Shriver, P W. Atkins and C.H.L. Langford, Oxford.
3. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
4. Concepts of Models of Inorganic Chemistry, B. Douglas, D. McDaniel and J Alexander, John Wiley.
5. Inorganic Chemistry, WW. Porterfield, Addison - Wesley.
6. Inorganic Chemistry, A.G. Sharpe, ELBS
7. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
Four Year Undergraduate Course Structure:
Subject: Chemistry Semester VI NEP (Revised)
For Students admitted in 2024-25 onwards
Quantum Mechanics and Spectroscopy (Physico Organic)

Semester VI **Paper 12** **Credits 4**

MM 100 (75 + 25)

Course outcome

This course provides students with a detailed knowledge of the fundamental aspects of the subject spectroscopy such as

- CO-1 Infrared spectroscopy in which characteristic absorptions of various functional groups.
- CO-2 Ultraviolet absorption spectroscopy, Beer Lambert Law, types of electronic transitions and the effect of conjugation and concept of chromophore and auxochrome.
- CO-3 Nuclear magnetic resonance, interpretation of NMR spectra of simple organic molecule.
- CO-4 Quantum mechanics as well as of spectroscopy. They will have comprehensive understanding of valence bond model and molecular orbital model.

Unit 1

- **Spectroscopy:**
  - Rotational Spectroscopy of Diatomic Molecules: Energy level of a rigid rotor (semi classical principles) selection rules, spectral intensity, distribution using population distribution (Maxwell – Boltzman distribution) determination of bond length, isotope effect.
  - Vibrational Spectrum-Infrared Spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of an harmonic motion and isotope on the spectrum.
  - Raman Spectrum: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

Unit 2

- **Elementary Quantum Mechanics:**
  - de Broglie's hypothesis, the Heisenberg's uncertainty principle, Hamiltonian operator. Statement of Born-oppenheimer approximation. Schrodinger wave equation and its importance. Physical interpretation of wave function, postulates of quantum mechanics, particle in one dimensional box. Schrodinger wave equation for H –atom and its separations into three equations (without derivation), quantum numbers, wave function, angular wave functions.

- **Basic idea of molecular orbital theory,**
    - Criteria for forming M.O's from A.O's, construction of M.O's by LCAO-H_2^+ ion, calculation of energy levels from wave functions, physical picture of bonding and antiboding wave functions, Hybrid Orbitals-sp, sp^2, sp^3, calculation of coefficients of A.O's used in sp and sp^2 hybrid orbital only. Introduction to valence bond model of H_2, comparison of M.O. and V.B. models.

Unit 3

- **Electronic Absorption and Vibrational Spectroscopy:**
    - Ultraviolet (UV) absorption spectroscopy -absorption laws (Beer- Lambert law); molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and Auxochrome, Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. U.V.spectra of conjugated enes and enones, woodward fieser rule
    - Infrared (I.R.) absorption spectroscopy- Molecular vibrations, Hook's law, Selection rules, intensity and position of I.R. bands, fingerprint region, characteristic absorptions of various functional groups and interpretation of I.R. spectra of simple organic compounds-hydrocarbons, aldehydes & ketones in IR spectrum (positions only)

Unit 4

- **Nuclear magnetic resonance (NMR):**
    - Spectroscopy, proton magnetic resonance (1H NMR) spectroscopy, nuclear shielding and deshielding. Chemical shifts and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of 'H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1, 1, 2 tribromoethane, ethyl acetate, toluene and acetophenones. Problems pertaining to the structure elucidation of simple organic compounds using 1H NMR spectroscopy techniques.
- **Introduction to Mass Spectrometry:**
    - Principle of mass spectrometry, the mass spectrum, mass spectrometry diagram, molecular ion, metastable ion, Nitrogen Rule, fragmentation process, McLafferty rearrangement.

Book Suggested

1. Physical Chemistry G.M. Barrow. International Student Edition IMC Graw Hill.
2. Principles of Physical Chemistry Volume III, B.R. Puri, L.P. Sharma, and M.S. Pathania, Vishal Publication, Jallandhar
3. Graduate Physical Chemistry, Volume III, L.R. Sharma and M.S. Pathania,2017
4. Fundamentals of Molecular spectroscopy, C.N. Banwell IV edition, Mc Graw hill education
5. Quantum Chemistry by R.K. Prasad, New Age International Pvt. Ltd
6. Fundamental Principles of Spectroscopy, B.K. Sharma, Krishna Publication.
7. Elementary Organic Spectroscopy, Principles and Chemical Application, Y, R. Sharma, S Chand
8. Spectroscopic Identification of Organic Compounds, Silverstein, Wiley
9. Spectroscopy of Organic Compounds, P.S. Kalsi, New Age International.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
Four Year Undergraduate Course Structure:
Subject: Chemistry Semester VI NEP (Revised)
For Students admitted in 2024-25 onwards
Polymer Chemistry (Chemistry Elective 3)

Semester VI **Paper 13A** **Credits 4**

MM 100 (75 + 25)

Course outcome:

Students will learn to:

- CO-1. define related concepts of polymers.
- CO-2. summarize historical evolution of the polymers.
- CO-3. recognize monomers and polymers.
- CO-4. evaluate the structure of polymers.
- CO-5. recognize bonds between polymer chains.
- CO-6. debate thermal character and affecting factors of thermal behaviours.
- CO-7. use determining method of molecular weights.
- CO-8. categorize polymers.
- CO-9. explain polymers production processes.

Unit 1

- **Introduction and Characterization of Polymer:**
  - Theory of reactivity of large monomeric molecules, ring formation vs. chain formation. Chain Reaction, Free radical, Cationic, Anionic and living polymers. Polymerization conditions and reactions, Coordination and co-polymerization, 3D network. IR, NMR of polymers and X-ray diffraction study. Microscopy, Thermal and chemical analysis, Physical testing hardness, tensile strength. Fatigue, Impact, Tear and abrasion resistance.

Unit 2

- **Structure and Properties**
  - Configuration of polymer chains, crystal structures of polymers. Morphology of crystalline polymers, strain-induced morphology, Melting point (Tm), effect of chain flexibility and other steric factors. Entropy and heat of fusion. The glass transition temperature (Tg), Relationship between Tm and Tg. Polymer structure and property relationship.

Unit 3

- **Polymer processing**
  - General idea about elastomers, plastics and fibers. Compounding and vulcanization of elastomers. Processing techniques: Calendaring, die casting, rotational casting, film casting, injection molding, blow molding, extrusion molding, thermoforming, foaming and reinforcing and fiber spinning.

- **Commercial and Specialty Polymers**
    - Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins silicone and PTFE polymers. Specialty polymers: Fire retarding polymers and electrically conducting polymers, liquid crystal polymer. Biomedical polymers – contact lens, dental, artificial heart, kidney, skin and blood cells – polymers.

Recommended Books:

1. Textbooks of Polymerscience, F.W. Billmeyer, Jr.Wiley.
2. Polymer Science, V.R. Gowariker, N.V. Vishwanathan and J. Sreedhar, Wiley-Estern.
3. Functional Monomers and Polymers, K. Takemoto, Y.Inaki and R.M. Ottanbrite.
4. Contemporary Polymer Chemistry, H. R. Alcock and F.W. Lambe, Prentice hall.
5. Physics and Chemistry of Polymers, J.M.G. Cowie, Blackie Academic and Professional.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
Four Year Undergraduate Course Structure:
Subject: Chemistry Semester VI NEP (Revised)
For Students admitted in 2024-25 onwards
Chemistry of Natural Products (Chemistry Elective 4)

Semester VI **Paper 13B** **Credits 4**

MM 100 (75 + 25)

Course Outcome

At the end of the course students will be able to...

- CO1 Learn the different types of alkaloids, steroids, vitamins & terpenes etc and their chemistry and medicinal importance.
- CO2 Explain the importance of natural compounds as lead molecules for new drug discovery.
- CO3 Explain vitamins Chemistry and Physiological significance of Vitamin CO4 Elaborate general methods of structural elucidation of compounds of
- natural origin.
- CO5 Learn advanced methods of structural elucidation of compounds of natural origin.

Unit 1

- **Alkaloids**
  - Introduction, Occurrence, medicinal importance and general methods of structure elucidation of alkaloids. Structure elucidation of papaverine and quinine.

Unit 2

- **Terpenoids**
  - Introduction, occurrence and classification of terpenoids and structure determination of menthol and zingiberene
- **Vitamins**
  - Classification, sources, biological importance of vitamins and structure determination of vitamin A, B1, B2.

Unit 3

- **Steroids**
  - Introduction, occurrence, importance of steroids, physiological action, stereochemistry and structure determination of cholesterol. Structure and semi synthesis of estrogen, testosterone and progesterone

Unit 4

- **Carbohydrates:**
  - Classification and nomenclature, configuration and conformation of monosaccharides, Erythro and threodiastereomers, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and

chain shortening of aldoses. Formation of glycoside, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+) glucose. Mechanism of mutarotation, structure of ribose and deoxyribose. An introduction to disaccharides (maltose, sucrose, lactose) and polysaccharide/starch and cellulose) without involving structure determination.

Suggested Books

1. Organic Chemistry By I.L. Finarv Volume 1 and 2
2. Phytochemical Methods, 2nd Edition, J. B. Harborne, 1984, Springer, Dordrecht
3. Classical Methods in Structure Elucidation of Natural Products, R. W. Hoffmann, 2018, Hoffmann, Wiley