DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry

	Framework	Credits
	Number of Semesters	8
	Number of credits per semester	24
	Credit Breakup	
Year 1	**Semester I**	
	Major Subject 1 (Chemistry) P1, P2	8
	Major Subject 2	8
	Minor Subject	4
	Co-curriculum CC1	4
	Semester II	
	Major Subject 1 (Chemistry) P3, P4	8
	Major Subject 2	8
	Minor Subject	4
	Vocational VC1(Chemistry)	4
Year 2	**Semester III**	
	Major Subject 1 (Chemistry) P5, P6	8
	Major Subject 2	8
	Minor Subject	4
	Co-curriculum CC2(Chemistry)	4
	Semester IV	
	Major Subject 1 (Chemistry) P7, P8	8
	Major Subject 2	8
	Minor Subject (inter/intra)	4
	Vocational VC2(Chemistry)	4
Choice will be given to student to opt in which major subject he wishes to do internship and minor project		
Year 3	**Semester V**	
	Major Subject 1 (Chemistry) P9, P10	8
	Major Subject 2	8
	Major Subject Elective (chemistry)P11X or P11Y	4
	Major Subject Internship for three to four weeks	4
	Semester VI	
	Major Subject 1(Chemistry) P12, P13	8
	Major Subject 2	8
	Major Subject Elective (Chemistry) P14X or P14Y	4
	Major Subject Minor Project (assignment)	4
Year 4	**Semester VII**	
	Major Subject 1(Chemistry) P15, P16, P17	12
	Major Subject Elective 1(chemistry) P18X or P18Y	4
	Major Subject Elective 2 (chemistry) P19X or P19Y	4
	Major Subject 1 Research Methodology	4
	Semester VIII	
	Major Subject 1 Dissertation	24

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry

PAPERS BEING OFFERED BY THE CHEMISTRY DEPARTMENT

Semester I				
Paper	**Major Branch**	**Type**	**Credits**	**Total Credits**
Paper 1 (P1)	Inorganic Chemistry 1	Theory	4	4
Paper 2 (P2)	Organic Chemistry 1	Theory	4	4
CC 1	Co-Curriculum	Language	4	4
Paper 2 (P1")	Organic Chemistry 1	Minor Theory	4	4
P1'	Second major subject	Theory	4	4
P2'	second major subject	Theory	4	4
	Total Credits			**24**
Semester II				
Paper	**Major Branch**	**Type**	**Credits**	**Total Credits**
Paper 3 (P3)	Physical Chemistry 1	Theory	4	4
Paper 4 (P4)	Chemistry Practical 1	Practical	4	4
VC 1	Chemistry Vocational 1	Food Chemistry	4	4
Paper 3 (P2")	Physical Chemistry 1	Minor Theory	4	4
P3'	Second major subject	Theory	4	4
P4'	second major subject	Theory	4	4
	Total Credits			**24**
Semester III				
Paper	**Major Branch**	**Type**	**Credits**	**Total Credits**
Paper 5 (P5)	Physical Chemistry 2	Theory	4	4
Paper 6 (P6)	Chemistry Practical 2	Practical	4	4
CC 2	Co-Curriculum	NCC/NSS/Soft skill Development	4	4
Paper 5 (P3")	Physical Chemistry 2	Minor Theory	4	4
P5'	Second major subject	Theory	4	4
P6'	second major subject	Theory	4	4
	Total Credits			**24**

DEPARTMENT OF CHEMISTRY
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Four Year Undergraduate Course Structure
Subject: Chemistry

Semester IV				
Paper	**Major Branch**	**Type**	**Credits**	**Total Credits**
Paper 7 (P7)	Inorganic Chemistry 2	Theory	4	4
Paper 8 (P8)	Organic Chemistry 2	Theory	4	4
VC 2	Chemistry Vocational 2	Introduction of Household Chemicals, Soaps and Detergents	4	4
Paper 7 (P4")	Inorganic Chemistry 2	Minor Theory	4	4
P7'	Second major subject	Theory	4	4
P8'	second major subject	Theory	4	4
	Total Credits			**24**
Choice will be given to student to opt in which major subject he wishes to do internship and minor project				
Semester V				
Paper	**Major Branch**	**Type**	**Credits**	**Total Credits**
Paper 9	Organic Chemistry 3	Theory	4	4
Paper 10	Chemistry Practical 3	Practical	4	4
Paper 11 x	Analytical Chemistry	Chemistry Elective 1	4	4
Paper 11 y	Chemical Energetics and Radiochemistry	Chemistry Elective 2		
IS	Chemistry Internship	Theory/Practical	4	4
P9'	Second major subject	Theory	4	4
P10'	second major subject	Theory	4	4
	Total Credits			**24**
Semester VI				
Paper	**Major Branch**	**Type**	**Credits**	**Total Credits**
Paper 12	Inorganic Chemistry 3	Theory	4	4
Paper 13	Quantum Mechanics and Spectroscopy	Theory	4	4
Paper 14 x	Polymer Chemistry	Chemistry Elective 3	4	4
Paper 14 y	Chemistry of natural products	Chemistry Elective 4		
MP	Chemistry Minor Project	Theory/Practical	4	4

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Subject: Chemistry

P11'	Second major subject	Theory	4	4
P12'	second major subject	Theory	4	4
	Total Credits			**24**
Semester VII				
Paper	**Major Branch**	**Type**	**Credits**	**Total Credits**
Paper 15	Inorganic/Organic/Physical Chemistry	Theory	4	4
Paper 16	Bioinorganic, Bioorganic and Biophysical Chemistry	Theory	4	4
Paper 17	Chemistry Practical 4	Practical	4	4
Paper 18 x	Supramolecular Chemistry	Chemistry Elective 5	4	4
Paper 18 y	Chemistry of Analgesics and Antipyretics	Chemistry Elective 6		
Paper 19 x	Science and Technology of Cosmetics	Chemistry Elective 7	4	4
Paper 19 y	Electrochemistry	Chemistry Elective 8		
RM	Research Methodology	Theory/Practical	4	4
Semester VIII				
Paper	**Major Branch**	**Type**	**Credits**	**Total Credits**
Project	Major Project-Dissertation	Theory/Practical	24	24

DEPARTMENT OF CHEMISTRY
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Four Year Undergraduate Course Structure
Subject: Chemistry Semester I

Paper	Major Branch	Type	Credits	Total Credits
Paper 1 (P1)	Inorganic Chemistry 1	Theory	4	4
Paper 2 (P2)	Organic Chemistry 1	Theory	4	4
CC 1	Co-Curriculum	Language	4	4
Paper 2 (P1")	Organic Chemistry 1	Minor Theory	4	4
P1'	Second major subject	Theory	4	4
P2'	second major subject	Theory	4	4
	Total Credits			**24**

DEPARTMENT OF CHEMISTRY
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Four Year Undergraduate Course Structure
Subject: Chemistry Semester I

Inorganic Chemistry 1

Semester I **Paper – 1 (P1)** **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 I

I. 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.

II. Periodic Properties and Classification based upon electronic configuration: Diagonal relationship, inert pair effect, atomic and ionic radii, van der waal radii, ionization energy,

III. Electron affinity and electronegativity: definition, method of determination, trends in periodic table and applications in predicting and explaining chemical behaviour.

Unit II

IV. Chemical Bonding

(a) 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 homonuclearand 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 electro
negativity difference.

(b) Weak interactions: hydrogen bonding, van der Waals forces.

Unit III

V. 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.

VI. 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.

VII. 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 IV

VIII. 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):

(a) Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
(b) Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
(c) Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
(d) Chemistry for degree students, R. L. Madan

Reference Books:

(a) Inorganic Chemistry, J.E.Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
(b) Inorganic Chemistry, D.E.Shriver, P W. Atkins and C.H.L. Langford, Oxford.
(c) Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
(d) Concepts of Models of Inorganic Chemistry, B.Douglas, D.McDaniel and J Alexander, John Wiley.
(e) Inorganic Chemistry, W.W. Porterfield, Addison - Wesley.
(f) Inorganic Chemistry, A.G. Sharpe, ELBS
(g) Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester I
Organic Chemistry 1 (Major P2 and Minor P1")

Semester I **Paper – 2** **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 preprations, reactivity & stereochemistry of SN1 &SN2 reactions of Halogen compounds.

Unit I

I. Structure and bonding: bond lengths, bond angles, bond energy, localised and delocalized π bonds, resonance, inductive and field effects, steric effect, tautomerism, inclusion compounds, clathrates, charge transfer complexes, van der Waals interaction, hyperconjugation, aromaticity.

II. Mechanism of Organic Reactions: Curved arrow notation, drawing electron movements with arrows, half headed and double-headed arrows, Reactive intermediates-generation, structure, stability and reactions of carbocation, carbanion, free radicals and carbenes, Arynes, Nitrenes.

III. Types of organic reactions-addition, elimination, substitution, rearrangement, condensation, methods of determination of reaction mechanism (product analysis, intermediates, isotopic effects, kinetic and stereochemical studies). Energy considerations.

Unit II

IV. 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 erythro diastereomers, 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 – III

V. Alkanes And Cycloalkanes: Methods of formation with special reference to Wurtz, Kolbe, Corey-House reactions and decarboxylation. Physical properties and chemical reactions. Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity.

Cycloalkanes: Nomenclature, methods of preparation. 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.

VI. Alkenes, Cycloalkenes, Dienes: methods of formation. Mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides. Regio-selectivity in alcohol-dehydration. Saytzeff's rule, Hofmann elimination. Physical properties and relative stabilities of alkenes. Chemical reactions of alkenes- Mechanisms involved in hydrogenation, electrophilic and free-radical additions. Markownikoff’s rule. Hydroboration-oxidation, oxymercuration-reduction, epoxidation, ozonolysis, hydrations, hydroxylation and oxidation with $KMnO_4$, polymerization of alkenes. Substitutions at allylic and vinylic positions of alkenes.

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.

VII. Alkynes: Structure and bonding in alkynes. Methods of formation, chemical reactions and acidity of alkynes. Mechanism of electrophilic and mucleophilic addition reactions, hydroboration-oxidation, reductions and oxidation reactions.

Unit IV

VIII. Arenes and Aromaticity: Nomenclature of benzene derivatives. Structure of benzene: molecular formula and Kekule structure. Stability and carbon carbon bond length of benzene, resonance structure, MO picture.

IX. Aromatic electrophilic substitution- general pattern of the mechanism, Arrhenium ion intermediate. Mechanism of nitration, halogenation, sulfonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activation and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction.

X. Alkyl and Aryl Halides: Methods of formation, chemical reactions. Mechanism of nucleophilic substitution reactions of alkyl halides, SN2 and SN1 reactions with energy profile diagrams, Aryl halides - Methods of

formation, nuclear and side chain reactions. Mechanisms of nucleophilic aromatic substitutions.

Text Books (Theory Courses):

(a) Organic Chemistry, Vol. I, I.L. Finar, Pearson Education.
(b) Organic Chemistry, M.K. Jain, Shoban Lal& Co.
(c) Pradeep's Organic Chemistry, S.N. Dhawan, Pradeep Publication.

Reference Books:

(a) Organic Chemistry, Morrison and Boyd, Prentice Hall.
(b) Organic Chemistry, L.G. Wade Jr. Prentice Hall.
(c) Fundamentals of Organic Chemistry Solomons, John Wiley.
(d) Organic Chemistry, Vol. I, II, III S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International)
(e) Organic Chemistry, F.A. Carey, McGraw-Hill Inc.
(f) Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester II

Paper	Major Branch	Type	Credits	Total Credits
Paper 3 (P3)	Physical Chemistry 1	Theory	4	4
Paper 4 (P4)	Chemistry Practical 1	Practical	4	4
VC 1	Chemistry Vocational 1	Food Chemistry	4	4
Paper 3 (P2")	Physical Chemistry 1	Minor Theory	4	4
P3'	Second major subject	Theory	4	4
P4'	second major subject	Theory	4	4
	Total Credits			**24**

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester II

Physical Chemistry 1 (Major P3 and Minor P2")

Semester II **Paper 3** **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 I

I. Mathematical Concepts: Logarithmic relations, curves scratching, equation of straight line and slopes, tracing of curves, differentiation of simple functions like x, ex, xn, sinx, logx; maxima and minima, partial differentiation. Integration of some useful/relevant functions; Permutations and Combinations. Factorials, Probability.

II. Computers: General introduction to computers, different components of a computer. Hardware and Software, input-output devices, binary numbers and its arithmetic; introduction to computer languages, Programming and operating systems.

Unit II

III. Gaseous State: Deviation of gases from ideal behaviour, van der Waals equation of State.

IV. 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.

V. Molecular Velocities: Qualitative discussion of the Maxwell's distribution of molecular velocities, collision numbers, mean free path and collision diameter. Liquification of gases (based on Joule Thomson effect).

VI. Liquid State: A qualitative description of intermolecular forces, structure of liquids,structural differences between solids, liquids and gases.

VII. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic, smectic and cholestric liquid crystals. Thermography and seven segment cell.

Unit III

VIII. Solid State: Definition of unit cell and space lattice.

IX. Laws of crystallography:

a. Law of constancy of interfacial angles

b. Law of rationality of indices

c. Symmetry elements in crystals and law of symmetry.

X. 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

XI. Colloidal State: Solids in liquids (sols): properties- Kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulz law, gold number.

XII. Liquids in liquids (emulsions): types of emulsions, preparation. Emulsifier.

XIII. Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids.

Unit IV

XIV. Chemical Kinetics:

a. Molecularity and order of reaction, concentration dependence of rates, integrated rate expression for- zero order, first order, second order, pseudo order reactions, half-life.

b. Determination of the order of reaction: Differential method, method of integration, half-life method and isolation method.

c. Brief outlines of experimental methods of studying chemical kinetics: conductometric, potentiometric, optical methods, polarimetry and spectrophotometery.

d. Theories of chemical kinetics: Arrhenius theory of reaction rate, effect of temperature on rate of reaction, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis).Thermodynamics aspect of transition state theory.

XV. Catalysis: Catalysis, classification of catalysis, characteristics of catalysed reactions,

Text Books (Theory Courses):

a. Physical Chemistry, Puri Sharma & Pathania.
b. Pradeep Physical Chemistry, Khetrapal, Pradeep Publication.
c. Computers and Common Sense, R. Hunt and Shelly, Prentice Hall.

Reference Books:

a. Physical Chemistry. G.M. Barrow. International Student Edition, McGrawHill
b. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
c. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
d. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.
e. Basic Programming with Application, V.K. Jain, Tata McGraw Hill.
f. Physical Chemistry, Glasstone

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester II
Chemistry Practical 1

Semester II **Paper 4 (P4)** **Credits 4**

Course Objective:

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

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

I. Qualitative Analyses:

a. 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.

II. Quantitative Analysis:

a. *Volumetric Analysis*

i. Determination of acetic acid in commercial vinegar using NaOH

ii. Determination of alkali content - antacid tablet using HCl.

iii. Estimation of calcium content in chalk as calcium oxalate by permanganometry

iv. Estimation of hardness of water by EDTA

v. Estimation of ferrous ions by dichromate method

vi. Estimation of copper using thiosulphate.

b. *Gravimetric Analysis*

i. Ba as $BaSO_4$ in the given solution of $BaCl_2$

ii. Analysis of Cu as CuSCN

iii. Analysis of Ni as $Ni(DMG)_2$

Record & Viva

Books Recommended

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

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester II
Food Chemistry

Semester II **Chemistry Vocational 1 (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 I

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 II

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

Unit III

Lipids: Refining of crude oils, hydrogenation. Vegetables and animal fats, butter, oleo oil and their use in cooking, frying and shortening. Flavor changes in fats and oils. Lipid oxidation, factors affecting lipid oxidation, autooxidation, biological significance of auto-oxidized lipids.

Unit IV

Enzymes: Enzyme activity in different food systems, food enzyme technology, immobilization of enzymes, removal of toxicants through enzymes, flavor production by enzymes. Additives, Emulsifiers, Antioxidants & their role in product preparation.

Vitamins: Role of vitamins in food industry, effect of various processing treatments.

References Books

a) Principles of Food Chemistry by John deMan, Springer.

b) Food chemistry by H.K Chopra P.S Panesar, Alpha Science International Ltd.

c) Food chemistry by Owen R. Fennema, CRC Publications.

d) Food Chemistry by Lillian Hoagland Meyer, Reinhoad Publishing Corporation.

e) Food theory and application second edition by Jane Bower, Pearson

f) Spices and Seasonings: A Food Technology Handbook, by Donna R. Tainter, Antony T.Grenis, Wiley

g) Handbook of Herbs and Spices: Volume 3 edited by K.V. Peter Woodhead Publishing

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester III

Paper	Major Branch	Type	Credits	Total Credits
Paper 5 (P5)	Physical Chemistry 2	Theory	4	4
Paper 6 (P6)	Chemistry Practical 2	Practical	4	4
CC 2	Co-Curriculum	NCC/NSS/Soft skill Development	4	4
Paper 5 (P3")	Physical Chemistry 2	Minor Theory	4	4
P5'	Second major subject	Theory	4	4
P6'	second major subject	Theory	4	4
	Total Credits			**24**

DEPARTMENT OF CHEMISTRY
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Four Year Undergraduate Course Structure
Subject: Chemistry Semester III

Physical Chemistry 2 (Major P5 and Minor P3")

Semester III **Paper 5** **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 I

I. Thermodynamics-1

a. Definition of thermodynamic terms: System, surroundings etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work.

b. First Law of Thermodynamics: Statement, definition of internal energy and enthalpy. 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.

II. Thermochemistry: Standard state, standard enthalpy of formation - 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.

Unit II

III. Thermodynamics - II

a. 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

b. 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.

IV. Gibbs and Helmholtz free energy functions and their definitions

Unit III

V. Electrochemistry -1:

a. Electrical transport - Conduction in metals and in electrolyte solutions, specific conductance, equivalent conductance, experimental determination of equivalent conductance and specific conductance, variation of equivalent and specific conductance with dilution. 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.

VI. Applications of conductivity measurements: Determination of degree of dissociation, determination of Ka of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

Unit IV

VII. Electrochemistry - II:

a. 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.

b. Electrolytic and Galvanic cells- Reversible and irreversible cells, conventional representation of electrochemical cells.

c. EMF of a cell and its measurements- Calculation of cell EMF. Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K)

d. Concentration cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titrations.

VIII. Definition of pH and pKa, determination of pH using quinhydrone and glass electrodes by potentiometric methods. Buffers - Mechanism of buffer action, Henderson-Hazel equation. Hydrolysis of salts.

Books Suggested (Theory Courses)

a. Physical Chemistry. G.M. Barrow. International Student Edition, McGraw Hill.

b. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.

c. The Elements of Physical Chemistry, P.W. Atkins, Oxford.

d. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.

e. Graduate physical Chemistry, Volume I-III By L.R. Sharma and M.S. Pathania

f. Principles of Physical Chemistry by B.R. Puri, L.P Sharma and M.S. Pathania, Vishal publication, Jallandhar.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester III
Chemistry Practical 2

Semester III **Paper 6 (P6)** **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

1. Chemical Kinetics
    a. To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
2. Distribution Law
    a. To study the distribution of iodine between water and CCl4.
3. Colloids
    a. To prepare arsenious sulphide sol and compare the precipitating power of mono-, bi- and trivalent anions.
4. Viscosity, Surface Tension
    a. To determine the percentage composition of a given binary mixture (non interacting systems) by viscosity method.
    b. To determine the percentage composition of a given binary mixture (non interacting systems) by surface tension method (acetone & ethyl methyl ketone).
5. Phase Equilibrium

a. To construct the phase diagram of two component (e.g. diphenylamine benzophenone) system by cooling curve method.

6. Thermochemistry

   a. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process.

   b. 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.

Organic Chemistry

a. Sublimation

b. Crystallization

c. Identification of organic compounds with derivatives (solid compounds of all functional groups and liquid compounds.

Record and Viva

Books Recommended

a) Chemistry Practical by S. Giri, D.N. Bajpai and O.P. Shukla, S. Chand Publication.

b) Practical Chemistry Volume 1-3 by Fateh Bahadur, Vishal Publication

c) Advanced Physical Chemistry by J.B. Yadav, Goel Publication

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester IV

Paper	Major Branch	Type	Credits	Total Credits
Paper 7 (P7)	Inorganic Chemistry 2	Theory	4	4
Paper 8 (P8)	Organic Chemistry 2	Theory	4	4
VC 2	Chemistry Vocational 2	Introduction of Household Chemicals, Soaps and Detergents	4	4
Paper 7 (P4")	Inorganic Chemistry 2	Minor Theory	4	4
P7'	Second major subject	Theory	4	4
P8'	second major subject	Theory	4	4
	Total Credits			**24**
Choice will be given to student to opt in which major subject he wishes to do internship and minor project				

Inorganic Chemistry 2 (Major P7 and Minor P4")

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 I

I. 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.

II. 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 - II

III. Coordination Compounds double salts: Werner's coordination theory and its experimental verification, Sidwick'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 III

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

V. Chemistry of Actinides: Electronic conformation, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.

Unit IV

VI. Oxidation and Reduction: Electrode potential, electrochemical series and its applications. Principles involved in the extraction of the elements.

VII. Acids and Bases : Arrhenius, Bronsted-Lowry, the Lux-Flood, solvent system and Lewis concept of acids and bases.

VIII. 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):

a. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
b. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
c. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
d. Chemistry for degree students, R. L. Madan

Reference Books:

a. Inorganic Chemistry, J.E. Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
b. Inorganic Chemistry, D.E. Shriver, P W. Atkins and C.H.L. Langford, Oxford.
c. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
d. Concepts of Models of Inorganic Chemistry, B. Douglas, D. Mc Daniel and J Alexander, John Wiley.
e. Inorganic Chemistry, W.W. Porterfield, Addison - Wesley.
f. Inorganic Chemistry, A.G. Sharpe, ELBS
g. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester IV
Organic Chemistry 2

Semester IV **Paper 8 (P8)** **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 I

I. Alcohols:

Monohydric alcohols - Methods of formation by reduction of aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols.

Dihydric alcohols - Nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacole-pinacolone rearrangement.

II. Ethers and Epoxides: Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions - cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening by Grignard and organolithium reagents.

UNIT II

III. Phenols:- Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols - electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.

IV. Aldehydes and Ketones: synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldedydes and ketones using 1,3-dithianes, synthesis of ketones from nitrites and from carboxylic acids. Physical properties. Mechanism of nucleophillic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Use of acetals as

protecting group, Oxidation of aldehydes, Baeyer-Viliiger oxidation of Ketones, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, $LiAlH_4$ and NaBH4 reductions. Halogenation of enolizable ketones. An introduction to α,β-unsaturated aldehydes and ketones.

UNIT III

V. Carboxylic Acids: physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids, Reactions of carboxylic acids, Hell-Volhard-Zelinsky reaction, Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids, Mechanism of decarboxylation. Methods of formation and chemical reactions of halo acids,

VI. Hydroxy acids: Preparation and reactions. Methods of formation and chemical reactions of unsaturated monocarboxylic acids. Dicarboxylic acids: Methods of formation and effect of heat and dehydrating agents.

VII. Carboxylic Acid Derivatives: Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution. Preparation of carboxylic acid derivatives, chemical reactions. Mechanisms of esterification and hydrolysis (acidic and basic).

UNIT IV

VIII. Organic Compounds of Nitrogen: Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media.

IX. Amines: Preparation, physical properties, stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydicand ketonic compounds. Gabriel -phthalimide reaction, Hoffmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.

Books Suggested (Theory Courses)

a) Organic Chemistry, Morrison and Boyd, Prentice Hall.
b) Organic Chemistry, L.G. Wade Jr. Prentice Hall
c) Fundamentals of Organic Chemistry Solomons, John Wiley.
d) Organic Chemistry, Vol. I, II, III, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
e) Organic Chemistry, F.A. Carey, McGraw-Hill Inc.
f) Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.
g) Organic Chemistry, Vol. I, II, I.L. Finar
h) Spectrometric Identification of organic compounds. Robert M. Silverstein, Clayton G. Bassler, Terence C. Morril, John Wiley.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester IV
Introduction of Household Chemicals, Soaps and Detergents

Semester IV **Chemistry Vocational 2 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.

CO 3 To enhance practical knowledge

CO 4 To motivate self-employment ability

CO 5 To create self-efficiency

UNIT I

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 II

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

UNIT III

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 IV

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:

a) Small scale industries and house hold industries in developing economy by Shetty M.C.
b) Manufacture of perfume cosmetics and detergents by Prasad Giri Raj
c) Industrial chemistry by B.K. Sharma
d) flavours & Essential oils, Industries SBP Board
e) Perfumes soaps & cosmetics by Poucher.
f) Manufacture of perfumes, cosmetics and detergents by Giriraj Prasad
g) Manufacture of perfumes, cosmetics and detergents by Prasad.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester V

Paper	Major Branch	Type	Credits	Total Credits
Paper 9	Organic Chemistry 3	Theory	4	4
Paper 10	Chemistry Practical 3	Practical	4	4
Paper 11 x	Analytical Chemistry	Chemistry Elective 1	4	4
Paper 11 y	Chemical Energetics and Radiochemistry	Chemistry Elective 2		
IS	Chemistry Internship	Theory/Practical	4	4
P9'	Second major subject	Theory	4	4
P10'	second major subject	Theory	4	4
	Total Credits			**24**

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester V
Organic Chemistry 3

Semester V **Paper 9 (P9)** **Credits 4**

Course outcome

Students on completion of the course will develop a comprehensive knowledge of

CO-1 The organometallic compounds such as Grignard reagent which have been widely used on both laboratory and commercial scale and is one of the most common organometallic reagents used for the formation of carbon–carbon bonds. Organosulphur compounds which have therapeutic use and pharmacology

CO-2 Carbohydrate, its classification and use in the food industry etc.

CO-3 Protein, aminoacid and peptides. Chemical structure of RNA and DNA.
CO-4 Various polymers, their method of polymerization and their use in industry

Unit I

Organometallic Compounds: Organomagnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organolithium compounds formation and reactions. Nomenclature, structural, features, methods of formation and chemical reactions of organosulphur compounds
Introduction and Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti- inflammatory agents (Aspirin, paracetamol); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital).
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 reaction in pyridine derivatives. 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 Indols synthesis, Skraup synthesis and Bischler – Nepieralski synthesis. Mechanism of electrophilic substitution reaction of indole, quinoline and isoquinoline.

Unit II

Carbohydrates: Classification and nomenclature, configuration and conformation of monosaccharides, Erythro and threo diastereomers, 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. Concept of glycosidation.

Unit III

Amino Acids, peptides, proteins and Nucleic Acids: Classification, structure and stereochemistry of amino acids. Acid-base behaviour, isoelectric point and electrophoresis, Preparation and reaction of a amino acids, structure and nomenclature of peptides and proteins. Classification of proteins, peptides structure determination, and group analysis. Selective hydrolysis of peptides. Classical peptide synthesis, solid phase peptide synthesis. Structure of peptides and proteins level of protein structures. Protein denaturation/renaturation.

Nucleic Acids: Introduction - Classification of nucleic acids Ribonucleosides and Ribonucleotides. The double helical structure of DNA.

Unit IV

Synthetic Polymers: Addition or chain-growth polymerization, Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step growth polymerization. Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resin, epoxy resins and poly urithanes. Natural and synthetic rubbers.

Synthetic Dyes: Colour and constitution / electronic concept classification of dyes. Chemistry and synthesis of Methyl orange, conge red, Malachite green, crystal violet, phenophthalein, Fluorescin, Alizarin and Indigo.

Books Suggested (Theory Courses)

a) Organic Chemistry, Morrison and Boyd, Prentice Hall.
b) Organic Chemistry, L.G. Wade Jr. Prentice Hall
c) Fundamentals of Organic Chemistry Solomons, John Wiley.
d) Organic Chemistry, Vol. I, II, III, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
e) Organic Chemistry, F.A. Carey, McGraw-Hill Inc.
f) Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.
g) Organic Chemistry, Vol. I, II, I.L. Finar

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester V
Chemistry Practical 3

Semester V **Paper 10 (P10)** **Credits 4**

Course Objective

The objectives of this course are to acquisition of skills in General Chemistry 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.

A: Inorganic Chemistry

I. Synthesis and Analysis

a. Preparation of potassium trioxalatoferrate (III), $K_3[Fe(C_2O_4)_3]$ and determination of itscomposition by permagnometry.

b. Preparation of Ni-DMG complex, $[Ni(DMG)_2]$

c. Preparation of copper tetraammine complex, $[Cu(NH_3)_4]SO_4$

d. Preparation of cis-and trans-bisoxalatodiaqua chromate (III) ion.

II. Colorimetry

a. To verify Beer-Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of thegiven solution.

b. Determination of Fe^{3+} content by thiocyanate method.

III. Solvent Extraction

a. Separation and estimation of Mg(II) and Fe(II) Ion Exchange Method

b. Separation and estimation of Mg(II) and Zn(II).

IV. Chromatography

a. Chromatographic separation of metal ions.

B: Organic Chemistry

I. Mixture Analysis

a. Organic mixture separation and identification (two components)

II. Preparation

b. One step preparation.

C: Physical Chemistry

I. Electrochemistry

a. To determine the strength of the given acid conductometrically using standard alkali solution.

b. To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.

c. To determine the ionisation constant of a weak acid conductometrically.

II. Refractometry and Polarimetry

a. To verify law of refraction of mixtures (e.g. of glycerol and water) using Abbe's refractometer.

b. To determine the specific rotation of cane sugar solution by polarimeter.

III. Molecular Weight Determination

a. Determination of molecular weight of a non-volatile solute by Rast method/Beckmann freezing point method.

b. Determination of the apparent molecular weight of non volatile solute at different concentration and determine Van't Hoff factor by ebullioscopy.

IV. Colorimetry

a. To verify Beer-Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of the given solution of the substance.

Books Recommended

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

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester V
Analytical Chemistry (Chemistry Elective 1)

Semester V **Paper 11 X (P11)** **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, chromatographicand 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-I

Electroanalytical Techniques:

a. **Conductometric:** Discussion of the nature of the curves of acid-base (including mixtures of acids), precipitation and complexometric titrations

b. **Potentiometric:** Different types of electrodes, discussion of the nature of the curves for oxidation-reduction and acid-base titrations, comparision with the conductometric method

c. **Voltametry:** Cyclic voltametry

d. **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-II

Thermoanalytical Methods:

a. **Thermogravimetry:** Apparatus, factors affecting TG, Interpretation of TG curves of $CaC_2O_4.H_2O$ and $MgC_2O_4.2H_2O$

b. **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-III

Radiochemical Methods

a. Isotope method

b. Inverse isotopic dilution

c. Neutron activation technique

a. Chromatographic Method:

(i) Gas Chromatography: GLC and GSC

(ii) HPLC

b. Spectral Methods:

(i) Nephelometry

(ii) Turbidimetry

(iii) Flame Photometry

Reference Books:

a) Fundamentals of Analytical Chemistry: D.A. Skoog, D.M. West and F.J. Holler, 1992, 6e
b) Quantitative Inorganic Analysis, A.I. Vogel, 2012, 7e
c) Instrumental Methods of Chemical Analysis: B.K. Sharma, 2011
d) Instrumental Methods of Chemical Analysis: H. Kaur, 2016, 12 e
e) Analytical Chemistry, Gary D. Christian, 2007, 6e
f) Instrumental Methods of Analysis: H.H. Willard, L.L. Merrit, Jr. J.A. Dean, 1974

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester V
Chemical Energetics and Radiochemistry (Chemistry Elective 2)

Semester V **Paper 11Y (P11)** **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

I. 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

II. Third law of thermodynamics, Nernst heat theorem .Thermodynamic derivation of Nernst distribution law and its application. Phase rule, Derivation of Gibbs phase rule and its application.

Unit II

III. Photochemistry

1. Interaction of radiation with matter, difference between thermal and photochemical processes.
2. 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 III

IV. Solutions, Dilute Solutions and Colligative Properties:

Ideal and non-ideal solutions, methods of expressing concentration of solutions, activity and activity coefficient, Dilute solution, Raoult's law, 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.

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:

a) Physical Chemistry G.M. Barrow. International Student Edition IMC McGraw Hill.
b) Graduate Physical Chemistry, Volume III L.R. Sharma and M.S. Pathania, 2017.
c) Principles of Physical Chemistry, Volume III, B.R. Puri, L.P. Sharma and M.S. Pathania, Vishal Publications, Jalanadhar.
d) Quantum Chemistry by R.K. Prasad.
e) Elements of Physical Chemistry, P.W. Atkins, Oxford
f) Physical Chemistry, R.A. Alberty: Wiley Eastern Ltd.
g) Physical Chemistry through Problems, S.K. Dogra and S. Dogra Wiley Eastern Ltd.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VI

Paper	Major Branch	Type	Credits	Total Credits
Paper 12	Inorganic Chemistry 3	Theory	4	4
Paper 13	Quantum Mechanics and Spectroscopy	Theory	4	4
Paper 14 x	Polymer Chemistry	Chemistry Elective 3	4	4
Paper 14 y	Chemistry of natural products	Chemistry Elective 4		
MP	Chemistry Minor Project	Theory/Practical	4	4
P11'	Second major subject	Theory	4	4
P12'	second major subject	Theory	4	4
	Total Credits			**24**

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VI

Inorganic Chemistry 3

Semester VI **Paper 12 (P 12)** **Credits 4**

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 - I

I. 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 - II

II. 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 - III

III. 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 - IV

IV. 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):

a. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
b. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
c. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
d. Chemistry for degree students, R. L. Madan

Reference Books:

a. Inorganic Chemistry, J.E. Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
b. Inorganic Chemistry, D.E. Shriver, P W. Atkins and C.H.L. Langford, Oxford.
c. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
d. Concepts of Models of Inorganic Chemistry, B. Douglas, D. McDaniel and J Alexander, John Wiley.
e. Inorganic Chemistry, WW. Porterfield, Addison - Wesley.
f. Inorganic Chemistry, A.G. Sharpe, ELBS
g. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VI
Quantum Mechanics and Spectroscopy

Semester VI **Paper 13 (P 13)** **Credits 4**

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.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VI
Quantum Mechanics and Spectroscopy

Semester VI **Paper 13 (P 13)** **Credits 4**

Unit I

I. Spectroscopy:

a. 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.

b. 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.

c. Raman Spectrum: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

Unit II

II. 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.

III. 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 III

I. Electromagnetic Spectrum Absorption Spectra:

a. 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

b. 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 IV

II. Spectroscopy: 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.

III. **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

a) Physical Chemistry G.M. Barrow. International Student Edition IMC Graw Hill.
b) Principles of Physical Chemistry Volume III, B.R. Puri, L.P. Sharma, and M.S. Pathania, Vishal Publication, Jallandhar
c) Graduate Physical Chemistry, Volume III, L.R. Sharma and M.S. Pathania,2017
d) Fundamentals of Molecular spectroscopy, C.N. Banwell IV edition, Mc Graw hill education
e) Quantum Chemistry by R.K. Prasad
f) Fundamental Principles of Spectroscopy, B.K. Sharma, Krishna Publication.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VI
Polymer Chemistry (Chemistry Elective 3)

Semester VI **Paper 14 X (P 14)** **Credits 4**

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 I

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 and NMR of polymers. X-ray diffraction study. Microscopy. Thermal and chemical analysis, physical testing hardness, tensile strength. Fatigue, impact. Tear and abrasion resistance.

Unit II

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 III

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.

Unit IV

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:

a) Textbooks of Polymer science, F.W. Billmeyer, Jr. Wiley.
b) Polymer Science, V.R. Gowariker, N.V. Vishwanathan and J. Sreedhar, Wiley-Estern.
c) Functional Monomers and Polymers, K. Takemoto, Y.Inaki and R.M. Ottanbrite.
d) Contemporary Polymer Chemistry, H. R. Alcock and F.W. Lambe, Prentice hall.
e) Physics and Chemistry of Polymers, J.M.G. Cowie, Blackie Academic and Professional.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VI
Chemistry of Natural Products (Chemistry Elective 4)

Semester VI **Paper 14 Y (P 14)** **Credits 4**

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-I

Alkaloids

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

Unit-II

Terpenoids

Introduction, occurrence and classification of terpenoids and structure determination of menthol and zingiberene

Unit-III

Vitamins

Classification, sources, biological importance of vitamins and structure determination of vitamin A, B1, B2.

Unit-IV

Steroids

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

Suggested Books

a) Organic Chemistry By I.L.Finar vol I and II
b) Phytochemical Methods, 2nd Edition, J. B. Harborne, 1984, Springer, Dordrecht
c) Classical Methods in Structure Elucidation of Natural Products, R. W. Hoffmann, 2018, Hoffmann, Wiley

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VII

Paper	Major Branch	Type	Credits	Total Credits
Paper 15	Inorganic/Organic/Physical Chemistry	Theory	4	4
Paper 16	Bioinorganic, Bioorganic and Biophysical Chemistry	Theory	4	4
Paper 17	Chemistry Practical 4	Practical	4	4
Paper 18 x	Supramolecular Chemistry	Chemistry Elective 5	4	4
Paper 18 y	Chemistry of Analgesics and Antipyretics	Chemistry Elective 6		
Paper 19 x	Science and Technology of Cosmetics	Chemistry Elective 7	4	4
Paper 19 y	Electrochemistry	Chemistry Elective 8		
RM	Research Methodology	Theory/Practical	4	4

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VII
Inorganic, Organic and Physical Chemistry

Semester VII **Paper 15 (P15)** **Credits 4**

Course Outcome:

CO 1. Cover wide area of studies of interdisciplinary area of the three branches of chemistry

CO 2. Have ideas of catalysis, kinetics and free energy relationship.

CO 3. Study stereochemical aspects of molecules and understand the spatial arrangements and its importance.

Unit I

Homogeneous Catalysis.: Basic concepts, Turn Over Number (TON), Turn Over Frequency (TOF). Hydrogenation of alkenes using Wilkinson's catalyst Hydroformylation of alkenes using Co and Rh catalysts

Free energy relationship: Thermodynamics and kinetic requirements, kinetic thermodynamic control, Hammonds postulate, Curtin-hammett principle. The Hammett equation and linear free energy relationship, substituent and reaction constants, Taft equation.
Theory of reaction rate: collision, activated complex and unimolecular reaction i.e. Lindeman and preliminary ideas.

The ideas of reaction kinetics in solution with special reference to kinetic salt effects. The fast reaction kinetics, Relaxation methods, flow and flash photolysis. Kinetics of enzyme reaction

Unit II

Higher boranes, carboranes, metalloboranes and metallocarboranes. Wade Rule. Metal carbonyls and halide clusters. Compounds with metal-metal multiple bonds

Unit III

Stereochemistry: optical activity in absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape. Stereochemistry of compound containing nitrogen, sulphur and phosphorous
Pericyclic Reactions Molecular orbital Symmetry, Frontier orbital of ethylene, 1,3-butadiene, 1,3,5- hexatriene and allyl system. Classification of pericyclic reactions. Woodward Halfmann correlation diagram, FMO and PMO approach, electrocyclic reaction – conrotatory and disrotatory motion, 4n, 4n+2 and allyl systems. Cycloaddition – antarafacial and suprafacial addition, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloaddition and chelotropic reactions. Sigmatropic rearrangement – Suprafacial and antarafacial shift of H, sigmatropic shift involving corban moieties, 3,3 and 5,5-sigmatropic rearrangement. Claisen, cope and aza-cope rearrangements. Fluxional tautomerism. Ene reaction

Unit IV

QUANTUM MECHANICS:
The variation theorem, linear variation principle. Perturbation theory (first order and non- degenerate). Simple application of variation method in

perturbation theory. Huckel theory of conjugated system, bond order and charge density calculation. Application to ethylene, butadiene etc. Ordinary angular momentum, eigen functions for eigen values of angular momentum.

Non Equilibrium Thermodynamics:
Thermodynamic criteria for non – equilibrium state, entropy production and entropy flow, entropy balance equation for different irreversible processes (e.g. heat flow, chemical reaction etc.) transformation of generalized fluxes and forces, nonequilibrium stationary states, phenomenological equation, microscopic reversibility and Onsager's reciprocity relation, electrokinetic phenomena, diffusion, electric conduction.

Recommended Books:

a) Organometallic Chemistry: A Unified Approach, R. C. Mehrotra and A. Singh, New Age International Publisher.
b) Basic Organometallic Chemistry, Concepts, Syntheses and Applications, B. D. Gupta and Anil J. Elias, University Press.
c) Inorganic Chemistry: Principles of Structure and Reactivity, James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Pearson Education

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VII
Bioinorganic, Bioorganic and Biophysical Chemistry

Semester VII **Paper 16 (P16)** **Credits 4**

Course Outcome:

CO 1. Have ideas of metalloenzymes, bioenergetics, transport and storage of dioxygen,electron transfer, metal storage and metals in medicine.

CO 2. Cover wide area of studies of interdisciplinary area of biology and chemistry.

CO 3. It includes the study of both natural phenomena such as the behaviour of metalloproteins as well as artificially introduced metals.

Unit I

Metal Storage Transport and Biomineralization

Ferritin, Transferring and Siderophores

Electron transfer in biology: Structure and functions of electron transfer proteins, Cytochromes and respiratory chain, iron sulphur proteins rubredoxin and ferridoxins.

Photosynthetic pigments: Photosynthesis, Chlorophyll molecule, Photosystem-I and Photosystem-II.

Metal Nucleic Acid Interactions:

Metal ions and metal complex interactions. Metal complexes-nucleic acid.

Unit II

Transport and Storage of Dioxygen: Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemerythrin, model synthetic complexes of iron, cobalt and copper.

Unit III

Enzyme and Mechanism of Enzyme Action: Introduction of enzymes, enzyme action, Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase A.

Co-Enzyme Chemistry: Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, lipoic acid, vitamin B12. Mechanisms of reactions catalyzed by the above cofactors

Unit IV

Bioenergetics: Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP, muscular contraction and energy generation in mechanochemical system.

Cell Membrane and Transport of Ions: Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport. Nerve conduction.

TRANSPORT OF IONS: Ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport.

BIOSENSORS: Definition, types, sensors for environmental, medical, food safety and biosecurity applications.

Recommended Books:

a) Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.
b) Understanding Enzymes, Trevor Palmer, Prentice Hall.
c) Enzyme Chemistry: Impact and Applications, Ed. Collin J Suckling, Chapman and Hall.
d) Enzyme Mechanisms Ed, M. I. Page and A. Williams, Royal Society of Chemistry.
e) Fundamentals of Enzymology, N.C. Price and L. Stevens, Oxford University Press.
f) Immobilized Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan, John Wiley.
g) Enzymatic Reaction Mechanisms, C. Walsh, W. H. Freeman.
h) Enzyme Structure and Mechanism, A Fersht, W.H. Freeman.
i) Biochemistry: The Chemical Reactions of Living Cells, D. E. Metzler, Academic Press. Principles of Biochemistry, A. L. Lehninger, Worth Publishers.
j) Biochemistry, L.Stryer, W.H.Freeman.
k) Biochemistry, J. David Rawn, Neil Patterson.
l) Biochemistry, Voet and Voet, John Wiley.
m) Outlines of Biochemistry, E. E. Conn and P. K. Stumpf, John Wiley.
n) Macromolecules: Structure and Function, F. Wold, Prentice Hall.
o) Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
p) Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
q) Inorganic Biochemistry volume I and II. ed. G.L. Eichhorn, Elsevier.
r) Progress in Inorganic Chemistry, Volume 18 and 38 ed. J.J. Lippard, Wiley.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VII
Chemistry Practical 4

Semester VII **Paper 17 (P17)** **Credits 4**

Course Outcome:

In order to make students understand the theories taught to them in B.Sc. semester vii in different branches of chemistry e.g. Inorganic, Organic, Physical, the following practical are introduced. Students will learn:

CO-1. Qualitative analysis of inorganic mixtures of 8 radicals

CO-2. Qualitative analysis and determination of two metal ions volumetrically and gravimetrically.

CO-3. The preparation of selected inorganic compounds and their characterization.

CO-4. Qualitative analysis of three component organic mixtures.

CO-5. students should be able to check the purity of organic molecules by the use of TLC and how to calculate their Rf values.

CO-6. Two steps synthesis involving different name reactions.

CO-7. The basic knowledge of conductance, electrochemistry, potentiometry and the kinetics of decomposition of the complexes spectrophotometrically.

INORGANIC CHEMISTRY

Inorganic: Qualitative analysis of inorganic mixture of 8 radicals containing not more than two of the following less common metals: Tl, Mo, W, Zr, Th, V, U.

Quantitative analysis Separation and determination of two metal ion Cu-Ni, Cu-Zn etc. involving volumetric and gravimetric methods.

Preparation and their characterization

- $VO(acac)_2$
- cis-$K[Cr(C_2O_4)_2(H_2O)_2]$
- $Na[Cr(NH_3)_2(SCN)_4]$
- $K_3[Fe(C_2O_4)_3]$
- $Hg[Co(SCN)_4]$

ORGANIC CHEMISTRY

Separation, purification, characterization and identification by making suitable derivatives of the three component Organic mixture (three solids or two solids and one liquid or two liquids and one solid) involving all the functional groups. Use TLC for checking the purity of the separated compounds and their derivatives and report their Rf values.

Two steps organic synthesis involving

1. Acetylation
2. Oxidation
3. Aldol condensation
4. Sandmeyer reaction
5. Acetoacetic ester Condensation
6. Aromatic Electrophilic Substitution.

7. Hydrolysis

PHYSICAL CHEMISTRY

Conductance measurement

1. Determination of cell constant of a given conductivity cell and also find out the equivalent conductance of a strong electrolyte at different concentrations at room temperature and the test the validity of Onsager equation.
2. Determine the solubility of sparingly soluble substance in water at given temperature by conductance method
3. Study hydrolysis of aniline hydrochloride by conductance method.
4. Determination of basicity of a given salt by conductance method.

Electrochemistry (EMF – Measurements) – Potentiometry / pH-metry

1. Determination of EMF of Daniel Cell by Potentiometric method $Zn/ZnSO_4$ (C_1) I I $CuSO_4$ (C_2)/Cu Where C_1 and C_2 (i) same concentration (ii) different concentration and hence to see the effect of dilution.
2. Determination of the solubility of a sparingly soluble salt in water by EMF method.
3. Determination of the strength of strong acid using pH – metric method.
4. Determine the pH a given buffer solution using given quinhydrone electrode.

Chemical kinetics

1. Determination of the rate constant and order of reaction for the hydrolysis of an ester catalyzed by an acid at a given temp.
2. Determine the velocity constant and order of reaction for hydrolysis of ethyl acetate by sodium hydroxide at given temperature (saponification of an ester)

Spectrophotometer

1. Study the kinetics of decomposition of the complex formed between sodium sulphide and sodium nitroprusside spectrophotometrically, and also find the order and rate constant of the reaction.

Recommended Books:

a) Vogels Text book of Quantitative Analysis revised, J. Bessett, R.C. Denney, G.H. Jellery and J. Mendhan ELBS
b) Experimental Inorganic Chemistry by Mounir A, Malati, Horwood series in Chemical Science (Horwood publishing Chichester) 1999.
c) Inorganic Experiments, J. Derexwoolings VCH
d) Microscale Inorganic Chemistry, Z. Scafran, R.M. Pike and M.M. Singh Wiley.
e) Practical Inorganic Chemistry, G. Marrand, B.W. Rockett, Van Nostrand.

f) The systematic Indentification of Organic Compounds, R.L. Shringer and D.Y. Curlin.
g) Qualitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
h) Basic concept of Analysis chemistry, S.M. Chopkar, Wiley Bastern.
i) Synthesis and characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.
j) Systematic Qualitative Organic Analysis, H. Middeton, AdwardArnoid.
k) Handbook of Organic Analysis Qualitative and Quantitative, H. Clark, Adward Ar.
l) Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
m) Practical Physical Chemistry, A.M. James and F.E. Prichand,

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VII
Supramolecular Chemistry (Chemistry Elective 5)

Semester VII **Paper 18X (P 18)** **Credits 4**

Course Outcome:

CO 1. Have understanding of theories behind supramolecular interaction and variousclasses of host-guest chemistry and its applications.

CO 2. Develop ideas for further research in the field of supramolecular chemistry.

CO 3. Molecular recognition, complex formation and host design, templates and self-assembly through various examples and applications.

Unit-I

Definition, classification of supramolecular host-guest compounds, nature of supramolecular interactions, Chelate and macrocyclic effects, General principles of molecular recognition, complex formation and host design, templates and self-assembly.

Unit-II

Host-Guest Chemistry (Cation Binding Hosts):

i. Crown ethers
ii. Cryptands
iii. Spherands

Unit-III

Host-Guest Chemistry (Anion Binding Hosts):

i. Expanded porphyrins
ii. Guanidinium Based reseptors

Unit-IV

Host-Guest Chemistry (Neutral Molecules Binding Hosts):

i. Solid State Clatharates
ii. Zeolites

Selected Applications in:

I. Catalysis
II. Ion Transport
III. Molecular switches, rectifiers and Molecular wires

Books Recommended

a) Supramolecular Chemistry: concepts and perspectives by J. M. Lehn, 1995
b) Supramolecular Chemistry by JW Steel and JL Atwood, 2004
c) Principles and Methods in Supramolecular Chemistry by H Scheneider and A Yatsimirsky,2000
d) Supramolecular Chemistry: an Introduction by F Vogtle, 1993
e) Perspectives in Supramolecular Chemistry, Vol.2, Crystal Engineering and molecularrecognition by Desiraju (Ed.), 2003

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VII

Chemistry of Analgesics and Antipyretics (Chemistry Elective 6)

Semester VII **Paper 18y (P 18y)** **Credits 4**

Course Objective:

The objective of this course is to provide students information about the recent development in the area of antipyretics and analgesics and also about the structure activity relationship which play pivotal role in drug development.

Course Outcome:

After completing the course, students shall be able to learn:

CO-1. The structural activity relationship of different class of drugs.

CO-2. The synthesis of drug molecules using the reactions of synthetic organic chemistry.

CO-3. Well acquainted with the synthesis of some important class of drugs.

CO-4. The mechanism pathways of certain class of medicinal compounds and their modes of action with receptors.

CO-5. The chemistry of drugs with respect to their pharmacological activity.

Unit I

Introduction, classification, mode of action, structural activity relationship of narcotic analgesics and applications of the following:

1. Derivatives of morphin
2. Morphinan
3. phenylpiperidine
4. benzazocine
5. diphenylpropylamine and isosters.

Unit II

Introduction, classification, mode of action, structural activity relationship of narcotic antagonists and applications of the following:

1. n-allyl-nor morphine
2. Levellorphan
3. Naloxone

Unit III

Synthesis of the following narcotic analgesics and antagonists:

1. Phenylpiperidine
2. Benzazocine
3. Diphenyl propylamine
4. n-allyl-nor morphine
4. Levellorphan
5. Naloxone

Unit IV

Introduction, classification, mode of action, structural activity relationship of antipyretic analgesics and applications and synthesis of the following:

1. Paracetamol
2. Asprin
3. Indomethacin
4. Diclophenac sodium
5. Ibuprofen

6. Piroxicam

Recommended Books:

a) Thomas L. Lemke, David A. Williams, Victoria F. Roche, S. William Zito, Foye's Principles of Medicinal Chemistry, 7th Ed., Lippincott Williams & Wilkins, 2012.
b) Graham L. Patrick, "An Introduction to Medicinal Chemistry", 5th Ed. Oxford University Press 2013.
c) D. Sriram, P. Yogeeswari, Medicinal Chemistry, Pearson Education India, 2009.
d) Ashutosh Kar, Medicinal Chemistry, 4th Edition, New Age Publication Publishers.

Science and Technology of Cosmetics (Chemistry Elective 7)

Semester VII **Paper 19X (P 19)** **Credits 4**

Course outcome:

CO-1. This course allows students to understand and learn about the chemistry of cosmetics.

CO-2. More specifically, this course aims to introduce the scientific aspects such as chemical, physical and biological functions of different ingredients present in the cosmetics.

CO-3. This course also gives information about the formulation and technology of cosmetics

Unit I

Basic concept of Cosmetics. Classification of cosmetic products for skin, hair and oral care.

Forms of cosmetics and their suitable examples: Solutions, creams, lotions, ointment, paste, gels, sticks, tablets, capsules, powders and aerosols.

Unit II

Cosmetic Ingredients and Classifications: Water, Surfactants, Foaming agents,

Emulsifiers, and Solubilizers, rheological additives, Antioxidants, Antimicrobial and Chelating agents used as preservatives.

Unit III

Perfume: Classification of perfumes, Perfume ingredients

Colour Cosmetics: Building block and formulation of Lipsticks, mascara, and nail polish

Hair conditioner: Building blocks and formulation of Hair conditioners, hair oils, hair dye, Herbal cosmetics

Unit IV

Use of nanotechnology in cosmetics, suspensions, creaming, cracking and phase inversion

Micrometrics: Methods of determining particle size, optical microscopy, sieving, sedimentation measurements

Powders: porosity, densities, bulkiness and flow properties.

Recommended Books:

a) Harry's Cosmeticology – Wilkinson, Moore, seventh edition, George Godwin.
b) Cosmetics – Formulation, Manufacturing and Quality Control, P.P. Sharma, 4th edition, Vandana Publications Pvt. Ltd., Delhi.
c) Drugs and Cosmetic act/rules by govt. of India Publication
d) Handbook of Cosmetic Science and Technology, 3rd Edition, André O. Barel, Marc Paye, Howard
e) Maibach, Marianne Mahieu Informa Healthcare USA, Inc.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VII
Electrochemistry (Chemistry Elective 8)

Semester VII **Paper 19Y (P 19)** **Credits 4**

Unit I

Electrokinetic Phenomenon

Electrokinetic Effects, Electrical double layer, quantitative treatment of electrokinetic phenomena, Electrokinetic potential/Zeta potentials and its determination, influence of ions on electrokinetic phenomena, Electro-Osmosis, Streaming potential, Sedimentation potential, Electrophoretic, Mobility and Bound hydrogen ion.

Unit II

Bioelectrochemistry

Threshold phenomena, Donnan Membrane Equilibrium and its application, Membrane
Potential, Hodges Huxley Equation, Core conductor model. Quantum Aspects of Charge transfer at electrode-solution interfaces, quantization of charge transfer tunneling. Theory of double layer
semiconductor solution interfaces, Limiting current in semiconductor electrode.

Unit III

Polarography and Voltametry

Electrode polarization, Theories and importance of overvoltage,Principle of polarography, variation of conventional polarographic methods, Pulse Polarography, Oscillographic polarography, Tensammetry, AC polarography, square wave—polarography, Anodic stripping and cyclic voltammetry, Qualitative and quantitative application of polarography, Determination of stoichiometry and formation constants of complexes.

Unit IV

Solid State Electrochemistry

Solid Fuel Cells and batteries, super Capacitor and semiconductors, Temperature dependence of electrical resistances, Coherent Length, Piezoelectric and pyroelectric materials, Conducting polymers, Fullerenes-Doped conductors. Brief idea of Electrochemistry of molten electrolytes and nonaqueous solvents.

Books Suggested (Theory Courses)

a. Physical Chemistry. G.M. Barrow. International Student Edition, McGraw Hill.
b. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
c. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
d. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.
e. Graduate physical Chemistry,VolumeI-III By L.R.sharma and M.s..Pathania

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VII
Research Methodology

Semester VII **Paper RM** **Credits 4**

Course Objective:

To provide students thorough knowledge of the literature and a comprehensive understanding of scientific methods and techniques applicable to their work.To give knowledge of Safety, Hazards and precautions in Laboratory. To introduce Chemistry related software and Databases and Data Analysis as per IUPAC protocol.

Course Outcome:

Student will learn-

CO-1. Minimize the risk of injury or illness to laboratory workers by ensuring that they have the training, information, support and equipment needed to work safely in the laboratory.

CO-2. Have understanding of different purification criteria at separation and be able to account for fundamental separation processes and their connection to molecular properties.

CO-3. IUPAC awareness on the world authority on chemical nomenclature, terminology, standardized methods for measurement, atomic weights and many other critically-evaluated data.

CO-4. Developing skill for systematic, articulate and orderly presentation of research work in a written form containing relevant information on the research work carried out.

Unit – I

Safety, Hazards and Precautions in Laboratory:

Brief idea about toxicity, explosive nature and ill effects of various chemicals generally used in research and precautions to handle them.

Unit – II

Computer Basics and Application

a. Introduction to basic software\
   i. MS Word,
   ii. Power Point
   iii. Excel

b. **Introduction to Chemistry related software**
   i. Gaussian,
   ii. Gaussview
   iii. ChemDraw

c. **Introduction to Databases**
   i. SciFinder
   ii. Scopus
   iii. Cambridge Structural Database

Unit – III

Purification Techniques:

a. A brief knowledge about various techniques such as distillation, fractional distillation, crystallization, fractional crystallization.

a. Chromatography:

- **i.** Column
- **ii.** TLC
- **iii.** Paper

Unit – IV

Data Analysis as per IUPAC and Association of Analytical Chemists' (AOAC) protocol:

Errors in chemical analysis, Repeatability and reproducibility, classification of errors, determination of accuracy of methods, improving accuracy of analysis, significant figures, mean, mode, median, standard deviation, comparison of results: T-test, F-test and Chi-square test, Rejection of results, presentation of data.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF LUCKNOW
LUCKNOW
Four Year Undergraduate Course Structure
Subject: Chemistry Semester VIII

Paper	Major Branch	Type	Credits	Total Credits
Project	Major Project-Dissertation	Theory/Practical	24	24