BABA MASTNATH UNIVERSITY

SCHEME OF EXAMINATION FOR B.Sc. UNDER CHOICE BASED CREDIT SYSTEM W.E.F. 2022-2023 IN PHASED MANNER

SUBJECT : CHEMISTRY
OUTCOME BASED CBCS Syllabi for B.Sc. Part-I, Part-II and Part-III

B.Sc. Part-I (1st Semester)

Paper No.	Paper code	Nomenclature	Max Marks Written + I.A#.	Total marks	Credits	Hours / week	Duration of Exam. (Hrs.)
I	22BCHE -101-C	Inorganic Chemistry-I	40+10	50	2	2	3
II	22BCHE -102-C	Physical Chemistry-I	40+10	50	2	2	3
III	22BCHE -103-C	Organic Chemistry-I	40+10	50	2	2	3
IV	22BCHE -104-CL	Chemistry Practical-I	40+10	50	2	6	6

B.Sc. Part-I (2nd Semester)

Paper No.	Paper code	Nomenclature	Max Marks Written + I.A#.	Total marks	Credits	Hours/ week	Duration of Exam. (Hrs.)
I	22BCHE -201-C	Inorganic Chemistry-II	40+10	50	2	2	3
II	22BCHE -202-C	Physical Chemistry-II	40+10	50	2	2	3
III	22BCHE -203-C	Organic Chemistry-II	40+10	50	2	2	3
IV	22BCHE -204-CL	Chemistry Practical-II	40+10	50	2	6	6

B.Sc. Part-II (3rd Semester)

Paper No.	Paper code	Nomenclature	Max Marks Written + I.A#.	Total marks	Credits	Hours/ week	Duration of Exam. (Hrs.)
I	22BCHE -301-C	Inorganic Chemistry-III	40+10	50	2	2	3
II	22BCHE -302-C	Physical Chemistry-III	40+10	50	2	2	3
III	22BCHE -303-C	Organic Chemistry-III	40+10	50	2	2	3
IV	22BCHE -304-CL	Chemistry Practical-III	40+10	50	2	4	6

B.Sc. Part-II (4th Semester)

Paper No.	Paper code	Nomenclature	Max Marks Written + I.A#.	Total marks	Credits	Hour/ week	Duration of Exam. (Hrs.)
I	22BCHE -401-C	Inorganic Chemistry-IV	40+10	50	2	2	3
II	22BCHE -402-C	Physical Chemistry-IV	40+10	50	2	2	3
III	22BCHE -403-C	Organic Chemistry-IV	40+10	50	2	2	3
IV	22BCHE -404-CL	Chemistry Practical-IV	40+10	50	2	4	6

B.Sc. Part-III (5th Semester)

Paper No.	Paper code	Nomenclature	Max Marks Written + I.A#.	Total marks	Credits	Hours /week	Duration of Exam. (Hrs.)
I	22BCHE-501-DSEC	Heterocyclic and Photochemistry	40+10	50	2	2	3
II	22BCHE-502- DSEC	Organomettalic Chemistry, Inorganic Polymers and Quantum Mechanics	40+10	50	2	2	3
III	22BCHE-503-DSECCL	Chemistry Practical-V	40+10	50	2	4	6

B.Sc. Part-III (6th Semester)

Paper No.	Paper code	Nomenclature	Max Marks Written + I.A#.	Total marks	Credits	Hours/ week	Duration of Exam. (Hrs.)
I	22BCHE-601-DSEC	Green Chemistry and Organic Polymers	40+10	50	2	2	3
II	22BCHE-602- DSEC	Nuclear Chemistry, Organosulphur Compounds and Catalysis	40+10	50	2	2	3
III	22BCHE-603-DSECCL	Chemistry Practical-VI	40+10	50	2	4	6

Program Outcomes (PO) for Under Graduate Programmes (CBCS) in the Faculty of Sciences, Baba Mastnath University

PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO3	Problem Solving	Capability of applying knowledge to solve scientific and other problems
PO4	Individual and Team Work	Capable to learn and work effectively as an individual , and as a member or leader in diverse teams, multidisciplinary settings
PO5	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO6	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific practices
PO7	Science and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO8	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO9	Environment and Sustainability	Ability to design and develop modern systems which are environmentally sensitive and to understand the importance of sustainable development
PO10	Ethics	Apply ethical principles and professional responsibilities in scientific practices
PO11	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

PROGRAMME SPECIFIC OUTCOMES

PSO1 Acquire good knowledge about the fundamentals and applications of chemical and scientific theories.
PSO2 All branches of Science and Technology are related to Chemistry.
PSO3 Easily assess the properties of all elements discovered.
PSO4 Will become familiar with the different branches of chemistry like analytical, physical, organic, inorganic, environmental and polymer.
PSO5 Will help in understanding the causes of environmental pollution and can open up new methods to control environmental pollution.
PSO6 Will develop analytical skills and problem-solving skills requiring application of chemical principles.
PSO7 Have the ability to synthesize, separate and characterize compounds using laboratory and instrumentation techniques.

B. Sc. Ist Year (Ist Semester)
Paper-I (22BCHE-101-C) Inorganic Chemistry-I (Theory)

Credit : 2 **Total Marks =50**
Time: 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each.

Section – A

Atomic Structure

Idea of de Broglie matter waves, Heinsenberg's uncertainty principle, atomic orbitals, quantum numbers, radial and angular wave functions, normal and orthogonal wave functions, significance of Ψ and Ψ2, probability distribution curves, shapes of s, p, d, f orbitals, Aufbau and Pauli exclusion principles, Hund's multiplicity rules, Electronic configuration of elements, effective nuclear charge, Slater's rules.

Periodic table and atomic properties

Classification of periodic table into s, p, d, f blocks, atomic and ionic radii, ionisation energy, electron affinity and electronegativity definition, methods of determination or evaluation, trend in periodic table (in s and p-block elements), Pauling , Mulliken, Allred Rachow and Mulliken Jaffe's electronegativity scale.

Section – B

Covalent Bond

Valence bond theory and its limitation, directional characteristics of covalent bond, various type of hybridisation and shapes of simple inorganic molecules and ions (BeF_2, BF_3, CH_4, PF_5, SF_6, IF_7,SO_4^{-2}, ClO_4^{-1}, NO_3^{-1}) valence shell electron pair repulsion (VSEPR) theory to NH_3, H_3O^+, SF_4, ClF_3, H_2O, $SnCl_2$, ClO_3^{-1} and ICl_2^{-1}. Molecular orbital theory of homonuclear (N_2, O_2) heteronuclear (CO and NO) diatomic molecules and ions, bond energy, bond angle, bond length and dipole moments, percentage ionic character from dipole moment and electronegativity difference.

Ionic Solids

Ionic structures (NaCl, CsCl, ZnS (Zinc blende), CaF_2) size effects, radius ratio rule and its limitations, Stoichiometric and Non stoichiometric defects in crystals, Lattice energy (mathematical derivation excluded) and Born- Haber cycle, Solvation energy and its relation with solubility of Ionic solids, Polarizing power and Polarisability of ions, Fajan's rule.

Course Outcomes :

CO1: States the postulates of quantum mechanics and Schrodinger equation to explain the structure of hydrogen atom.

CO2: To study and explain the Radial and angular nodes and their significance in describing shapes of s,p and d orbitals.

CO3: Know about Spin quantum numbers and magnetic quantum numbers and their significance.

CO4: Have knowledge about Electronic configuration, Effective nuclear charge and slater's rule.

CO5: To learn about Ionic bonding and energy consideration in ionic bonding to Explain Lattice energy and solvation energy.

CO6: To study Born-Haber cycle, polarizing power and polarizability.

CO7: To apply VSEPR theory in explaining shapes of some inorganic molecules and ions.

CO8: Know about Rules of LCAO method, Bonding and antibonding molecular orbitals.

Reference Books:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. &Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry:Principles of Structure and Reactivity*, Pearson Education India, 2006.
- Pradeep's inorganic chemistry, Volume I.
- R Chand, inorganic chemistry, Volume I.
- Modern publications,inorganic chemistry, Volume I.

B. Sc. Ist Year (Ist Semester)
Paper-II (22BCHE-102-C) Physical Chemistry-I (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each.

Section – A

Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation,Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation,Van der Waals equation of state for real gases. Boyle temperature(derivation not required). Critical phenomena, critical constants and their calculation from Van der Waals equation. Andrews isotherms of CO_2.continuity of states, Law of corresponding states, Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.
Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision number,collision frequency, collision diameter and mean free path of molecules.

Section – B

Liquids

Structure of liquids, vapour pressure, Surface tension, viscosity of a liquid and coefficient of viscosity. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

Solids

Forms of solids. Unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. Elementary idea of symmetry and symmetry elements, X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Course Outcomes :

CO1: To learn about Role of temperature and pressure to establish the state of gases and describe the Concept of critical temperature, pressure and volume of real gases

CO2: To understand the Maxwell distribution law and various parameters associated with collisions ideal gas molecules

CO3: To study the Physical properties of liquids like surface tension, viscosity and their measurements

CO4: To understand the morphology of crystalline solids and have knowledge about various types of symmetries present in different solids

CO5: To be able to describe X-rays diffraction and Bragg's law

CO6: To have knowledge about solutions and colligative properties and their application in determining molar mass of solute.

Reference Books:

- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- B. R. Puri, Madan S. Pathania , L. R. Sharma *Principles of Physical Chemistry*, *48th Ed.*, Vishal Publications.
- Peter Atkins , Julio de Paula , James Keeler *Atkins' Physical Chemistry*, Oxford University Press.

B. Sc. Ist Year (Ist Semester)
Paper-III (22BCHE-103-C) Organic Chemistry-I (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section.Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each.

Section-A

Fundamentals of Organic Chemistry

Structure and Bonding: Localized and delocalized chemical bond, Van der Waals interactions, resonance: conditions, resonance effect and its applications, hyperconjugation, inductive effect, Electromeric effect & their comparison.

Mechanism of Organic Reactions:Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking. Types of reagents–electrophiles and nucleophiles.Types of organic reactions (Substitution, Addition, Elimination, Rearrangement etc.). Reactive intermediates: Carbocations, carbanions, free radicals, carbenes (structure & stability).

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values.

Stereochemistry of Organic Compounds

Concept of isomerism: Types of isomerism, Optical isomerism, elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers and meso compounds (tartaric acid and 2,3-dichlorobutane), threo- and erythro-diastereomers (Erythrose, Threose, 2,3-dichlorobutane), resolution of enantiomers, Relative and absolute configuration, R & S nomenclature. Geometric isomerism: Configuration of geometric isomers. Cis-Trans and E & Z nomenclature, Conformational isomerism: conformational analysis of ethane and n-butane; chair, boat, half chair and twist boat conformations of cyclohexane (interconversions and energy level diagram). Interconversions of Newman projection and Sawhorse formulae, Wedge Formula and Fischer representations (Erythrose, Threose and Tartaric acid), Difference between configuration and conformation.

Section-B

Alkanes and Cycloalkanes

IUPAC nomenclature of branched and unbranched alkanes, classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation: Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids, physical properties. Mechanism of free radical halogenation of alkanes: reactivity and selectivity.

Nomenclature, Baeyer's strain theory and its limitations, theory of strainless rings.

Alkenes and Dienes:

Nomenclature of alkenes, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halide.The Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes, mechanisms involved in halogenations and halohydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration–oxidation, oxymercuration, reduction, ozonolysis, hydration, hydroxylation and oxidation with KMnO4.

Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of butadiene. Chemical reactions: 1,2 and 1,4 additions (Electrophilic & free radical mechanism), Diels-Alder reaction (effects of substituent excluded)

Alkynes:

Nomenclature, structure and bonding in alkynes. Methods of formation.Chemical reactions of alkynes, acidity of alkynes.Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation of alkynes.

Course Outcomes:

CO1: Have sound knowledge of the basic organic chemistry like electron displacement effects with suitable examples.

CO2: Get information about the types of structural and stereoisomers, optical isomerism, and different nomenclature like D/L, RS, cis/trans, E/Z etc. of various organic compounds.

CO3: Learn nomenclature of various type of alkanes and cycloalkanes, preparation and their chemical reactions.

CO4: Sound knowledge of alkenes, alkynes, dienes and their chemical reactions.

Reference Books:

- Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, New Delhi (1988).
- Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
- Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
- Bahl, A. &Bahl, B.S. *Advanced Organic Chemistry,* S. Chand, 2010.
- Pradeep's organic chemistry, Volume I, II
- R Chand, organic chemistry, Volume I,II
- Modern publications, organic chemistry, Volume I,II
- New Age International (P) Ltd, Publishers, Volume I,II.

B. Sc. Ist Year (Ist Semester)

Paper-IV (22BCHE-104-CL) Chemistry-I (Practical-I)

Credit : 2 **Total Marks =50**

Time : 6 Hrs. **(40 EM + 10 IA)**

Volumetric Analysis

1. Preparation of reference solutions.
2. Redox titrations: Determination of $Fe^{2+,}$ $C_2O_4^{2-}$ (using $KMnO_4$, $K_2Cr_2O_7$)
3. Iodometric titrations: Determination of Cu^{2+} (using standard hypo solution).
4. Complexometric titrations: Determination of $Mg^{2+,}$ Zn^{2+} by EDTA.
5. To determine the surface tension of at least two liquids using a stalagmometer by drop no. and drop weight methods (Use of organic solvents excluded).
6. To study the effect of surfactant on surface tension of water.
7. To determine the viscosity of at least two liquids by using Ostwald's viscometer (Use of organic solvents excluded).
8. To determine the specific refractivity of at least two liquids.

Course Outcomes :

CO1: To gain knowledge about Preparation of standard solutions used in the lab.

CO2: Know about Redox , iodometric titrations and complexometric titrations.

CO3: To study the concept of surface tension and its determination by various methods.

CO4: To know about viscosity and its measurements by using Ostwald's viscometer.

Scheme of Practical Examination

Duration : 6 Hrs. (Two Session of Three Hours)

Distribution of Marks :

1. **Experiment 1 = 12 Marks**
2. **Experiment 2 = 12 Marks**
3. **Lab. Record = 08 Marks**
4. **Viva-Voce = 08 Marks**

B.Sc. Ist Year (IInd Semester)
Paper-I (22BCHE-201-C) Inorganic Chemistry-II (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each.

Section – A

Hydrogen Bonding and Vander Waals forces
Hydrogen Bonding – Definition, types, effects of hydrogen bonding on properties of substances, application Brief discussion of various types of Van der Waals forces.

Metallic Bond and semiconductors
Metallic bond – Qualitative idea of valence bond and Band theories of metallic bond (conductors, semiconductors, insulators). Semiconductors – Introduction, types and applications.

s-Block elements
Comparative study of the elements including diagonal relationship, Anomalous behaviour of Lithium and Beryllium compared to other elements in the same group, salient features of hydrides, oxides, halides, hydroxides (methods of preparation excluded), behaviour of solution in liquid NH3.

Chemistry of Noble Gases
General physical properties, low chemical reactivity, chemistry of xenon, structure and bonding in fluorides, oxides and oxyfluorides of xenon.

Section – B

p-Block elements:
Electronic configuration, atomic and ionic size, metallic character, melting point, ionization energy, electron affinity, electronegativity, inert pair effect and diagonal relationship.

Boron family (13th group):

Diborane: Preparation, properties and structure (as an example of electron deficient compound and multicenter bonding), Borazine chemical properties and structure, relative strength of Trihalide of Boron as lewis acids, structure of aluminium(III) chloride.

Carbon family and Nitrogen family (14th and 15th group):

Catenation, Carbides, fluoro carbons, silicates (structural aspects). Oxides: Structure of oxides of nitrogen and phosphorus, Oxyacids : Structure and relative acid strength of oxyacids of nitrogen and phosphorus, structure of white and Red phosphorus.

Oxygen family (16th group):
Oxy acids of sulphur – structure and acidic strength, Hydrogen Peroxide – properties and uses.

Halogen family (17th group):

Interhalogen compounds (their properties and structures), Hydra and oxy acids of chlorine – structure and comparison of acid strength.

Course Outcomes :

CO1: To know the concept and able to explain types and effect of hydrogen bonding and van der waals forces on properties of substances.

CO2: To learn about the various theories of metallic bonding with reference to conductors, insulators and semiconductors and their applications.

CO3: To know about the diagonal relationship among S- block elements and about hydrides, oxides, hydroxides and halides of S-block elements.

CO4: Learn about chemistry of noble gases with special reference to xenon.

CO5 To know about the physical and chemical properties of p-block elements.

CO6: Have knowledge about the boron family elements their structure, preparation and properties of diborane and borazine.

CO7: To learn about the elements of carbon and nitrogen family and concept of catenation, carbides and fluorocarbons.

CO8: To know about the elements of oxygen family and have knowledge about the chemical properties of oxides of sulphur.

Reference readings

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. &Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry:Principles of Structure and Reactivity, Pearson Education India, 2006.
- Pradeep's inorganic chemistry, Volume I.
- R Chand, inorganic chemistry, Volume I.
- Modern publications,inorganic chemistry, Volume I.

B. Sc. Ist Year (IInd Semester)
Paper-II (22BCHE-202-C) Physical Chemistry-II (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each.

Section – A

Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first, second and third order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Effect of temperature on the rate of reaction. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

Section – B

Conductance

Conductance, equivalent and molar conductance and their variation with dilution for weak and strong electrolytes. Arrhenius theory of ionization, Ostawald's dilution Law. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements:determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Concepts of pH and pK_a , Buffer solution, Buffer action, Henderson – Hazel equation, Buffer mechanism of buffer action, Conductometric titrations (only acid-base).

Course Outcomes :

CO1: To have the knowledge about the concepts of rates of chemical reactions and its applications in derivation of reactions of various orders and half-life

CO2: To be able to explain about the physical and magnetic properties associated with various molecular substances

CO3: To have information about conductance and its applications to deduce various parameters related to electrolytic solutions, to know about pH and conductometric titrations

CO4: Know about Concept of basics of cells their EMF determination by use of Nernst equation and thermodynamic properties

Reference Books:

- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- B. R. Puri, Madan S. Pathania , L. R. Sharma*Principles of Physical Chemistry* Vishal Publications.
- Peter Atkins , Julio de Paula , James Keeler *Atkins' Physical Chemistry*, Oxford University Press.
- K.J. Laidler, *Chemical Kinetics*, Perason.

B. Sc. Ist Year (IInd Semester)
Paper-III (22BCHE-203-C) Organic Chemistry-II (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section.Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each.

Section-A

Arenes and Aromaticity

Nomenclature of benzene derivatives: Aromatic nucleus and side chain. Aromaticity: the Huckel rule, aromatic ions, annulenes up to 10 carbon atoms, aromatic, anti-aromatic and non-aromatic compounds. Aromatic electrophilic substitution, mechanism of nitration, halogenation, sulphonation, and Friedel-Crafts reaction.Activating , deactivating substituents. Orientation in monosubstituted benzenes.

Alkyl and Aryl Halides

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms and stereochemistry (inversion and racemization) of nucleophilic substitution reactions of alkyl halides, SN^2 and SN^1 reactions with energy profile diagrams.

Methods of formation and reactions of aryl halides, The addition-elimination and the elimination - addition mechanisms of nucleophilic aromatic substitution reactions.

Relative reactivities of alkyl halides vsallyl, vinyl and aryl halides.

SECTION-B

Alcohols and Epoxides

Monohyric alcohols: nomenclature, 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 pinacol-pinacolone rearrangement.
Synthesis of epoxides. Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening,

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

Phenols

Nomenclature, structure and bonding.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, Mechanisms of Fries rearrangement, Claisen rearrangement, Reimer-Tiemann reaction, Kolbe’s reaction

Carboxylic Acids & Acid Derivatives

Nomenclature of Carboxylic acids, structure and bonding, physical properties, Preparation of carboxylic acids.Reactions of carboxylic acids.Hell-Volhard-Zelinsky reaction.Mechanism of decarboxylation.Relative stability of acyl derivatives.Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.

Mechanisms of esterification and hydrolysis (acidic and basic).

Course Outcomes:

CO1: Know aboutHuckel's rule of aromaticity and various methods of preparation of aromatic Hydrocarbons.

CO2: Get knowledge about the mechanism of S_N1 and S_N2 reactions and other various chemical reactions of aryl and aryl halides.

CO3: Know aboutalcohols, phenols, ethers, epoxides and their chemical reactions.

CO4: Knowledge about various methods for the preparation of carboxylic acid, carboxylic derivatives (ester, amide, acid chlorides, anhydrides) and their chemical reactions.

Reference Books:

- Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
- Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
- Bahl, A. &Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
- Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
- Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
- Pradeep's organic chemistry, Volume I & II.
- R Chand, organic chemistry, Volume I & II.
- Modern publications, organic chemistry, Volume I & II.
- New Age International (P) Ltd, Publishers, Volume I, II.

B. Sc. Ist Year (IInd Semester)
Paper-IV (22BCHE-204-CL) Chemistry-II (Practical)

Credit : 2 **Total Marks =50**

Time : 6 Hrs. **(40 EM + 10 IA)**

1. Preparation and purification through crystallization or distillation and ascertaining their purity through melting point or boiling point
   (i) Iodoform from ethanol (or acetone)
   (ii) *m-Dinitrobenzene* from nitrobenzene (use 1:2 conc. HNO_3 -H_2SO_4 mixture if fuming HNO_3 is not available)
   iii) p-Bromoacetanilide from acetanilide
   iv) Dibenzalacetone from acetone and benzaldehyde
   v) 2,4-DNP derivative of Benzophenone/Acetophenone.
2. To study the process of (i) sublimation (ii) Crystallization of camphor and phthalic acid.
3. Qualitative Analysis of any one of the following Inorganic cations and anions by paper chromatography (Pb^{2+}, Cu^{2+}, Ca^{2+}, Ni^{2+}, Cl^-, Br^-, I^-, PO_4^{3-} and NO_3^-).

Course Outcomes :

CO1: To learn about ,How to Purify organic compounds by crystallisation(with alcohol and water), sublimation and distillation.

CO2: Able to prepare various organic compounds and also their derivatives.

CO3: To study the process of sublimation and crystallization of camphor and phthalic acid.

CO4: Able to analyze qualitatively inorganic cations and anions using paper chromatography.

Scheme of Practical Examination

Duration : 6 Hrs. (Two Session of Three Hours)

Distribution of Marks :

1. **Experiment 1** = **12 Marks**
2. **Experiment 2** = **12 Marks**
3. **Lab. Record** = **08 Marks**
4. **Viva-Voce** = **08 Marks**

B. Sc. (IIIrd Semester)

Paper-I (22BCHE-301-C) Inorganic Chemistry-III (Theory)

Credit : 2 **Total Marks =50**

Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section – A

Chemistry of d-Block elements

Definition of transition elements, position in the periodic table, General characteristic properties of d-Block elements, Comparison of properties of 3d elements with 4d and 5d elements with reference only to ionic radii, oxidation state, magnetic and spectral properties and stereochemistry. Stability of various oxidation states, Structure and properties of some compounds of transition elements- TiO_2, $VOCl_2$, $FeCl_3$, $CuCl_2$ and $Ni(CO)_4$.

Coordination Compounds

Werner's theory of coordination compounds, effective atomic number, chelates, nomenclature of coordination compounds, Isomerism in coordination compounds, valence bond theory of transition metal complexes.

Section – B

Chemistry of f-Block elements

Lanthanides: Electronic structure, oxidation states, magnetic properties, complex formation, colour, ionic radii and lanthanide contraction, occurrence, separation of lanthanides, Lanthanide compounds. Actinides: General characteristics of actinides, chemistry of separation of Np, Pu and Am from uranium, Transuranic elements, comparison of properties of Lanthanides and actinides with transition elements.

Course Outcomes :

CO1: Have good knowledge about d-block elements particularly of transition elements.

CO2: To study the comparison between 3d elements with 4d and 5d elements with reference to ionic radii, oxidation state, magnetic properties and spectral properties some compounds of transition elements.

CO3: To know about position of f block elements in periodic table and their general characteristics.

CO4: To study the occurrence and separation of lanthanides and lanthanide compounds.

CO5: Have knowledge of actinides their existence and general properties.

CO6: To compare the properties of Lanthanides and actinides with transition elements.

CO7: To know about the basic concepts of coordination chemistry like EAN, Werner theory of coordination and isomerism in coordination complexs.

Reference Books :

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. &Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry:Principles of Structure and Reactivity, Pearson Education India, 2006.
- Pradeep's inorganic chemistry, Volume II.
- R Chand, inorganic chemistry, Volume II.
- Modern publications,inorganic chemistry, Volume II.

B.Sc. IInd Year (IIIrd Semester)
Paper-II (22BCHE-302-C) Physical Chemistry-III (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each.

Section – A

Thermochemistry

Definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. pH determination using hydrogen electrode and quinhydrone electrode. Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

Section – B

Chemical Equilibrium

Equilibrium constant and free energy, concept of chemical potential. Thermodynamic derivation of the law of chemical equilibrium.Temperature dependence of equilibrium constant. Distinction between ΔG and ΔG^{o}, Le Chatelier's principle.Relationships between K_p, $K_c$and K_x for reactions involving ideal gases. Clausius–Clapeyron equation and its applications. Nernst distribution law and its applications.

Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics (Pb-Ag system only), desilverisation of lead.

Course Outcomes :

CO1: To know about the laws and concepts of chemical thermodynamics and their applications in thermochemical calculations.

CO2: To have knowledge about electrolytic concentration cells with and without transference and their EMF calculation, applications of the concept to determine liquid junction potential, pH determination using potentiometry and potentiometric titrations.

CO3: To understand the basic terms related to chemical equilibrium and derive the law thermodynamically, deduce relation between various equilibrium constants and determining partition coefficient of a solvent dissolved in two immiscible solvents.

CO4: To have good knowledge about fundamental concepts of phase equilibrium and their applications in studying one and two-component systems including eutectics.

Reference Books:

- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- B. R. Puri, Madan S. Pathania , L. R. Sharma*Principles of Physical Chemistry* Vishal Publications.
- Peter Atkins , Julio de Paula , James Keeler *Atkins' Physical Chemistry*, Oxford University Press.
- S.Glasstone, *An Introduction To Electrochemistry*, Affiliated East- West Press Pvt. Limited, New Delhi.
- S. Glasstone *Thermodynamics For Chemists.*

B.Sc. IInd Year (IIIrd Semester)
Paper-III (22BCHE-303-C) Organic Chemistry-III (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B(not more than 2-3 parts) carry 8 marks each**.**

Section – 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. UV spectra of conjugated enes and enones,Woodward-Fieser rules, calculation of λmax of simple conjugated dienes and αβ-unsaturated ketones (upto one DB extension).

Infrared (IR) absorption spectroscopy

Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds (Acetaldehyde, acetone, nitrobenzene, methylbenzoate, phenylacetate, aniline, phenol).

Amines

Structure and nomenclature of amines, physical properties. Separation of a mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines.

Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles, reductive amination of aldehydic and ketonic compounds. Gabriel phthalimide reaction, Hofmann bromamide reaction. Electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid.

Section – B

Diazonium Salts

Mechanism of diazotization, structure of benzene diazonium chloride, Replacement of diazo group by H, OH, F, Cl, Br, I, NO_2 and CN groups, reduction of diazonium salts to hydrazines and coupling reaction.

Aldehydes and Ketones

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, advantage of oxidation of alcohols with chromium trioxide (Sarett reagent) pyridinium chlorochromate (PCC) and pyridinium dichromate. Physical properties, Comparison of reactivities of aldehydes and ketones. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and

Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction. Oxidation of aldehydes, Baeyer– Villiger oxidation of ketones, Cannizzaro reaction. MPV, Clemmensen, Wolff-Kishner, $LiAlH_4$ and $NaBH_4$ reductions.

Enolates

Keto-enol tautomerism of ethyl acetoacetate, Acidity of α-hydrogens, alkylation of diethyl malonate (synthesis of butyric acid, isovaleric acid) and ethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation.

Course Outcomes:

CO1: Have knowledge of various absorption laws (Beer-Lambert law), molar absorptivity, analysis UV spectra and application of UV spectroscopy in structure elucidation.

CO2: Able To describe absorptions of various functional groups and applications of IR spectroscopy.

CO3: To synthesize and know reactions of amines.

CO4: To discuss synthetic application of diazonium salt.

CO5: Know about the preparation of aliphatic, aromatic aldehydes and ketones and various important name reactions of aldehydes and ketones.

CO6: Get knowledge about the acidity of α-hydrogens of diethyl malonate, ethyl acetoacetate and the synthesis and Keto-enol tautomerism of ethyl acetoacetate.

Reference Books:

- Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
- Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa (1998).
- Petrucci, R.H. *General Chemistry*, 5th Ed., Macmillan Publishing Co.: New York (1985).
- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Pradeep's organic chemistry, Volume II & III.
- R Chand, organic chemistry, Volume II & III.
- Modern publications, organic chemistry, Volume II & III.
- New Age International (P) Ltd, Publishers, Volume II.

B.Sc. IInd Year (IIIrd Semester)
Paper-IV (22BCHE-304-CL) Chemistry-III (Practical)

Credit : 2 **Total Marks =50**
Time : 6 Hrs. **(40 EM + 10 IA)**

1 Colorimetry:
To verify Beer - Lambert law for $KMnO_4$ /$K_2Cr_2O_7$ and determine the concentration of the given $KMnO_4$ /$K_2Cr_2O_7$ solution.

2 Preparations: Preparation of Cuprous chloride, tetra ammine cupric sulphate, chrome alum, potassium trioxalatochromate(III) and Nickel Hexammine chloride.

3 To determine the Critical Solution Temperature of phenol – water system.

4 To determine the solubility of benzoic acid at various temperatures and to determine the ▲H of the dissolution process.

5 To determine the enthalpy of neutralisation of a weak acid/weak base vs. strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.

6 To determine the enthalpy of solution of solid calcium chloride.

7 To study the distribution of Benzoic Acid between Benzene and water.

8 Determine rate constant of hydrolysis of ethyl acetate.

Course Outcomes:

CO1: To verify the Beer's lambert law using potassium permanganate and potassium dichromate and also quantitation of these analytes.

CO2: To prepare simple coordination complexes viz.Cuprous chloride, tetra-ammine cupric sulphate, chrome alum, potassium trioxalatochromate(III) and Nickel Hexammine chloride.

CO3: Able to find out critical solution temperature of phenol water system.

CO4: To determine the enthalpy of solution of calcium chloride enthalpy of neutralization and ionization using different combinations of acids and bases.

CO5: To perform hydrolysis of ethyl acetate and find out rate constant of the reaction.

Scheme of Practical Examination
Duration : 6 Hrs. (Two Session of Three Hours)
Distribution of Marks :

1. **Experiment 1 = 12 Marks**
2. **Experiment 2 = 12 Marks**
3. **Lab. Record = 08 Marks**
4. **Viva-Voce = 08 Marks**

B. Sc. II Year (IVth Semester)
Paper-I (22BCHE-401-C) Inorganic Chemistry-IV (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section – A (15 hrs.)

Metal- Ligand Bonding in Transition Metal complexes

Limitations of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal field parameters.

Thermodynamics and Kinetic Aspects of metal complexes

A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, Irving William Series, substitution reactions of square planer complexes of Pt[II], Trans effect.

Magnetic properties of Transition metal complexes

Types of magnetic materials, magnetic susceptibility, method of determining magnetic susceptibility, spin only formula, L-S coupling, correlation of μs and μeff values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.

Section –B (15 hrs.)

Electronic spectra of Transition metal complexes

Selection rules for d-d transition, spectroscopic ground states, spectrochemical series, orgel energy level diagram for d^1 and d^9 states, discussion of electronic spectrum of $[Ti(H_2O)_6]^{+3}$ complex ion.

Theory of Qualitative and Quantitative Analysis

Chemistry of analysis of various groups of basic and acidic radicals, chemistry of identification of acid radicals in typical combination, chemistry of interference of acid radicals including their removal in the analysis of basic radicals, common ion effect, solubility product, theory of precipitation, co-precipitation, post precipitation, purification of precipitates.

Course Outcomes :

CO1: To recapitulate the concept of valence bond theory and know the concept of crystal field theory with reference to splitting of d orbital's in octahedral, tetrahedral and square planar complexes and factors affecting the crystal field parameters.

CO2: To explain the factors responsible for the stability of coordination complexes and various substitution reactions of square planar complexes with reference to trans effect.

CO3: To study the magnetic properties of transition metal complexes and various types of magnetic materials and their magnetic susceptibility.

CO4: To explain the methods for the determination of magnetic susceptibility.

CO5: To apply the magnetic moment data for 3d metal complexes and study the selection rules for the d-d transitions.

CO5: Able to calculate the spectroscopic terms for various metal ions.

CO6: Have knowledge about orgal level diagrams for d^1 and d^9 electronic states and the electronic spectrum of $[Ti(H_2O)_6]^{+3}$complex ion.

Reference Books:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. &Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
- Pradeep's inorganic chemistry, Volume III.
- R Chand, inorganic chemistry, Volume III.
- Modern publications,inorganic chemistry, Volume III.
- Coordination chemistry by Ajai kumar, Aaryush publications, Delhi.

B. Sc. IInd Year (IVth Semester)
Paper II (22BCHE-402-C) Physical Chemistry-IV (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section – A

Quantum Mechanics-I

Black-body radiation, Planck's radiation law, photoelectric effect, postulates of quantum mechanics, quantum mechanical operators, Role of operators in quantum mechanics, commutation relations, Hamiltonian operator, Hermitian operator, average value of square of Hermitian as a positive quantity. Schrödinger equation (basic idea), Determination of wave function & energy of a particle in one dimensional box.

Introduction to Statistical Mechanics

Need for statistical thermodynamics, thermodynamic probability, Maxwell-Boltzmann distribution statistics, Born oppenheimer approximation, partition function and its physical significance.

Section – B

Spectroscopy

Introduction: Electromagnetic radiation, regions of spectrum, basic features of spectroscopy, statement of Born-Oppenheimer Approximation, Degrees of freedom.

Rotational Spectrum

Selection rules, Energy levels of rigid rotator (semi-classical principles), rotational spectra of diatomic molecules, spectral intensity distribution using population distribution (Maxwell-Boltzmann distribution), determination of bond length and isotopic effect.

Vibrational spectrum

Selection rules, Energy levels of simple harmonic oscillator, pure vibrational spectrum of diatomic molecules, determination of force constant and qualitative relation of force constant and bond energy, idea of vibrational frequencies of different functional groups.

Raman Spectrum

Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules, Quantum theory of Raman spectra. Give more stress on numerical problems of all spectroscopy.

Course Outcomes :

CO1: To know about dual characteristic of matter and extend this fact to obtain postulates of quantum mechanics and quantum-mechanical operators, apply Schrödinger equation to determine the physical observables for particle in a box.

CO2: To understand the need of statistical mechanics and Maxwell-Boltzmann distribution, partition function and its significance.

CO3: To have sound knowledge about the consequences of interaction of radiation with matter resulting into various types of spectra.

CO4: To be able to solve various numerical problems related to spectroscopy.

Reference Books:

- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- B. R. Puri, Madan S. Pathania, L. R. Sharma*Principles of Physical Chemistry* Vishal Publications.
- Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
- House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA(2004).
- Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).
- Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).
- Pradeep's physical chemistry, Volume III.
- R Chand, physical chemistry, Volume III.
- Modern publications, physical chemistry, Volume III.

B. Sc. IInd Year (IVth Semester)
Paper-III (22BCHE-403-C) Organic Chemistry-IV (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus,is compulsory. There will be four questions from section **A** andfour from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section.Question no.1 carry 8 marks and all questions in Section A & B(not more than 2-3 parts) carry 8 marks each**.**

Section – A

NMR Spectroscopy

Principle of nuclear magnetic resonance, the PMR spectrum,number of signals, peak areas, , magnetic equivalent and nonequivalent protons, positions of signals and chemical shift, shielding and deshielding of protons, proton counting, splitting of signals and coupling constant. Discussion of PMR spectra of the molecules: ethyl bromide, n-propyl bromide, isopropyl bromide, 1,1-dibromoethane, ethanol, acetaldehyde, ethyl acetate, toluene, benzaldehyde and acetophenone.

Organometallic Compounds

Grignard reagents: formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions. Reactions of Grignard and organolithium reagents with epoxides.

Section – B

Carbohydrates

Classification and nomenclature of Monosaccharides, mechanism of osazone formation, interconversion of glucose, fructose and mannose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Determination of ring size of glucose and fructose. Open chain and cyclic structure of D(+)-glucose & D(-) fructose. Mechanism of mutarotation. An introduction to disaccharides (maltose, sucrose and lactose; reducing and non-reducing) and polysaccharides (starch and cellulose) without involving structure determination.

Amino Acids and Peptides sequencing

Classification α-of amino acids. Acid-base behavior, isoelectric point, Preparation (Gabriel phlamide, Erlenmeyer azlactone, Strecker method) and properties of α-amino acids(ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test, Hydantoin formation), Structure and nomenclature of peptides, Peptide structure determination, end group analysis (DNFB, Edman thiohydantoin and carboxypeptidase method), selective hydrolysis of peptides.

Introduction to Heterocyclic Compounds

Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Comparison of basicity of pyridine, piperidine and pyrrole.

Course Outcomes:

CO1: Get knowledge about the principle of nuclear magnetic resonance and the PMR spectra of the

various molecules.

CO2: Brief description of organometallic compounds.

CO3: To have knowledge about classification, structures and important reactions of carbohydrates and amino acids.

CO4: Get knowledge aromatic behaviour and basicity of simple heterocyclic compounds.

Reference Books:

- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- C.N. Banwell: Fundamentals of Molecular Spectroscopy.
- Finar, I. L. *Organic Chemistry* (*Volume 2),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Berg, J.M., Tymoczko, J.L. &Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
- Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.*, W. H. Freeman.
- Berg, J.M., Tymoczko, J.L. &Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
- Pradeep's organic chemistry, Volume III.
- R Chand, organic chemistry, Volume III.
- Modern publications, organic chemistry, Volume III.
- New Age International (P) Ltd, Publishers Volume, I and III.

B. Sc. IInd Year (IVth Semester)
Paper-IV (22BCHE-404-CL) Chemistry-IV (Practical)

Credit : 2 **Total Marks =50**
Time : 6 Hrs. **(40 EM + 10 IA)**

1. Systematic identification (detection of extra elements, functional groups, determination of melting point or boiling point and preparation of at least one pure solid derivative) of the following simple mono and bifunctional organic compounds: Naphthalene, anthracene, acenaphthene, benzyl chloride, *p*-dichlorobenzene, *m*-dinitrobenzene, *p*-nitrotoluene, resorcinol, hydroquinone, -naphthol, -naphthol, benzophenone, ethyl methyl ketone, benzaldehyde, vanillin, oxalic acid, succinic acid, benzoic acid, salicylic acid, aspirin, phthalic acid, cinnamic acid, benzamide, urea, acetanilide, benzanilide, aniline hydrochloride, p-toluidine, phenyl salicylate (salol), glucose, fructose, sucrose, *o*-, *m*-, *p*-nitroanilines, thiourea.

2. **Gravimetric Analysis:**
   Quantitative estimations of, Cu^{2+} as copper thiocyanate, Ni^{2+} as Ni– dimethylglyoxime and Al^{3+} as oxinate.

Course Outcomes:

CO1: To identify extra elements present in various solid organic compounds.

CO2: Able to identify functional group present in organic compounds.

CO3: Able to measure melting point, solubility behaviour, pH range, flame testing etc. of organic Compounds.

CO4: To perform gravimetric analysis and also able to analyze quantitatively copper, nickel and aluminium in the given solution.

Scheme of Practical Examination
Duration : 6 Hrs. (Two Session of Three Hours)
Distribution of Marks :

1.	**Experiment 1**	**=**	**12 Marks**
2.	**Experiment 2**	**=**	**12 Marks**
3.	**Lab. Record**	**=**	**08 Marks**
4.	**Viva-Voce**	**=**	**08 Marks**

B. Sc. IIIrd Year (Vth Semester)
Paper-I (22BCHE-501-DSEC) (Heterocyclic and Photochemistry) (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carries 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each.

Section - A

Heterocyclic compounds

Recapitulation of concept of Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Comparison of basicity of pyridine, piperidine and pyrrole. Mechanism of nucleophilic substitution reactions in pyridine derivatives.Introduction to condensed five and six-membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of, quinoline and isoquinoline.

Section - B

Photochemistry:

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grotthus-Draper law, Stark-Einstein law (law of photochemical equivalence), 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), chemiluminescence. Brief introduction and description of photochemical reactions of simple carbonyl compounds, alkenes and aromatic compounds, Barton Reaction, Hofmann-Loffler-Freytag reaction.

Course Outcomes:

CO1: Knowledge about condensed five and six-membered heterocyclic rings, basicity of pyridine, piperidine and pyrrole and the preparation and reactions of indole, quinoline and isoquinoline.

CO2: Basic information of photochemistry and laws of photochemistry.

CO3: To learn about Phosphorescence and fluorescence.

Reference Books:

- Seymour, R. B. & Carraher, C.E. *Polymer Chemistry: An Introduction*, Marcel Dekker, Inc. New York, 1981.
- Odian, G. *Principles of Polymerization*, 4th Ed. Wiley, 2004.
- Billmeyer, F.W. *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.
- Ghosh, P. *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991.
- K. K. Rohatgi, Mukherjee,*Fundamentals of Photochemistry*, New Age International.
- Pradeep's organic chemistry, Volume III.
- R Chand, organic chemistry, Volume III.
- Modern publications, organic chemistry, Volume III.
- New Age International (P) Ltd, Publishers, Volume III.

B. Sc. IIIrd Year (Vth Semester)
Paper-II (22BCHE-502-DSEC) (Organomettalic Chemistry, Inorganic Polymers and Quantum Mechanics) (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. **Q.No.1**, based on the whole syllabus, is compulsory. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each.

Section – A

Organometallic chemistry

Definition, classification and nomenclature of organometallic compounds, preparation, properties and bonding of alkyls of Li, Al, Hg and Sn, concept of hapticity of organic ligand, Structure and bonding in metal-ethylenic complexes, Structure of Ferrocene, classification in metal carbonyls, preparation, properties and bonding in mononuclear carbonyls.

Silicones and Phosphazenes

Nomenclature, classification, prepration and uses of silicones, elastomers, polysiloxane copolymers, poly phosphazenes and bonding in triphosphazene.

Section – B

Quantum Mechanics-II

To show quantum mechanically that position and momentum cannot be predicated simultaneously, Extension of Schrödinger wave equation to two and three dimensional boxes, separation of variables, probability distribution, energy, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion:Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.

Rigid rotator model of rotation of diatomic molecules. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Course Outcomes :

CO1: To study the nomenclature, classification, preparation and bonding in organometallic compounds and of metal carbonyls also.

CO2: To know about various inorganic clusters compounds with special reference to silicones and phosphazenes.

CO3: To have sound knowledge about the concepts of dual nature of matter and its applications to obtain Schrödinger wave equation and angular momentum.

CO4: To solve Schrödinger equation for a particle present in various systems viz., two and three-dimensional boxes, harmonic oscillator and rigid rotator.

Reference books

- B. R. Puri, Madan S. Pathania , L. R. Sharma*Principles of Physical Chemistry* Vishal Publications.
- Chandra, A. K. *Introductory Quantum Chemistry*Tata McGraw-Hill (2001).
- House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA (2004).
- Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).
- Pradeep's organic chemistry, Volume II and III.
- R Chand, organic chemistry, Volume III.
- Modern publications, organic chemistry, Volume II and III.
- New Age International (P) Ltd, Publishers, Volume II and III.

B. Sc. IIIrd Year (Vth Semester)
Paper-III (22BCHE-503-DSECCL) (Chemistry Practical – V)

Credit : 2 **Total Marks =50**
Time : 6 Hrs. **(40 EM + 10 IA)**

Semimicro qualitative analysis of mixture containing not more than four radicals (excluding interfering, Combinations and insoluble's): Pb^{2+}, Hg^{2+}, Hg_2^{2+}, Ag+ , Bi_3 + , Cu^{2+}, Cd^{2+}, As^{3+}, Sb^{3+}, Sn^{2+}, Fe^{3+}, Cr^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, NH_4^+ ,CO_3^{2-} , S^{2-} , SO_3^{2-} , $S_2O_3^{2-}$, NO^{2-} , CH_3COO^- , Cl^- , Br^- , I^- , NO^{3-}, $SO4^{2-}$,$C_2O_4^{2-}$, PO_4^{3-},BO_3^{3-}

Thin Layer Chromatography
(Determination of Rf values and identification of organic Compounds) Separation of a mixture of coloured organic compounds using common organic solvents.

Find out the total dissolved solids present in given water sample.

Course Outcomes:

CO1: To analyze the given inorganic mixture qualitatively for various cations and anions present in them.

CO2: Able to determine Rf values.

CO3: Identification of organic compounds.

CO4: Able to perform thin layer chromatography to separate various components present in the Mixture and determination of TDS of water.

Scheme of Practical Examination

Duration : 6 Hrs. (Two Session of Three Hours)
Distribution of Marks :

1. **Experiment 1 = 12 Marks**
2. **Experiment 2 = 12 Marks**
3. **Lab. Record = 08 Marks**
4. **Viva-Voce = 08 Marks**

B. Sc. IIIrd Year (VIth Semester)

Paper-I (22BCHE-601-DSEC) Green Chemistry and Organic Polymers (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. Q.No.1, based on the whole syllabus, is compulsory. There will be four questions from section A and four from section B. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each.

Section – A

Green chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry.

Limitations/ Obstacles in the pursuit of the goals of Green Chemistry, Principles of Green Chemistry and Designing a Chemical synthesis, Twelve principles of Green Chemistry with their explanations and examples.

Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following: Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products , Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. Prevention/ minimization of hazardous/ toxic products reducing toxicity.

(Function) hazard × exposure; waste or pollution prevention hierarchy. Green solvents– water as a solvent for organic reactions, ionic liquids, PEG, solvent less processes, immobilized solvents and how to compare greenness of solvents.

Section – B

Organic Polymers

Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step growth polymerization.

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties). Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

Course Outcomes:

CO1: Know about the principle of green chemistry.

CO2: To apply the knowledge of green chemistry.

CO3: To know about basics of organic polymers and their applications.

Reference Books:

- Ahluwalia, V.K. & Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers (2005). Anastas, P.T. & Warner, J.K.: Green Chemistry - Theory and Practical, Oxford University Press (1998).
- Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).
- Cann, M.C. & Connely, M.E. Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
- Ryan, M.A.& Tinnesand, M. Introduction to Green Chemistry, American Chemical Society, Washington (2002).
- Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition, 2010.

B. Sc. IIIrd Year (VIth Semester)
Paper-II (22BCHE-602-DSEC) Nuclear Chemistry, Organosulphur Compounds and Catalysis (Theory)

Credit : 2 **Total Marks =50**
Time : 3 Hrs. **(40 EM + 10 IA)**

Note: Nine questions will be set. Q.No.1, based on the whole syllabus, is compulsory. There will be four questions from section A and four from section B. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carries 12 marks and all questions in Section A & B (not more than 2-3 parts) carry 12 marks each.

Section – A

Nuclear chemistry

Radioactivity, Rays from radioactive materials, radioactive disintegration, half-life period, radioactive equilibrium. Steady state, Theory of radioactivity, Carbon dating.

Nuclear fission, Calculation of energy released in nuclear fission, the fission chain reaction, The concept of critical mass, Nuclear fusion, Nuclear reactions, Radiation chemistry, Radiolysis of water, Nuclear reactor.

Radioactive isotopes, radiochemical principle in the use of tracers, applications of tracers in chemical investigations, physiochemical methods, analytical applications, age determinations, medical applications, agricultural applications.

Section – B

Organosulphur Compounds

Nomenclature, structural features, Methods of formation and chemical reactions of thiols,trioethers, sulphonic acids, sulphonamides and sulphaguanidine.

Catalysis

General characteristics of catalytic reactions, Acid-base catalysis, Enzyme catalysis, Michaelis-Menten equation, Effect of temperature on enzyme catalysis, Heterogeneous catalysis, Surface reactions, Kinetics of surface reactions, Unimolecular surface reactions, Bimolecular surface reactions, Effect of temperature on surface reactions, Autocatalysis and Oscillatory reactions.

Course Outcomes :

CO1: To know the basic concepts of nuclear chemistry and various processes occurs during the nuclear reactions.

CO2: Have knowledge about basic of catalysis and their related aspects.

CO3: To know about the types of organosulphur compounds and their studies.

Reference Books:

- Willard, H.H., Merritt, L.L., Dean, J. & Settle, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
- Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
- Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry, 6th Ed., Saunders College Publishing, Fort Worth (1992).
- Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman.
- Dean, J. A. Analytical Chemistry Notebook, Mc Graw Hill.

B. Sc. IIIrd Year (VIth Semester)
Paper-III (22BCHE-603-DSECCL) (Chemistry Practical – VI)

Credit : 2 **Total Marks =50**
Time : 6 Hrs. **(40 EM + 10 IA)**

1. To determine the strength of the given acid solution (mono acid only) conductometrically.
2. To determine the solubility and solubility product of a barium sulphateconductometrically.
3. To determine the strength of a given Ferrous ammonium sulphate solution potentiometrically.
4. To determine the molecular weight of a non-volatile solute by Rast method.
5. Preparation of acidic and basic buffers and comparison of their pH with theoretical values.
6. To determine the specific rotation of an optically active substance (any two).
7. Determination of Fructose/glucose ratio in honey sample.
8. Quantitation of protein (Casein) in milk/butter.
9. Synthesis of the following organic compounds:
   (a) To prepare m-nitroaniline from m-dinitrobenzene.
   (b) To prepare S-Benzyl-iso-thiouronium chloride from Thiourea.

Course Outcomes:

CO1: To perform conductometric titrations to find out strength of monobasic acid and also solubility and solubility product of a sparingly soluble salt.

CO2: Able to conduct the potentiometric titrations.

CO3: Can separate the binary liquid mixture using distillation.

CO4: Able to synthesize various organic compounds in the lab.

Scheme of Practical Examination

Duration : 6 Hrs. (Two Session of Three Hours)
Distribution of Marks :

1. **Experiment 1 = 12 Marks**
2. **Experiment 2 = 12 Marks**
3. **Lab. Record = 08 Marks**
4. **Viva-Voce = 08 Marks**