SYLLABUS FOR THE BATCH FROM YEAR 2023 TO YEAR 2026

B.A. / B.Sc.

(12+3 SYSTEM OF EDUCATION)

Chemistry

(Credit Based Grading System)

Examinations: 2023–26

GURU NANAK DEV UNIVERSITY AMRITSAR

B.A./B.Sc. (Semester System) (12+3 System of Education) (CBGS) *(Batch 2023-26)*
(Faculty of Sciences)

INDEX

B.A./B.Sc. (12+3 System of Education) *(Semester–I) (CBGS) (Batch 2023-26)*
(Faculty of Sciences)

SEMESTER–I

CHEMISTRY

(INORGANIC CHEMISTRY–I)

(THEORY)

Time: 3 Hrs. **Marks: 50**
Credits: 2-0-0 **30 Hrs.**

Instructions for the Paper Setters:-
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

I. Atomic Structure **7 Hrs.**

Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of ψ and ψ^2, quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s,p,d orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements and ions.

SECTION–B

II. Periodic Properties **8 Hrs.**

Position of elements in the periodic table; effective nuclear charge and its calculations. Atomic and ionic radii, ionization energy, electron affinity and electronegativity –definition, methods of determination or evaluation, trends in periodic table and applications in predicting and explaining the chemical behaviour.

SECTION–C

III. Chemical Bonding **8 Hrs**

Covalent Bond –Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridizationand shapes of simple inorganic molecules and ions. BeF_2, BF_3,CH_4, PF_5, SF_6, IF_7, $SnCI_2$, XeF_4, BF_4, $SnCl_6$, CO_3^{2-}, NO_3^-, NO_2^-, ClO_4^-, ClO_3^-, SO_4^{2-}. Valence shellelectron pair repulsion (VSEPR) theory to NH_3, H_3O^+, SF_4,CIF_3, ICl_2 and H_2O. MO theory, homonuclear (elements and ions of 1st and 2nd row), and heteronuclear (BO, CN^-, CO, NO^+, CO^+, CN) diatomic molecules, multicenter bonding in electron deficient molecule (Boranes). Percentage ionic character from dipole moment and electronegativity difference.

SECTION–D

IV. **Ionic Solids** **7 Hrs**

Concept of close packing, Ionic structures, (NaCI type, Zinc blende and Wurtzite, CaF_2 and antifluorite), radius ratio rule and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born–Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule. Metallic bond– free electron, valence bond and band theories.

Weak Interactions –Hydrogen bonding, vander Waals forces.

Books Suggested:-

1. Cotton, F.A., Wilkinson, G., Gaus, P.L., Basic Inorganic Chemistry; 3rd edition, Pubs: John Wiley Sons. 1995.
2. Lee, J.D., Concise Inorganic Chemistry; 4th edition, Pubs: Chapman Hall Ltd., 1991.
3. Shriver, D.E., Alkins, P.W., Langford, C.H., Inorganic Chemistry; 4th edition, Oxford Publisher: Oxford University Press, 2006.
4. Douglas, B. McDamiel, D., Alexander, J., Concepts and Models of Inorganic Chemistry; 3rd edition, Pubs: John Wiley and Sons Inc., 1994.
5. Miessler, G.L., Larr, D.A., Inorganic Chemistry; 3rd edition, Pubs: Pearson Education Inc., 2004.
6. Jolly, W.L., Modern Inorganic Chemistry; 2nd edition, Pubs: McGraw-Hill Publishing Company Limited, 1991.
7. Purcell, K.F., Kotz, J.C., Inorganic Chemistry; Pubs: W.B. Saunders Company, 1977.
8. Puri, B.R., Sharma, L.R., Kalia, K.C., Principles of Inorganic Chemistry; 30th edition, Pubs: Milestones Publisher, 2006-07.
9. University General Chemistry, C.N.R. Rao, Macmillan.
10. Inorganic Chemistry, W.W. Porterfield Addison-Wesley.
11. Inorganic Chemistry, A.G. Sharpe, ELBS.

B.A./B.Sc. (12+3 System of Education) *(Semester–I) (CBGS) (Batch 2023-26)*
(Faculty of Sciences)

SEMESTER–I

CHEMISTRY

(ORGANIC CHEMISTRY–I)

(THEORY)

Time: 3 Hrs. **Marks: 75**
Credits: 3-0-0 **45 Hrs.**

Instructions for the Paper Setters:-
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

I. Structure and Bonding (5 Hrs.)
Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bond, Vander Waals interactions, hydrogen bonding,
Electron displacement: resonance effect, hyperconjugation, Inductive and electrometric effects and their applications.

II. Mechanism of Organic Reactions (6 Hrs.)
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.
Reactive intermediates –Carbocations, carbanions, free radicals, carbenes, arenes and nitrenes (examples, formation and stability). Assigning formal charges on intermediates and other ionic species.

SECTION–B

III. Alkanes (4 Hrs.)
Isomerism in alkanes, sources, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey–House reaction and decarboxylation of carboxylic acids), physical properties and chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity.

IV. Alkenes and Alkynes (8 Hrs.)

Nomenclature of alkenes, methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides. The Saytzeff 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-demercuration, reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$.

Substitution at the allylic and vinylic positions of alkenes.

Alkyne: 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, metal-ammonia reductions, oxidation and polymerization.

SECTION–C

V. Alkyl Halides (7 Hrs.)

Nomenclature and classes of alkyl halides, chemical reactions. Mechanisms of nucleophilic substitution reaction of alkyl halides, SN_2 and SN_1 reactions with energy profile diagrams. Nucleophilic elimination reaction.

VI. Cycloalkanes: (5 Hrs.)

Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring : banana bonds.

SECTION–D

VII. Arenes and Aromaticity (10 Hrs.)

Aromaticity : the Huckel's rule, aromatic ions.

Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of benzene: Molecular formula and Kekule structure. Stability and carbon carbon bond lengths of benzene, resonance structure.

Aromatic electrophilic substitution–general pattern of the mechanism, role of σ and π complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, reactivity and orientation of disubstitution. Side chain reactions of benzene derivatives.

Methods of formation and chemical reactions of alkylbenzenes.

Books suggested:-

1. Solomons, T.W., Fryhle, C.B., Organic Chemistry; 9th edition, Pubs: Wiley India, 2007.
2. Wade Jr., L.G., Singh, M.S., Organic Chemistry; 6th edition, Pubs: Pearson education, 2008.
3. Fundamentals of Organic Chemistry, Solomons, John Wiley.
4. Introduction to Organic Chemistry, Sireitwieser, Heathcock and Kosover, Macmilan.

B.A./B.Sc. (12+3 System of Education) *(Semester–I) (CBGS) (Batch 2023-26)*
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SEMESTER–I

CHEMISTRY

(PRACTICAL)

Duration: 3½ Hrs. **Marks: 50**
Credits: 0-0-2 **6 Period/Week**

Inorganic Chemistry: Semi Micro analysis. Cation analysis, Separation and identification of ions from groups I, II, III, IV, V, and VI. Anionic analysis. Four ions with no interference.

Organic Chemistry Laboratory Techniques
Determination of Melting Point

Naphthalene 80–82^{o}C	Cinnamic acid 132.5–133^{o}C
Benzoic acid 121.5–122^{0}C	Salicylic acid 157.5–158^{o}C
Urea 132.5–133^{o}C	Acetanilide 113.5–114^{o}C
Succinic Acid 184.5–185^{o}C	m–dinitro benzene 90^{o}C
P–dichlorobenzene 52^{o}C	Aspirin 135^{o}C

Determination of Boiling Point

Ethanol 78^{o}C	Cyclohexane 81.4^{o}C,
Benzene–80^{o}C	Toluene 110°C

Practical Examination

1) Inorganic Mixture	25
2) Melting Point/Boiling point of organic substance	10
3) Viva–Voce	10
4) Note Book	05

Books Suggested:-

1. Vogel's Qualitative Inorganic Analysis, revised, Svehla, Orient Longman.
2. Experimental Inorganic Chemistry, W.G. Palmer, Cambridge. Standard Methods of Chemical. Analysis, W.W. Scott: The Technical Press.
3. Laboratory Manual in Organic Chemistry, R.K. Bansal, Wiley Eastern.
4. Vogel's Textbook of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, ELBS.
5. Experiments in General Chemistry, C.N.R. Rao and U.C. Aggarwal, East-West Press.

SEMESTER–II

CHEMISTRY

(INORGANIC CHEMISTRY–II)

(THEORY)

Time: 3 Hrs. **Marks: 75**
Credits: 3-0-0 **45 Hrs.**

Instructions for the Paper Setters:-
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

I. s–Block Elements–I **11 Hrs.**

General characteristics of group I elements: Atomic and ionic radii, Ionisation energies, Melting and boiling point, density, electropositive or metallic character, oxidation states, flame colouration, photoelectric effect, nature of compound, lattice energies.
Chemical properties: Action with air, action with hydrogen, action with water, solutions in liquid ammonia, reducing nature.
Anomalous Behaviour of lithium and its diagonal relationship with magnesium.

General characteristics of group II elements: Atomic and ionic radii, melting and boiling point, ionisation energy, electropositive character, flame coloration, tendency to form bivalent ions. Chemical properties: action with air, Combination with hydrogen, Action with water, Action with nitrogen, Formation of halides. Anomalous Behaviour of Beryllium and its diagonal relationship with Magnesium. Solvation and complexation tendencies of alkali metals and alkaline earth metals. Role of Alkali metals and alkaline earth metals.

II. Acids and Bases
Arrhenius, Bronsted-Lowry, the Lux-Flood, solvent system and Lewis concepts of acids and bases.

SECTION–B

III. p-Block Elements **11 hrs.**
Group 13:
General characteristics, Atomic and ionic radii, melting and boiling point, Ionisation energies, Oxidation states, Electropositive character, Tendency to form covalent compounds, **Compounds of group 13**: Hydrides, Oxides and hydroxidesm, Oxoacid; Boric acid: Preparation from Borax, Colemanite, Boron nitride.
Structure and Properties of Boric acid: Action of heat, Acidic nature. Reaction with ethyl alcohol, calcium fluoride and sulphuric acid.

Preparation, properties and structure of Diborane. Borazine: preparation, properties and structure. Boron halides: Relative strength of trihalides of Boron as lewis acids, Boron hydrides ($LiBH_4$,$NaBH_4$), Structural difference between trihalides of Boron and Aluminium, Anomalous behaviour of Boron and its diagonal relationship with Silicon.

Group 14

General characteristics; Atomic radii, Ionisation energies, Melting and boiling point, oxidation state, metallic character, catenation, Allotropy, Tendency to form multiple bonding.

Compounds of group 14: Hydrides of silicon its preparation and properties, toxic nature of CO, Dioxide of carbon and silicon (CO_2 & SiO_2). Comparison of carbon tetrachloride and silicon tetrachloride. Chemistry of Fullerenes

Group 15

General characteristics: Atomicradii, Ionisation energies, Electronegativity, Oxidation states, Metallic character, Catenation, Allotropy, Elemental state.

Compounds: Preparation, structure, comparative characteristics of hydrides of group 13 elements. Ammonia: Preparation by Haber's process, chemical properties

Hydrazine: Preparation by Raschig's process, chemical properties.

Hydrides of Phosphorus: its laboratory preparation, chemical properties and uses.

Oxides of nitrogen and phosphorus, Oxo acids of nitrogen and phosphorus (structure and basicity), Nitric acid: preparation By Ostwald's process and properties, halides of P

SECTION–C

IV.p–Block Elements-II **11 Hrs.**

Group 16

General characteristics: Atomic radii, Ionisation energies, Melting and boiling point, Electron affinity, Oxidation state, Catenation, Elemental state, Allotropy.

Compounds: Comparative characteristics of Hydrides of group 16, Chemical properties of SO_2, structure of SO_2 & SO_3, Oxoacid of sulphur: structure and basicity. Prpreparation of sulphuric acid by contacts process and its chemical properties

Group 17

General characteristics: Atomic radii, Ionisation energies, melting and boiling point, Electron affinity, Electronegativity, Nonmetallic character, colour, Oxidation state and reactivity

Compounds: Characteristics of hydrides of group 17, Relative acidic strength of hydro acids and Oxoacids of group 17, structure of interhalogen compounds and polyhalides.

Important compounds of p-block

Carbides, fluorocarbons, tetrasulphurtetranitride, Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.

SECTION–D

V. Chemistry of Transition Elements **12 Hrs.**

General characteristics of Transition Elements. Properties of the elements of the first transition series, Relative stability of their oxidation state. Coordination number and geometry.

General characteristics of elements of Second and Third Transition Series. Difference in the properties of first transition elements with second and third transition series elements in respect of ionic radii, oxidation states, magnetic behaviour.

Compounds of transition elements: TiO_2, $TiCl_4$, Peroxo compounds of chromium, chromyl chloride test, potassium permanganate, manganese dioxide, ring test for nitrate, Prussian blue and Turnbull's blue, difference between chromous acetate and copper acetate, sodium nitroprusside

Books Suggested:-

1. Cotton, F.A., Wilkinson, G., Gaus, P.L., Basic Inorganic Chemistry; 2nd edition, Pubs: John Wiley and Sons, 1995.
2. Lee, J.D., Concise Inorganic Chemistry; 4th edition, Pubs: Chapman & Hall Ltd., 1991.
3. Shriver, D.E., Atkins, P.W., Inorganic Chemistry; 4th edition, Pubs: Oxford University Press, 2006.
4. Douglas, B., Medaniel, D., Atenander, J., Concepts and Models of Inorganic Chemistry; 3rd edition, Pubs: John Wiley and Sons Inc., 1994,
5. Porterfeild, W.W., Wesky, A., Inorganic Chemistry; Pubs: Addison-Wesky Publishing Company, 1984.
6. Miessler, G.L., Tarr, D.A., Inorganic Chemistry; 3rd edition, Pubs: Pearson Education Inc., 2004,
7. Jolly, W.L., Modern Inorganic Chemistry; 2nd edition, Pubs: Tata McGraw-Hill Publishing Company Limited, 1991.
8. Purcell, K.F., Kotz, J.C., Inorganic Chemistry; Pubs: W.B. Saunders Company, 1977.
9. Puri, B.R., Sharma, L.R., Kalia, K.K., Principles of Inorganic Chemistry; 30th edition, Pubs: Milestones Publisher, 2006-07.
10. Inorganic Chemistry, W.W. Porterfield Addison-Wesley.
11. Inorganic Chemistry, A.G. Sharpe, ELBS.

SEMESTER–II

CHEMISTRY

(PHYSICAL CHEMISTRY–I)

(THEORY)

Time: 3 Hrs. **Marks: 50**
Credits: 2-0-0 **30 Hrs.**

Instructions for the Paper Setters:-
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Note: Log table and scientific calculators are allowed

SECTION–A

I. Gaseous States **7 Hrs.**

Postulates of kinetic theory of gases, deviation from ideal behaviour, Van der Waal's equation of state.
Critical Phenomena: PV isotherms of real gases, continuity of states, the isotherms of Van der Waal's equation, relationship between critical constants and Van der Waals constants, the law of corresponding states, reduced equation of state.
Molecular Velocities: Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquefaction of gases.

SECTION–B

II. Liquid State **8 Hrs.**
Intermolecular forces, surface tension and viscosity of liquids and its determination. Structure of liquids (a qualitative description). Structural differences between solids, liquids and gases.
Liquid crystals: Difference between liquids crystal, solid and liquid. Classification, structure of nematic and cholestric phases. Thermography and seven segment cell.

SECTION–C

III. Colloidal State **7 Hrs.**
Definition of colloids, classification of colloids. Solids in liquids (Sol): kinetic, optical and electrical properties, stability of colloids, protective action, Hardy Schulze law, gold number. Liquids in liquids (emulsions): Types of emulsions, preparation. Emulsifiers. General applications of colloids.

SECTION–D

IV. Solutions, Dilute Solutions and Colligative Properties 8 Hrs.

Ideal and non–ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, colligative properties, Raoult's law, Non-ideal system, azeotropes-HCl-H_2O and ethanol-water system.
Relative lowering of vapour pressure, molecular weight determination. Osmosis, Law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

Books Suggested:-

1. Atkins, P., Paula, J.de, Atkins Physical Chemistry; 8th edition, Pubs: Oxford University Press, 2008.
2. Puri, B.R., Sharma, L.R., Pathania, M.S., Principles of Physical Chemistry; 43rd edition, Pubs: Vishal Publishing Co., 2008.
3. Barrow, G.M., Physical Chemistry; 6th edition, Pubs: McGraw Hill Inc, 1996.
4. Rao, C.N.R., University General Chemistry; Pubs: Macmillan India, 1985.
5. Berry, R.S., Rice, S.A., Ross, J., Physical Chemistry; 2nd edition, Pubs: Oxford University Press, 2000.
6. Albert, R.A., Silbey, R.J., Physical Chemistry; 1st edition, Pubs: John Wiley & Sons Inc., 1992.
7. Dogra, S.K., Dogra, S., Physical Chemistry Through Problems; Pubs: Wiley Eastern Limited, 1991.
8. Levine, I.N., Physical Chemistry; 5th edition, Pubs: Tata McGraw Hill Publishing Co. Ltd., 2002.
9. Moore, W. J., Basic Physical Chemistry; Pubs: Prentice Hall of India Pvt. Ltd, 1983.
10. University General Chemistry, C.N.R. Rao, Macmillan.

B.A./B.Sc. (12+3 System of Education) *(Semester–II) (CBGS) (Batch 2023-26)*
(Faculty of Sciences)

SEMESTER–II

CHEMISTRY

(PRACTICAL)

Duration: 3½ Hrs. **Marks: 50**
Credits: 0-0-2 **6 Period/Week**

Crystalisation :

Concept of recrystalisation.

1. Phthalic acid from hot water (using fluted filter paper & stem less funnel)
2. Acetanilide from boiling water.
3. Naphthalene from Ethanol
4. Benzoic acid from water

Physical Chemistry

1. To determine the specific reaction rate of hydrolysis of ethyl acetate catalysed by Hydrogen ions at room temperature.
2. To study the effect of acid strength on hydrolysis of an ester.

Viscosity, Surface Tension (Pure Liquids) and thermochemistry

3. To study the viscosity and surface tension of Sucrose glycerine solution in water.
4. To determine the enthalpy of neutralisation of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.
5. To determine the enthalpy of dissolution of Potassium Chlorate/Calcium chloride and calculate the lattice energy of Potassium Chlorate from its enthalpy data using Born Haber cycle.

Practical Examination:

Marks

1)	Crystalisation	10
2)	Physical Experiment	25
3)	Viva–Voce	10
4)	Note Book	05

Books Suggested:-

1. Experimental Organic Chemistry, Vol. I & II, P.R. Singh, D.S. Gupta and K.S. Bajpai, Tata McGraw Hill.
2. Laboratory Manual in Organic Chemistry, R.K. Bansal, Wiley Eastern.
3. Vogel's Textbook of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, ELBS.
4. Experiments in General Chemistry, C.N.R. Rao and U.C. Aggarwal, East-West Press.
5. Experiments in Physical Chemistry, R.C. Das and B. Behra, Tata McGraw Hill.
6. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing House.
7. Advanced Experimental Chemistry, Vol. I, Physical, J.N. Guru and R. Kapoor, S. Chand & Co.
8. Selected Experiments in Physical Chemistry, N.G. Mukherjee, J.N. Ghosh & Sons.
9. Experiments Physical Chemistry, J.C. Ghosh, Bharati Bhavan.

SEMESTER–III

CHEMISTRY

ORGANIC CHEMISTRY–II

(THEORY)

Time: 3 Hrs. **Marks: 50**
Credits: 2-0-0 **30 Hrs.**

Instructions for the Paper Setters:-
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

I. Stereochemistry Organic Compounds **(8 Hrs.)**

Concept of isomerism. Types of isomerism.
Optical isomerism- elements of symmetry, molecular chirality, enantiomers, stereogeniccentre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogeniccentres, diastereomers, threo and erythrodiasteremers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature.
Geometric isomerism–determination of configuration of geometric isomers. E & Z system of nomenclature.

SECTION–B

II. Isomerism **(7 Hrs.)**

Conformational isomerism–conformational analysis of ethane and n–butane; conformation of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivatives. Newman projection and Sawhorse formulae, Fischer and flying wedge formulae. Difference between configuration and conformation.

III. Alcohols

Classification and nomenclature. Monohydric alcohols—nomenclature. Acidic nature. Reactions of alcohols, cleavage of O-H bond, C-O bond and dehydration reactions, regioselectivity of dehydration. Dihydric alcohols—nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAC)_4$] and [HIO_4] and pinacol-pinacolone rearrangement.

SECTION–C

IV. Phenols **(8 Hrs.)**

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, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Reimer Tiemann reaction.

V. Preparation of 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, synthesis of aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids.

SECTION–D

VI. Properties of Aldehydes and Ketones (7 Hrs.)

Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Witting reaction. Mannich reaction. Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-Villiger oxidation of Ketones, Cannizzaro reaction. MPV, Clemmensen, Wolff-Kishner, $LIAIH_4$ and $NaBH_4$ reductions. Halogenation of enolizable ketones.

Coupling reaction using Transition metal/metal complexes (formation of C-C bonds): concept of Homo and Cross coupling reactions with emphasis on Glaser reaction, Ullman reaction, Sonogashira, Suzuki, Hiyama, Negishi and Kumada coupling reactions.

Books Suggested:-

1. Morrison, R.T., Boyd, R.N., Organic Chemistry; 6th edition, Pubs: Prentice-Hall, 1992.
2. Wade Jr., L.G., Singh, M.S., Organic Chemistry; 6th edition, Pubs: Pearson Education, 2008.
3. Mukherji, S.M., Singh, S.P., Kapoor, R.P., Organic Chemistry; Pubs: Wiley Eastern Limited, 1985, Vol. I, II, III.
4. Solomons, T.W., Fryhle, C.B., Organic Chemistry; 9th edition, Pubs: Wiley India, 2007.
5. Carey, F.A., Organic Chemistry; 4th edition, Pubs: McGraw-Hill, 2000.
6. Streitwieser, A., Clayton, Jr., Heathcock, H., Introduction to Organic Chemistry; 3rd edition, Pubs: Macmillan Publishing Company, 1989.
7. University General Chemistry, C.N.R. Rao, Macmillan.

SEMESTER–III

CHEMISTRY

PHYSICAL CHEMISTRY–II

(THEORY)

Time: 3 Hrs. **Marks: 75**
Credits: 3-0-0 **45 Hrs**

Instructions for the Paper Setters:-
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

I. Thermodynamics-I **11 Hrs.**
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.
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.

SECTION–B

II. Thermochemistry: **12 Hrs.**
Standard state, types of enthalpy of reactions, 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 and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchhoff's equation.

III. Thermodynamics-II
Second Law of Thermodynamics: Need for the law, different statements of the 2^{nd}law, Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature.
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, Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases.

SECTION–C

IV. Thermodynamics-III **11 Hrs.**
Third Law of Thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions; Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P,V and T.

Equilibrium

V. Chemical Equilibrium

Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Determination of K_p, K_c, $K_a$and their relationship, Clausius-Clapeyron equation, applications.

SECTION–D

VI. Introduction to Phase Equilibrium 11 Hrs.

Statement and meaning of the terms-phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibria of one component system-water, CO_2 and S systems. Phase equilibria of two component systems-solid-liquid equilibria, simple eutectic-Bi-Cd, Pb-Ag systems, desilverisation of lead. Solid solutions-compound formation with congruent melting point (Mg-Zn) and incongruent melting point, NaCl-H_2O, $FaCl_3$-H_2O and $CuSO_4$-H_2O system. Freezing mixtures, acetone-dry ice.

Partially miscible liquids Phenol-water, triethylamine-water, Nicotine-water System. Lower and upper consulate temperature, Effect of impurity on consolute temperature, immiscible liquids, steam distillation.

Nernst distribution law-thermodynamic derivation and applications.

Books Suggested:-

1. Atkins, P., Paula, J.de, Atkins Physical Chemistry; 8th edition, Pubs: Oxford University Press, 2008.
2. Puri, B.R., Sharma, L.R., Pathania, M.S., Principles of Physical Chemistry; 43rd edition, Pubs: Vishal Publishing Co., 2008.
3. Barrow, G.M., Physical Chemistry; 6th edition, Pubs: McGraw Hill Inc, 1996.
4. Rao, C.N.R., University General Chemistry; Pubs: Macmillan India, 1985.
5. Berry, R.S., Rice, S.A., Ross, J., Physical Chemistry; 2nd edition, Pubs: Oxford University Press, 2000.
6. Albert, R.A., Silbey, R.J., Physical Chemistry; 1st edition, Pubs: John Wiley & Sons Inc., 1992.
7. Dogra, S.K., Dogra, S., Physical Chemistry Through Problems; Pubs: Wiley Eastern Limited, 1991.
8. Levine, I.N., Physical Chemistry; 5th edition, Pubs: Tata McGraw Hill Publishing Co. Ltd., 2002.
9. Moore, W. J., Basic Physical Chemistry; Pubs: Prentice Hall of India Pvt. Ltd, 1983.
10. Metz, C.R., Theory and Problems of Physical Chemistry; Schaum's outline series, 2nd edition, Pubs: McGraw-Hall Book company, 1989.

SEMESTER–III

CHEMISTRY

(PRACTICAL)

Duration: 3½ Hrs. **Marks: 50**
Credits: 0-0-2 **6 Period/Week**

Quantitative Analysis
Volumetric Analysis

a. Determination of acetic acid in commercial vinegar using NaOH.
b. Determination of alkali content-antacid tablet using HCI.
c. Estimation of calcium content in chalk as calcium oxalate by permanganometry.
d. Estimation of hardness of water by EDTA.
e. Estimation of ferrous and ferric by dichromate method.
f. Estimation of copper using sodiumthiosulphate.

Gravimetric Analysis

Analysis of Cu as CuSCN and Ni as Ni (dimethylgloxime)

Organic Chemistry Laboratory Techniques
Thin Layer Chromatography

Determination of Rf values and identification of organic compounds.
a. Separation of green leaf pigments (spinach leaves may be used).
b. Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5).

Practical Examination

1) Volumetry / Gravimetry	25
2) Thin Layer chromatography	10
3) Viva-Voce	10
4) Note Book	05

Books Suggested:-

1. Vogel's Textbook of Quantitative Inorganic Analysis (revised), J. Bassett, R.C. Denney, G.H. Jeffery and J. Mandham, ELBS.
2. Standard Methods of Chemical. Analysis, W.W. Scott: The Technical Press.
3. Experimental Inorganic Chemistry, W.G. Palmer, Cambridge.
4. Laboratory Manual in Organic Chemistry, R.K. Bansal, Wiley Eastern.
5. Vogel's Textbook of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, ELBS.
6. Experiments in General Chemistry, C.N.R. Rao and U.C. Aggarwal, East-West Press.
7. Experimental Organic Chemistry, Vol. I & II, P.R. Singh, D.S. Gupta and K.S. Bajpai, Tata McGraw Hill.

B.A./B.Sc. (12+3 System of Education) *(Semester–IV) (CBGS) (Batch 2023-26)*
(Faculty of Sciences)

SEMESTER–IV

CHEMISTRY

INORGANIC CHEMISTRY–III

(THEORY)

Time: 3 Hrs. **Marks: 75**
Credits: 3-0-0 **45 Hrs**

Instructions for the Paper Setters:-
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

I. Coordination Compounds **11 Hrs.**

Nomenclature of coordination compounds, Werner's coordination theory and its experimental verification, effective atomic number, polydentate, chelating ligands and chelation, factors affecting stability of chelates, structural and stereoisomerism in coordination compounds with co-ordination number 4 and 6, resolution of racemic mixture, Valence bond theory of transition metal complexes, hybridization and geometry of complexes of Cr ions, Fe and its ions, Co^{3+}, Ni and its ions, Cu^{2+}. Magnetic properties and colour of coordination compounds. Application of coordination compounds.

SECTION–B

II. Non-aqueous Solvents **12 Hrs.**

Physical properties of a solvent and their role in chemical reaction. Types of solvents and their general characteristics, types of reactions in non-aqueous solvents. Characteristics properties and reactions of liquid NH_3 and liquid SO_2 as non-aqueous solvents.

III. Oxidation and Reduction

Oxidation-reduction as electron transfer reaction, oxidation number, redox reactions, Use of redox potential data (electrochemical series), analysis of redox cycle, redox stability in water, brief description and uses of Frost, Latimer and Pourbaix diagrams.

SECTION–C

IV. Chemistry of Lanthanide Elements **11 Hrs.**

Electronic structure, general charaters of lanthanide, oxidation states, magnetic properties, atomic and ionic radii, lanthanide contraction, cause and consequences. Methods of separation of lanthanide from each other, Electronic absorption and uses of lanthanides.

V. Chemistry of Actinides

General features and chemistry of actinides, Electronic and magnetic properties of actinides and their general comparison with the lanthanide elements, similarities between the later actinides and the later lanthanides. Use as nuclear fuel, transuranic elements.

SECTION–D

VI. Bioinorganic Chemistry **11 Hrs.**

Essential and trace elements in biological processes, essential bulk elements and their role in biological processes. Metalloporphyrins with special reference to haemoglobin and myoglobin. Role and function of haemoglobin and myoglobin. Chemistry of transfer of O_2 and CO_2. Biological role of alkali (Na^+& K^+) and alkaline earth metal ions with special reference to Ca^{2+} and Mg^{2+}. Importance of trace elements in biology.

Books Suggested:

1. Cotton, F.A., Wilkinson, G., Gaus, P.L., Basic Inorganic Chemistry; 3rd edition, Pubs: John Wiley Sons. 1995.
2. Lee, J.D., Concise Inorganic Chemistry; 4th edition, Pubs: Chapman Hall Ltd., 1991.
3. Shriver, D.E., Atkins, P.W., Langford, C.H., Inorganic Chemistry; 4th edition, Oxford Publisher: Oxford University Press, 2006.
4. Douglas, B. McDaniel, D., Alexander, J., Concepts and Models of Inorganic Chemistry; 3rd edition, Pubs: John Wiley and Sons Inc., 1994.
5. Porterfield, W.W., Wesley, A., Inorganic Chemistry; Pubs: Addison-Wesley Publishing Company, 1984.
6. Miessler, G.L., Larr, D.A., Inorganic Chemistry; 3rd edition, Pubs: Pearson Education Inc., 2004.
7. Jolly, W.L., Modern Inorganic Chemistry; 2nd edition, Pubs: McGraw-Hill Publishing Company Limited, 1991.
8. Purcell, K.F., Kotz, J.C., Inorganic Chemistry; Pubs: W.B. Saunders Company, 1977.
9. Puri, B.R., Sharma, L.R., Kalia, K.C., Principles of Inorganic Chemistry; 30th edition, Pubs: Milestones Publisher, 2006-07.
10. Inorganic Chemistry, W.W. Porterfield Addison-Wesley.
11. Inorganic Chemistry, A.G. Sharpe, ELBS.
12. University General Chemistry, C.N.R. Rao, Macmillan.

B.A./B.Sc. (12+3 System of Education) *(Semester–IV) (CBGS) (Batch 2023-26)*
(Faculty of Sciences)

SEMESTER–IV

CHEMISTRY

ORGANIC CHEMISTRY–III

(THEORY)

Time: 3 Hrs. **Marks: 50**
Credits: 2-0-0 **30 Hrs**

Instructions for the Paper Setters:-
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

I. Carboxylic Acids **(8 Hrs.)**
Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation.

II. Carboxylic Acids Derivatives
Structure and nomenclature of acid chlorides, esters, amides and acid anhydrides, Relative stability & reactivity 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).

SECTION–B

III. Ethers and Epoxides **(8 Hrs.)**
Nomenclature of ethers and methods of their formation, physical properties. Chemical reaction-cleavage and autoxidation, Ziesel's method. Synthesis of epoxides. Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxiedes.

IV. Heterocyclic Compounds
Introduction: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.

SECTION–C

V. Organic Compounds of Nitrogen (7 Hrs.)

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes, Mechanisms of nucleophilc substitution in nitroarenes and their reduction in acidic, neutral and alkaline media. Reactivity, Structure and nomenclature of amines, Methods of preparation of amines by Reductive amination of aldehydic and ketonic compounds, Gabriel-phthalimide reaction and Hofmann bromamide reaction. 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.

SECTION–D

VI. Organometallic Compounds (7 Hrs.)

Organomagnesium Compounds: The Grignard reagents formation, structure and chemical reactions.

Organolithium Compounds: Formation and chemical reactions.

Organozinc and Organo copper Compounds: Nomenclature, structural features, Methods of formation and chemical reactions.

Book Suggested:-

1. Morrison, R.T., Boyd, R.N., Organic Chemistry; 6th edition, Pubs: Prentice-Hall, 1992.
2. Wade Jr., L.G., Singh, M.S., Organic Chemistry; 6th edition, Pubs: Pearson Education, 2008.
3. Mukherji, S.M., Singh, S.P., Kapoor, R.P., Organic Chemistry; Pubs: Wiley Eastern Limited, 1985, Vol. I, II, III.
4. Solomons, T.W., Fryhle, C.B., Organic Chemistry; 9th edition, Pubs: Wiley India, 2007.
5. Carey, F.A., Organic Chemistry; 4th edition, Pubs: McGraw-Hill, 2000.
6. Streitwieser, A., Clayton, Jr., Heathcock, H., Introduction to Organic Chemistry; 3rd edition, Pubs: Macmillan Publishing Company, 1989.
7. Introduction to Organic Chemistry, Sireitwieser, Heathcock and Kosover, Macmilan.

SEMESTER–IV

CHEMISTRY

(PRACTICAL)

Duration: 3½ hrs. **Marks: 50**
Credits: 0-0-2 **6 Period/Week**

Qualitative Analysis
Detection of elements (N, S and halogens)
Detection of functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds. Conformation of compound by melting/boiling point and preparation its derivatives.

Practical Examination

1) Detection of Elements	10
2) Detection of functional group, melting point& derivative preparation	25
3) Viva-Voce	10
4) Note Book	05

Book Suggested:-

1. Experimental Organic Chemistry, Vol. I & II, P.R. Singh, D.S. Gupta and K.S. Bajpai, Tata McGraw Hill.
2. Laboratory Manual in Organic Chemistry, R.K. Bansal, Wiley Eastern.
3. Vogel's Textbook of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, ELBS.
4. Experiments in General Chemistry, C.N.R. Rao and U.C. Aggarwal, East-West Press.

B.A./B.Sc. (12+3 System of Education) *(Semester–V) (CBGS) (Batch 2023-26)*
(Faculty of Sciences)

SEMESTER–V

CHEMISTRY

(INORGANIC CHEMISTRY–IV)

(THEORY)

Time: 3 Hrs. **Marks: 50**
Credits: 2-0-0 **30 Hrs**

Instructions for the Paper Setters:-
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

1. Metal-ligand Bonding in Transition Metal Complexes (8 Hrs)
Limitations of valence bond theory, an elementary idea of crystalfield theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, crystal field stabilization energy for d-orbital electrons in tetrahedral and octahedral complexes, Spectrochemical series, factors affecting the crystalfield parameters, Structural and Thermodynamic effects of inner orbital splittings, Jahn-Teller effects.

SECTION–B

2. Magnetic Properties of Transition Metal Complexes (8 Hrs)
Types of magnetic behaviour, methods of determining magnetic susceptibility by Gouy's and Faraday method. Variation of magnetic susceptibility with temperature, ferromagnetic and antiferromagnetic substances, spin-only formula. L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for characterization of 3d-metal complexes. Temperature independent paramagnetism, anomalous magnetic moment, paramagnetic and diamagnetic equilibrium.

3. Thermodynamic and Kinetic Aspects of Metal Complexes
A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, Nucleophilic Substitution reactions in square planar complexes: rate law, Trans- effect, Mechanism of nucleophilic substitution in square planar complexes.

SECTION–C

4. Electronic Spectra of Transition Metal Complexes (7 Hrs)
Term symbols and coupling scheme, LS coupling, calculation of ground term state, microstates, Types of electronic transitions, selection rules and relaxations, splitting of Russel-Saunder states in octahedral and tetrahedral, spectrochemical series, Orgel diagram of one electron-one hole system (d^1, d^4, d^6 & d^9) and two electron-two hole system (d^2, d^3, d^7 & d^8) in octahedral and tetrahedral complexes.
Study of electronic transition in Cr^{3+} (octahedral), Co^{2+} (octahedral & tetrahedral), Mn^{2+} (octahedral), Ni^{2+} (octahedral) complexes. Limitation of Orgel diagram.

SECTION–D

5. Organometallic Compounds: (7 Hrs)

Definition, nomenclature and classification of organometallic compounds. σ and π complexes, types of organoligands, EAN rule, bonding in organometals,

Preparation, properties, bonding and applications of alkyllithium and organoaluminium compounds (AlR_3).Metal olefin complexes, bonding in metal-ethylenic complexes, Mechanism of homogeneous hydrogenation reactions of alkene. Metal carbonyls: examples and bonding.

Books Suggested:-

1. Cotton, F.A., Wilkinson, G., Gaus, P.L., Basic Inorganic Chemistry; 3rd edition, Pubs: John Wiley Sons. 1995.
2. Lee, J.D., Concise Inorganic Chemistry; 4th edition, Pubs: Chapman Hall Ltd., 1991.
3. Shriver, D.E., Alkins, P.W., Langford, C.H., Inorganic Chemistry; 4th edition, Oxford Publisher: Oxford University Press, 2006.
4. Douglas, B. McDamiel, D., Alexander, J., Concepts and Models of Inorganic Chemistry; 3rd edition, Pubs: John Wiley and Sons Inc., 1994.
5. Porterfield, W.W., Wesley, A., Inorganic Chemistry; Pubs: Addison-Wesley Publishing Company, 1984.
6. Miessler, G.L., Larr, D.A., Inorganic Chemistry; 3rd edition, Pubs: Pearson Education Inc., 2004.
7. Jolly, W.L., Modern Inorganic Chemistry; 2nd edition, Pubs: McGraw-Hill Publishing Company Limited, 1991.
8. Purcell, K.F., Kotz, J.C., Inorganic Chemistry; Pubs: W.B. Saunders Company, 1977.
9. Puri, B.R., Sharma, L.R., Kalia, K.C., Principles of Inorganic Chemistry; 30th edition, Pubs: Milestones Publisher, 2006-07.
10. Inorganic Chemistry, W.W. Porterfield Addison-Wesley.
11. Inorganic Chemistry, A.G. Sharpe, ELBS.

B.A./B.Sc. (12+3 System of Education) *(Semester–V) (CBGS) (Batch 2023-26)*
(Faculty of Sciences)

SEMESTER–V

CHEMISTRY

(PHYSICAL CHEMISTRY–III)

(THEORY)

Time: 3 Hrs. **Marks: 75**
Credits: 3-0-0 **45 Hrs**

Instructions for the Paper Setters:-
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

1. Electrochemistry – I **(12 hrs.)**

Conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution, Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only).
Migration of ions, Transport number: definition and determination by Hittorf method and moving boundary method, factors affecting transport number.
Applications of conductivity measurements: determination of degree of dissociation, determination of Ka of acids, determination of solubility product of sparingly soluble salt, conductometric titrations.

Electrolytic and Galvanic cells-reversible and irreversible cells, conventional representation of electrochemical cells.Standard electrode potential, standard hydrogen electrode, reference electrodes, sign conventions, electrochemical series and its significance. Nernst equation, derivation of cell E.M.F. and single electrode potential. EMF of a cell and its measurements. Calculation of thermodynamic quantities of cell reactions (ΔG,ΔH and K).
Types of reversible electrodes: gas- metal ion, metal ion, metal insoluble salt-anion and redox electrodes. Electrode reactions. EMF of reversible electrodes.

SECTION–B

2. Electrochemistry – II **(11 Hrs.)**

Polarization, over potential, hydrogen overvoltage and its application. Concept of activities and activity coefficient.
Concentration cells with and without transference, liquid junction potential, application of concentration cells, valency of ions, solubility product and pH determination, potentiometric titrations.

3. Nuclear Chemistry

Introduction: Radioactivity, Nuclear Structure, Size of Nucleus, Mass Defects and Binding Energy, Nuclear Stability, Nuclear Forces, Nuclear Spin and Moments of Nuclei, Nuclear Models, Nuclear Decay Processes, The Laws of Radioactive Decay, Soddy-Fajans Group Displacement Law, Rate of Nuclear Decay and Half Life Time (Kinetics of Radioactive Decay), Induced Nuclear Reactions, Types of Nuclear Processes, High Energy Nuclear Reactions, Nuclear Reaction Cross-Section, Artificial radioactivity, Detection and Measurement of Radioactivity, Nuclear Fission, Nuclear Fusion, Applications of Radioactivity.

SECTION–C

4. Spectroscopy (11 Hrs.)

Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom.

5. Rotational Spectrum

Diatomic molecules. Energy levels of a rigid rotor (semi classical principles), selection rules, spectral intensity and position of lines, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect.

SECTION–D

6. Vibrational Spectrum (11 Hrs.)

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, vibration-rotation spectra, P, Q and R branches, structural information from IR spectra, 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, O, Q and S branches. Comparison with IR spectra.

7. Electronic Spectrum

Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck-Condon principle. Qualitative description of σ, π, and n M.O., their energy levels and the respective transitions.

Books Suggested:-

1. Atkins, P., Paula, J.de, Atkins Physical Chemistry; 8th edition, Pubs: Oxford University Press, 2008.
2. Berry, R.S., Rice, S.A., Ross, J., Physical Chemistry; 2nd edition, Pubs: Oxford University Press, 2000.
3. Albert, R.A., Silbey, R.J., Physical Chemistry; 1st edition, Pubs: John Wiley & Sons Inc., 1992.
4. Levine, I.N., Physical Chemistry; 5th edition, Pubs: Tata McGraw Hill Publishing Co. Ltd, 2002.
5. Moore, W. J., Basic Physical Chemistry; Pubs: Prentice Hall of India Pvt. Ltd, 1983.
6. Metz, C.R., Theory and problems of Physical Chemistry; Schaum's outline series, 2nd edition, Pubs: McGraw-Hall Book Company, 1989.
7. W. Kemp, "Organic Spectroscopy".
8. C.N. Banwell "Fundamentals of Molecular Spectroscopy".
9. D.L. Pavia, G.M. Lampan and G. S. Kriz, Introduction to Spectroscopy" Hartcourt College Publishers, 2001

SEMESTER–V

CHEMISTRY

(PRACTICAL)

Duration: 3½ Hrs. **Marks: 50**
Credits: 0-0-2 **6 Period/week**

(I) Synthesis and Analysis

(a) Preparation of Sodium trioxalatoferrate (III)
(b) Preparation of Ni-DMG Complex
(c) Preparation of Copper tetrammine complex
(d) Preparation of cis-bisoxalatodiaquachromate (III) ion

(II) Physical Chemistry

(a) Conductometric Titrations

(i) Determine the end point of the following titrations by the conductometric methods.
Strong acid-Strong base
Weak acid-Strong base
(ii) Determine the composition of a mixture of acetic acid and the hydrochloric acid by conductometric titration.

(b) Molecular Weight Determination of acetanilide, napthalane, using camphor as solvent **(Rast's methods).**

(c) pH metric titration :

(i) strong acid with strong base,
(ii) weak acid with strong base and determination of dissociation constant of a weak acid.

(d) Phase Equilibria to determine the distribution coefficient of iodine between CCI_4 and water.

(e) **Refractometry**

(i) Determination of refractive index of a liquid by Abbe refractometer, and hence the specific and molar refraction.
(ii) To determine the composition of unknown mixture of two liquids by refractive index measurements.

Practical Examination

1) Inorganic Synthesis	15
2) Physical experiment	20
3) Viva- Voce	10
4) Note Book	05

Books Suggested:-

1. Experimental Inorganic Chemistry, W.G. Palmer, Cambridge.
2. Handbook of preparative Inorganic Chemistry, Vol. I & II, Brauer, Academic Press.
3. Inorganic Synthesis, McGraw Hill.
4. Experiments in General Chemistry, C.N.R. Rao and U.C. Aggarwal, East-West Press.
5. Experiments in Physical Chemistry, R.C. Das and B. Behra, Tata McGraw Hill.
6. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing House.
7. Advanced Experimental Chemistry, Vol. I, Physical, J.N. Guru and R. Kapoor, S. Chand & Co.
8. Selected Experiments in Physical Chemistry, N.G. Mukherjee, J.N. Ghosh & Sons.
9. Experiments Physical Chemistry, J.C. Ghosh, Bharati Bhavan.

B.A./B.Sc. (12+3 System of Education) *(Semester–VI) (CBGS) (Batch 2023-26)*
(Faculty of Sciences)

SEMESTER–VI

CHEMISTRY

ORGANIC CHEMISTRY– IV

(THEORY)

Time: 3 Hrs. **Marks: 75**
Credits: 3-0-0 **45 Hrs**

Instructions for the Paper Setters:-
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

1. Spectroscopy (12 hrs.)
Nuclear Magnetic Resonance (NMR) spectroscopy.
Magnetic properties of nuclei, Principle of NMR, Proton Magnetic Resonance (1HNMR) spectroscopy, equivalent and non-equivalent protons, nuclear shielding and deshielding, choosing solvent, chemical shift and factors affecting chemical shift, spin-spin splitting, areas and peak intensity of signals, Application of PMR, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone.

2. Electromagnetic Spectrum: Absorption Spectroscopy-I
Infrared (IR) Absorption spectroscopy – Introduction and principle of IR spectroscopy, Hooke's law, Fundamental vibrations, Selection rules, intensity and IR bands, factors affecting vibration frequencies, characteristic absorption of various function groups, interpretation of IR spectra of simple organic compounds.

SECTION–B

3. Electromagnetic Spectrum: Absorption Spectroscopy-II (11 Hrs.)
Ultraviolet (U.V.) absorption spectroscopy introduction- Beer-Lambert law, molar absorptivity, types of electronic transitions, Concept of chromophores and auxochrome, Bathochrome, hypsochrome, hyperchrome, hypochromic shifts, solvent effect on electronic transition, UV spectra of conjugated compounds, Woodward-Fieser Rule, application of UV spectroscopy.

4. Problems based on spectroscopy
Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and PMR spectroscopic techniques.

5. Organic Synthesis *via* Enolates
Acidity of α-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate.
Alkylation of 1,3-dithianes. Alkylation and acylation of enamines.

SECTION–C

6. Carbohydrates (11 Hrs.)

Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threodiastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+)-glucose. Mechanism of mutarotation.

Structures of ribose and deoxyribose

An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

SECTION-D

7. Amino Acids, Peptides, Proteins and Nucleic Acids (11 Hrs.)

Classification, structure and stereochemistry of amino acids. Acid-base behaviour, isoelectric point and electrophoresis. Preparation and reactions of α-amino acids.

Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins. Levels of protein structure. Protein denaturation/renaturation.

Nucleic acids: Introduction. Constituents of nucleic acids. Ribonucleosides and ribonucleotides. The double helical structure of DNA.

Books Suggested :

1. Spectrometric Identification of Organic Compoundsby Robert M. Silverstein, Francis X. Webster , David J. Kiemle, David L. Bryce ;**Publisher:** Wiley, 1981
2. Morrison, R.T., Boyd, R.N., Organic Chemistry; 6th edition, Pubs: Prentice-Hall, 1992.
3. Wade Jr., L.G., Singh, M.S., Organic Chemistry; 6th edition, Pubs: Pearson Education, 2008.
4. Mukherji, S.M., Singh, S.P., Kapoor, R.P., Organic Chemistry; Pubs: New Age International, 1985, Vols. I, II, III.
5. Carey, F.A., Organic Chemistry; 4th edition, Pubs: McGraw-Hill, 2000.
6. Solomons, T.W., Fundamentals of Organic Chemistry; 5th edition, Pubs: John Wiley & Sons, 1997.
7. Streitwieser, A., Clayton, Jr., Heathcock, H., Introduction to Organic Chemistry; 3rd edition, Pubs: Macmillan Publishing Company, 1989.
8. D.L. Pavia, G.M. Lampan and G. S. Kriz, Introduction to Spectroscopy" Hartcourt College Publishers, 2001

B.A./B.Sc. (12+3 System of Education) *(Semester–VI) (CBGS) (Batch 2023-26)*
(Faculty of Sciences)

SEMESTER-VI

CHEMISTRY

PHYSICAL CHEMISTRY–IV

(THEORY)

Time: 3 Hrs. **Marks: 50**
Credits: 2-0-0 **30 Hrs**

Instructions for the Paper Setters:-
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION–A

1. Quantum Mechanics-I **(7 hrs.)**
Black-body radiation, Planck's radiation law, Photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect.
de Broglie hypothesis, Heisenberg's uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box, quantization of energy levels, extension to two and three dimensional boxes, degeneracy.

SECTION–B

2. Quantum Mechanics-II **(8 hrs.)**
Simple harmonic oscillator model of vibrational motion, setting up Schrodinger equation and discussion of solution and wave functions. Rigid rotator model of rotation of diatomic molecules transformation to spherical polar coordinates spherical harmonics and their discussion. Qualitative investigation H-atom, setting up Schrodinger equation, radial and angular part, radial distribution functions of 1s, 2s, 2p, 3s, 3p and 3d.

SECTION–C

3. Solid State **(7 Hrs.)**
Definition of space lattice and unit cell, Law of crystallography- (i) Law of constancy of interfacial angles, (ii) Law of rationality of indices, (iii) Symmetry elements in crystals.
X-ray diffraction by crystals. Derivation of Bragg’s Law in Reciprocal space. Determination of crystal structure of NaCl, KCl by use of Powder method; Laue’s method.

SECTION-D

4. Photochemistry (8 Hrs.)

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

Books Suggested :

1. Atkins, P., Paula, J.de, Atkins, Physical Chemistry; 8th edition, Pubs: Oxford University Press, 2008.
2. Puri, B.R., Sharma, L.R., Pathania, M.S., Principles of Physical Chemistry; 43rd edition, Pubs: Vishal Publishing Co., 2008.
3. Barrow, G.M., Physical Chemistry; 6th edition, Pubs: McGraw Hill Company Inc., 1996.
4. Rao, C.N.R., University General Chemistry; Pubs: Macmillan of India, 1985.
5. Berry, R.S., Rice, S.A., Ross, J., Physical Chemistry; 2nd edition, Pubs: Oxford University Press, 2000.
6. Albert, R.A., Silbey, R.J., Physical Chemistry; I edition, Pubs: John Wiley & Sons Inc., 1992.
7. Dogra, S.K., Dogra, S., Physical Chemistry Through Problems, Pubs: Wiley Eastern Ltd., 1991.
8. Levine, I.N., Physical Chemistry; 5th edition, Pubs : Tata McGraw Hill Publishing Co. Ltd., 2002.
9. Moore, W.J., Basic Physical Chemistry; Pubs : Prentice Hall of India Pvt. Ltd., 1983.
10. Metz, C.R., Theory and Problems of Physical Chemistry; Schaum's outline series, 2nd edition, Pubs: McGraw-Hall Book Company, 1989.
11. Banwell, C.N., McCash, E.M., Fundamentals of Molecular Spectroscopy; 4th edition, Pubs: Tata McGraw Hill Publishing Co. Ltd., 1999.
12. Atkins, P. Friedman, R., Molecular Quantum Mechanics; 4th edition Pubs: Oxford University Press, 2007.
13. Levine, I.N., Quantum Chemistry; 5th edition, Pubs: Prentice Hall International Inc., 2000.
14. Inorganic Chemistry, W.W. Porterfield Addison-Wesley.
15. Inorganic Chemistry, A.G. Sharpe, ELBS.

SEMESTER-VI

CHEMISTRY

(PRACTICAL)

Duration 3½ Hrs. **M. Marks: 50**
Credits: 0-0-2 **6 Period/week**

(I) Organic Chemistry Laboratory Techniques

(a) Column Chromatography

a) Separation of o & p nitrophenol
b) Separation of Leaf pigments from Spinach leaves
c) Separation of o & p nitro aniline
d) Separation of dyes.

(b) Synthesis of Organic Compounds

a) Preparation of p-nitroacetanilide
b) Preparation of p-bromoacetanilide
c) Green Chemistry Experiment: Preparation of benzilic acid from Benzyl-using green approach.
d) Preparation of Methyl Orange, Methyl Red
e) Nitration of Salicyclic Acid by green approach (using ceric ammonium nitrate)

Practical Examination

1)	Column Chromatography	18
2)	Organic Synthesis	17
3)	Viva-Voce	10
4)	Note Book	05

Books suggested:

1. Experimental Organic Chemistry, Vol. I & II, P.R. Singh, D.S. Gupta and K.S. Bajpai, Tata McGraw Hill.
2. Laboratory Manual in Organic Chemistry, R.K. Bansal, Wiley Eastern.
3. Vogel's Textbook of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, ELBS.
4. Experiments in General Chemistry, C.N.R. Rao and U.C. Aggarwal, East-West Press.