St. Aloysius (Autonomous) College, Jabalpur
Department of Chemistry

MARKS SCHEME FOR BSc. III & IV SEMESTER

COURSE CODE: S2 CHEMITRY

COURSE TYPE: MAJORAND MINOR **SUBJECT: CHEMISTRY**

MAXIMUM MARKS: 100 **CREDIT VALUE: 6**

TOTAL MARKS:

SUBJECT	EXAMINATION	MAX. MARKS	MIN. MARKS
CHEMISTRY	CCE EXAM	40	35
	FINAL EXAM	60	

ASSISMENT AND EVALUATION

Assessment and presentation	09
Class test-I (Objective Question)	08
Class test-II (Descriptive Question)	08
Overall performance throughout the year(attendance and behavior)	15
Total	**40**

Theory Paper:

SECTION WISE MARKS DISTRIBUTION

S. No.	SECTION	TOTAL NO. OF QUESTION	MARKS
1	A	Objective Question	5 X 1= 5
2	B	Short Answer Question	5 X 4 = 20
3	C	Long Answer Question	5 X 7 = 35
		Total	**60**
	Internal and ExternalMarks	**Grand Total**	**40+ 60 =100**

Class	*CourseType*	*CourseCode*	*Course Title (Theory/Practical)*	*Marks*	
B.Sc. III Semester	Major/ Minor	S2 CHEM1T	Reactions, Reagents and Mechanisms in Organic chemistry (Theory)	Max: 100	Min: 35

Course objectives:

- To understand organic reaction mechanisms
- To impart a thorough knowledge about the chemistry of some selected organic reagents with a view to develop proper aptitude towards the study of organic compounds and their reactions
- To build up an understanding about pericyclic reactions and to predict the reaction outcome
- To develop the concept of Photochemistry and use, mechanism and application of some photochemical reactions

UNIT – I

Substitution Reactions

Aliphatic Nucleophilic Substitution: Introduction, the S_N1, S_N2 and S_Ni mechanism, neighbouring group participation, effect of substrate, nucleophile, leaving group and reaction medium. Aliphatic Electrophilic Substitution: Elementary treatment. Aromatic Nucleophilic Substitution :The S N Ar, S N 1 and benzyne S RN 1 mechanisms, effect of substrate, nucleophile, and reaction medium. Aromatic Electrophilic Substitution: Arenium ion mechanism, orientation/directive influence. (electronic explanation only) and rectivity, diazonium coupling, Vilsmeir reaction

Keywords/Tags: Nucleophilic Substitution, Electrophilic Substitution, S_N1, S_N2, S_Ni, S_NAr

UNIT – II

Addition and Elimination Reactions

Addition Reactions: Introduction, reactions involving addition to nucleophile, electrophile and free radicals, regio-selectivity and chemo-selectivity, orientation and reactivity, Markovnikov and Anti Markovnikov's addition .Elimination Reactions: Introduction E1, E2 and E1cB mechanisms, effect of substrate, attacking species, leaving group and reaction medium, Orientation-Saytzaff and Hofmann Rule.

Keywords/Tags: Addition Reactions, Elimination Reactions, Saytzaff rule, Markovnikov's addition, regio-selectivity and chemo-selectivity.

UNIT – III

Reagents, Catalysts and Rearrangements (Mechanism and Applications)

Reagents and Catalysts: Preparation, properties and applications of important reagents and catalysts in organic synthesis with mechanistic details: Grignard reagent, N- bromosuccinimide(NBS), diazomethane, anhydrous aluminium chloride ($AlCl_3$), sodamide ($NaNH_2$), Ziegler-Natta catalyst.

Rearrangements (Reaction Mechanism and Applications): Introduction, Types of rearrangements, Rearrangement to electron deficient Carbon (Pinacol-pinacolone, benzylic acid & amp; Wangler-Meerwein), Rearrangement to electron deficient Nitrogen (Hofmann-Lossen- Curtius& Backmann), Rearrangement to electron deficient Oxygen (Baeyer-Villiger& Dakin)Rearrangement to electron rich Carbon (Witting), Aromatic Rearrangements (Fries &Claisen)

Keywords/Tags*:* Rearrangement, Reagents, Catalysts, NBS, sodamide, Grignard

UNIT – IV

Oxidation & Reduction Reactions

Oxidation reactions: Introduction, metal based and non- metal based oxidation, Oxidation of alcohols to

carbonyls (chromium, manganese and silver based reagents), alkenes to epoxides(peroxides/peracids based), alkenes to diols (manganese and Osmium based), alkenes to carbonyls with bond cleavage (manganese and lead based), oppenauer oxidation. Oxidationof amino group to nitro group: Oxidation by alkaline KMnO4, Oxidation of aliphatic and aromatic amines by peracids, oxidation of primary and secondary amines to hydroxyl amine by hydrogen peroxide.

Reduction reactions: Introduction, reduction to carbon-carbon multiple bonds, carbonyl groups and nitro compounds: Catalytic hydrogenation: heterogenous (Pd-C and Raney Ni),homogeneous(Wilkinson's Catalyst)Hydride transfer reagents: sodium borohydride and lithium aluminium hydride, metal based reduction: Birch reduction and Clemmensen reduction. Reduction of nitro compound by catalytic hydrogentation and metal (with mechanism.

Keywords/Tags*:* Oxidation, Reduction, hydrogenation, Wilkinson's Catalyst, metal based reduction

UNIT – V

Photochemical and Pericyclic Reactions

Photochemical Reactions: Introduction to Photochemistry, electronic excitations, Jablonskidiagram, Norrish type I and II reactions and cis-trans isomerism

Pericyclic Reactions: Introduction of Pericyclic Reactions and their classification(Electrocyclic, Sigmatropic rearrangement and Cycloaddditions) 2+2 and 4+2 cycloaddditions, Claisen and Cope rearrangement.

Keywords/ tags: Photochemistry, Pericyclic Reactions, Norrish Reactions, Cycloadddition

Course Outcome: By the end of this course students will be able to-

- Develop knowledge of various organic reactions, reagents and their mechanism inunderstanding organic synthesis.
- Understand the applications of the reactions in the various industries likepharmaceutical, polymer, pesticides, textile, dye etc.
- Develop knowledge about important key reactions used in higher studies and research in chemistry.

Reference Books:

1 Clayden J., Graves N. and Warren S., "Organic Chemistry", Oxford University 2012, 2nd
2 March J,and Smith M.B. "Advanced Organic Chemistry" John Wily and Sons, 6th
3. Bruckner R., "Organic mechanism reactions stereochemistry and synthesis", 2010 Springer, Berlin,
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B.Sc. III Semester	Elective	S2 CHEM1T	Reactions, Reagents and Mechanisms in Organic chemistry (Theory)	Max: 100	Min: 35

Course objectives:

- To understand organic reaction mechanisms
- To impart a thorough knowledge about the chemistry of some selected organic reagents with a view to develop proper aptitude towards the study of organic compounds and their reactions
- To build up an understanding about pericyclic reactions and to predict the reaction outcome
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(a) *Substitution Reactions*

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Addition Reactions: Introduction, reactions involving addition to nucleophile, electrophile and free radicals, regio-selectivity and chemo-selectivity, orientation and reactivity, Markovnikov and Anti Markovnikov's addition .Elimination Reactions: Introduction E1, E2 and E1cB mechanisms, effect of substrate, attacking species, leaving group and reaction medium, Orientation-Saytzaff and Hofmann Rule.

Keywords/Tags: Nucleophilic Substitution, Electrophilic Substitution, S_N1, S_N2, S_Ni, S_NAr Addition Reactions, Elimination Reactions, Saytzaff rule, Markovnikov's addition, regio-selectivity and chemo-selectivity.

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Keywords/Tags*:* Rearrangement, Reagents, Catalysts, NBS, sodamide, Grignard

UNIT – III

Oxidation & Reduction Reactions

Oxidation reactions: Introduction, metal based and non- metal based oxidation, Oxidation of alcohols to carbonyls (chromium, manganese and silver based reagents), alkenes to epoxides(peroxides/peracids based), alkenes to diols (manganese and Osmium based), alkenes to carbonyls with bond cleavage (manganese and lead based), oppenauer oxidation. Oxidation of amino group to nitro group: Oxidation by alkaline KMnO4, Oxidation of aliphatic and aromatic amines by peracids, oxidation of primary and secondary amines to hydroxyl amine by hydrogen peroxide.

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***Keywords/Tags**:* Oxidation, Reduction, hydrogenation, Wilkinson's Catalyst, metal based reduction

UNIT – IV

Photochemical and Pericyclic Reactions

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Pericyclic Reactions: Introduction of Pericyclic Reactions and their classification(Electrocyclic, Sigmatropic rearrangement and Cycloaddditions) 2+2 and 4+2 cycloaddditions, Claisen and Cope rearrangement.

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4. Kalsi P.S., "Organic reactions and their mechanisms" New Age Science, London, editio 2010, 3rd

5. synthesis" John Wily and Sons, New Jersey, 2005, second edition

6. Li J.J., "Name reactions are collection of detailed mechanism and synthetic application"Springer International Publishing, Switzerland, 2014, fifth edition

7. Hornback J.M. "Organic Chemistry" Thomson Learning, Singapore, 2006, second edition

8. Singh J. and Singh J., "Photochemistry and Pericyclic Reactions" New

Class	*CourseType*	*CourseCode*	*Course Title (Theory/Practical)*	*Marks*	
B.Sc. III Semester	Major/ Minor/ Elective	S2CHEM1P	Organic Qualitative Analysis, reactions and synthesis(Practical)	Max: 100	Min: 35

Course objectives:

- To develop the skills for identification, separation and purification of organic compounds
- To widen problem solving ability and scientific thinking which will be helpful in Higher studies and research

EXTERNAL ASSESSMENT: 60 marks

Inorganic Chemistry

- Crystallization of $CuSO_4$
- Sublimation of a mixture of Napthalene

Physical Chemistry- Volumetric analysis.

- Determination of acetic acid in commercial vinegar using NaOH.
- Determination of alkali content- antacid tablet using HCl.
- Estimation of calcium content in chalk as calcium oxalate by permagnatometry.
- Estimation of hardness of water by EDTA.

Organic Chemistry

- ***Paper chromatography : Ascending***

Determination of Rf values and identification of organic compounds- Separation of a mixture of phenylalanine and glycine, alanine and aspartic acid. Spray reagent ninhydrin.

- Binary mixture analysis containing two solids Separation, identification and preparation of derivatives
- Preparation

i) Acetylation (ii) Benzolyation (iii) Meta-dinitro benzene (iv) Picric acid

INTERNAL ASSESSMENT: **40 marks**

Internal assessment	**Marks**	**External assessment**	**Marks**
Class Interaction/	**15**	**Viva- Voce on Practical**	**15**
Attendance	**5**	**Practical Record File**	**10**
Assignment (Charts/ model seminar/Rural services/ Technology dissemination/ Report of Excursion/ Lab visits/ Survey/ Industrial visit)	**20**	**Table work/ Experiments**	**35**
TOTAL	**40**		**60**

Course Learning Outcome: By the end of this course students will be able to:

- Perform various reactions, which will be helpful in understanding organic synthesis.
- Understand the use reagents while performing experiments based on certain organic reactions
- Analyze and Synthesize some organic compounds
- Understand the use of chromatographic techniques and its application in monitoring organic reactions
- Develop an understanding for the applications of qualitative analysis.

Class	*Course Type*	*CourseCode*	*Course Title (Theory/Practical)*	*Marks*	
B.Sc. IV Semester	Major/ Minor	S2 CHEM2T	Transition Elements, Chemi-energetics, Phase Equilibria(Theory)	Max: 100	Min: 35

Course objectives:

- To enrich the students with the understanding of fundamentals and concepts of thermodynamics, thermochemistry, phase equilibrium, Solutions, Electrochemistry, adsorption, adsorption and its applications.
- To enable the students to understand the fundamentals of the inorganic chemistry through schematic study of transition, inner transition elements and their properties and compounds
- To build up an understanding of coordination chemistry, their reactions, structure, isomerism and applications

UNIT – I

Chemistry of d- & f-block elements

(a) Chemistry of Transition elements: First, Second and Third Transition series**.** General group trends with special reference to- Electronic Configuration, Coordination Geometry, Colour, Variable Valency, Spectral, Magnetic and Catalytic Properties, Ability to form Complexes.

(b) Chemistry of Inner Transition elements: Lanthanides and Actinides. General group trends with special reference to Electronic Configuration, Oxidation States, Colour, Spectral and Magnetic Properties. Lanthanide Contraction. Separation of Lanthanides (lon-exchange method only).

(c) Transuranic elements: General Introduction.

Keywords/Tags: Knowledge Tradition of Indian Chemistry, Transition elements, Spectral Properties, Magnetic Properties, Catalytic Properties, Lanthanide Contraction.

UNIT –II

Coordination Chemistry

(a) Structures, Stereochemistry and Metal-Ligand Bonding in Transition Metal Complexes: Werner theory for complexes. Electronic interpretation by Sidwik.

(b) Valence Bond Theory (VBT)- Postulates and applications for Tetrahedral, Square planar and Octahedral complexes. Limitations of VBT.

(c) Crystal Field Theory (CET); Postulates and application: Crystal field splitting of d-orbitals Crystal field stabilization energy (CFSE) in Tetrahedral, Square planar and Octahedral complexes, CFSE of weak and strong fields. Factors affecting the crystal field parameters. Measurement of 10 Dq (Δo) and factors affecting its magnitude. Comparison of octahedral and tetrahedral coordination. Tetragonal distortions from octahedral geometry. Jahn-Teller theorem. Square planar geometry. Limitations of CFT. Qualitative aspect of Ligand field and Molecular Orbital (MO) Theory. Spectrochemical and Nephelauxetic series. Coordination number, coordination geometries of metal ions, types of ligands.

(d) Isomerism in coordination compounds:

Structural isomerism: Ionization, Linkage, Coordination-Ligand Isomerism.

Stereo isomerism: Geometrical isomerism: Square planar metal complexes of type- $[MA_2B_2]$,$[MA_2BC]$, $[M(AB)_2]$, [MABCD]. Octahedral metal complexes of type-$[MA_4B]$, $[M(AA)_2B_2$:], $[MA_3B_3]$.Optical isomerism: Tetrahedral complexes of type- [MABCD] complexes of type- $[M(AA)_2B_2]$, $[M(AA)_3]$.

UNIT- III

Thermodynamics

(a) First Law of Thermodynamics: Concept of heat (Q), work (W), internal energy (U),Statement of the first Law, Enthalpy(H),Relation between heat capacities. Calculation of Q, W, ΔU and ΔH under isotherm and adiabatic conditions for Reversible, Irreversible and free (ideal and Van der Waals) expansions of gas. Joule Thomson effect and its theory, Inversion temperature.

(b) Second Law of Thermodynamics: Carnot cycle, Statement of the Second Law of Thermodynamics. Concept of Entropy, Calculation of entropy change for Reversible and irreversible processes, Concept of residual entropy, Free energy Function: Gibbs and Helmholtz functions. Variation of entropy(S), Gibbs free energy (G), work function (A) with temperature (T), volume (V) & pressure (p).Free energy change and spontaneity, Gibbs-Helmholtz equation.

(c) Third Law of Thermodynamics: Nernst heat theorem and its significance, Statement of third law, Calculation of absolute entropy of substance.

Keyword/Tag: Thermodynamics, Law of Thermodynamics, Carnot cycle, Enthalpy, Free energy

UNIT- IV

Electrochemistry

Electrical Conduction: conduction in metals and in electrolyte solutions, specific and equivalent conductance, Measurement of equivalent conductance. Effect of dilution on conductivity Migration of ions and Kohlrausch-law and its application.

Weak and strong electrolytes: Theory of Strong electrolytes, Debye-Huckel Onsagar's(DHO) theory and equation.

Transport Numbers: determination of Transport numbers by Hittorf method and movingboundary method.

Electrode reactions: Nernst equation, Derivation of equation for single electrode potential. Electrode: Reference electrodes, Standard hydrogen electrode Quinhydrone, glass electrodes, Calomel electrode.Standard electrode potential, Electrochemical Series and its application. Electrochemical Cell: Nernst equation, calculation of e.m.f. of cell

Keyword/Tag: Electrical Transport, Conduction, DHO theory, Transport Numbers Nernst equation, Electrode, Electrochemical Series

UNIT – V

Phase equilibrium

Concept phase, component and the degree of freedom, thermodynamic derivation of the Gibbs phase rule for reactive and nonreactive system.

Clausius-Clapeyron and its applications Solid –Liquid, Liquid-Vapour and Solid–Vapourequilibria.

Phase diagrams for one component system with application: water, and Sulphur. Phasediagrams for system of solid-liquid equilibria involving-Eutectic, Congruent and Incongruent melting points. Water and Sulphur system simple, Ag-Pb and Mg-Zn system, NaCl-H_2O system.

Binary solution:, Raoult' law. Non-ideal system or azeotropes mixture Immiscible Liquid,Steam Distillation.

Keyword/Tag: Phase equilibrium, Gibbs phase rule, Clausius-Clapeyron equation Raoult's Law

Course outcome- By the end of this course students will be able to-:

- Develop an understanding about traditional Indian Chemistry
- Understand the concepts of chemistry of d & f block elements, basic concepts of coordination chemistry.
- Explain Stereochemistry of transition metal complexes.
- Gain a thorough knowledge about Laws of thermodynamics and thermochemistry
- Develop the concept of phase equilibrium with reference to solid solution, liquid-liquid mixture, partially miscible liquids.
- Develop an understanding about basic concepts of electrochemistry, various types ofelectrodes and

their reactions.

Reference Books:

1. Bariyar R and GoyalS, BSc Chemistry combined (in Hindi) Krishna education publishers, year2019
2. Lee J.D., Concise Inorganic Chemistry, Wiley, 2008,5th edition
3. Kalia K.C, .Puri B.R., Sharma L.R.,Principles of Inorganic Chemistry, Vishal PublishingCompany 2020
4. Sodhi G.S.,Textbook of Inorganic Chemistry, Viva Books private limited, New Delhi
5. Singh J, Singh J and Anandvardhan, A logical approach to modern inorganic chemistry, Anu books, 2019
6. Gopalan R and Ramalingan V, Concise coordination chemistry, Vikas publishing houseprivate limited, New Delhi, 2005, 1st edition
7. Madan R. L., Chemistry for degree students, BSc II year, S. Chand and Company limited, New Delhi, 2011
8. Prakash S, Tuli G.D. Basu S.K. and Madan R.D., Advanced Inorganic Chemistry, volume 2, S Chand and company limited, New Delhi, 2007, 19th edition
9. Malik W.U., Tuli G.D and Madan R.D. Selected topics in inorganic chemistry, S Chand and company limited, New Delhi 2014
10. Puri B.R., Pathania M.S., Sharma L.R., Principals of physical chemistry, Vishal Publishing Company 2020

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B.Sc. IV Semester	Elective	S2 CHEM2T	Transition Elements, Chemi-energetics, Phase Equilibria(Theory)	Max: 100	Min: 35

Course objectives:

- To enrich the students with the understanding of fundamentals and concepts of thermodynamics, thermochemistry, phase equilibrium, Solutions, Electrochemistry, adsorption, adsorption and its applications.
- To enable the students to understand the fundamentals of the inorganic chemistry through schematic study of transition, inner transition elements and their properties and compounds
- To build up an understanding of coordination chemistry, their reactions, structure, isomerism and applications

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(c) Transuranic elements: General Introduction..

Coordination Chemistry

(d) Structures, Stereochemistry and Metal-Ligand Bonding in Transition Metal Complexes: Werner theory for complexes. Electronic interpretation by Sidwik.

(e) Valence Bond Theory (VBT)- Postulates and applications for Tetrahedral, Square planar and Octahedral complexes. Limitations of VBT.

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Structural isomerism: Ionization, Linkage, Coordination-Ligand Isomerism.

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Keywords/Tags: Knowledge Tradition of Indian Chemistry, Transition elements, Spectral Properties, Magnetic Properties, Catalytic Properties, Lanthanide Contraction.

UNIT- II

Thermodynamics

(c) First Law of Thermodynamics: Concept of heat (Q), work (W), internal energy (U),Statement of the first Law, Enthalpy(H),Relation between heat capacities. Calculation of Q, W, ΔU and ΔH under isotherm and adiabatic conditions for Reversible, Irreversible and free (ideal and Van der Waals) expansions of gas. Joule Thomson effect and its theory, Inversion temperature.

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Keyword/Tag: Electrical Transport, Conduction, DHO theory, Transport Numbers Nernst equation, Electrode, Electrochemical Series

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Phase equilibrium

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Phase diagrams for one component system with application: water, and Sulphur. Phasediagrams for system of solid-liquid equilibria involving-Eutectic, Congruent and Incongruent melting points. Water and Sulphur system simple, Ag-Pb and Mg-Zn system, NaCl-H_2O system.

Binary solution:, Raoult' law. Non-ideal system or azeotropes mixture Immiscible Liquid,Steam Distillation.

Keyword/Tag: Phase equilibrium, Gibbs phase rule, Clausius-Clapeyron equation Raoult's Law

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Class	*Course Type*	*Course Code*	*Course Title (Theory/Practical)*	*Marks*	
B.Sc. IV Semester	Major/Minor/Elective	S2CHEM2P	Metal complex preparation, Thermochemistry & phase equilibrium experiments (Practical)	Max: 100	Min: 35

Course Objectives:

- To enable the students to create an understanding about the laboratory practices, variouslaboratory and analytical techniques.
- To enrich the students with the concepts of physical chemistry viz. thermodynamic andphase equilibrium

EXTERNAL ASSESSMENT: 60 marks

Inorganic Chemistry

- To obtain pure water from NaCl solution by distillation.
- To obtain pure potash alum by the process of crystallization.

Volumetric Analysis

- To determine the percentage of acetic acid in commercial vinegar.
- Estimation of calcium content in chalk as calcium oxalate by permagnatometry.
- To prepare M/20 solution of Mohr's salt and, using this solution find out the molarity and strength of the given potassium permanganate ($KMnO_4$) solution.

Gravimetry -Estimation of Copper

Physical Chemistry

A. Phase equilbrium

- To determine the critical solution temperature of two partially miscible liquid by determining their solubility in each other.
- To study the effect of solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquid (e.g., phenol water system).

B. Thermochemistry

To determine the enthalpy of neutralization of weak acid/weak base versus strong acid/strong base and determine the enthalpy of ionization of the weak acid/base.

INTERNAL ASSESSMENT: **40 marks**

Internal assessment	**Marks**	**External assessment**	**Marks**
Class Interaction/Quiz	**15**	**Viva- Voce on Practical**	**15**
Attendance	**10**	**Practical Record File**	**10**
Assignment (Charts/ model seminar/ Rural services/ Technology dissemination/ Report of Excursion/ Lab visits/ Survey/ Industrial visit)	**15**	**Table work/ Experiments**	**35**
TOTAL	**40**		**60**

Course Outcome: By the end of this course students will be able to:

- Develop an understanding of preparation of inorganic complexes.
- Explain the use of calorimeter for thermochemistry experiments.
- Determine the enthalpy of various systems and reactions

- Perform the experiments on phase equilibria with understanding of changes involved intransitions
- Gain a thorough knowledge about construction of phase diagrams and study of reactionequilibrium