SYLLABI FOR FOUR-YEAR UNDERGRADUATE PROGRAMME

IN

CHEMISTRY

AS PER NATIONAL EDUCATION POLICY (NEP) 2020

Recommended by the 1st meeting of the Board of Studies (BoS), Department of Chemistry, and approved by the 1st meeting of the Academic Council of Lakhimpur Girls' College (A), held on 28 June 2026, vide Resolution No. AC/1/2026/05.

LAKHIMPUR GIRLS' COLLEGE (AUTONOMOUS)

NORTH LAKHIMPUR, LAKHIMPUR -787031, ASSAM

The syllabus is prepared considering syllabus of Dibrugarh University as model syllabus for the Department of Chemistry, Lakhimpur Girls' College (A), with necessary modifications/ additions keeping in view the contexts and academic requirements.

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN CHEMISTRY, LAKHIMPUR GIRLS' COLLEGE (AUTONOMOUS)

- **THE PREAMBLE**

Education aims to develop an individual into a human being through moral, spiritual, and cultural development. It also aims to the acquisition of knowledge, skills, and attitudes to adjust properly to one's environment. In a broader sense, it is an instrument to achieve larger societal goals. In addition to these, education has further responsibility of developing core competencies such as communication skills required to articulate thoughts and ideas effectively, using oral and written communication skills, and presenting information and explanations in a well-structured manner.

Change is the law of nature. With the continuously changing society, the nature and scope of education also change and widen. Since education plays a crucial role in the development of social issues all-around, must be up-to-date to address all these problems. Educators and educational practitioners should also change them accordingly.

The main purpose of the Undergraduate Programme in Chemistry is to familiarize students with basic-level to high-level Chemistry which connects the post-graduate program. Significant efforts are given to motivate students to do research in Chemistry. Due importance is also given to the study of application-oriented topics which is very much relevant and useful to the present scenario.

INTRODUCTION

Undergraduate programmes were traditionally conceived as preparation for post-graduation. The rigidity in choosing subjects through fixed combinations had to be reconsidered. The aspects of all-round development of the students, skill acquisition outside chosen subjects and research were undermined but the National Education Policy-2020 (NEP-2020) has changed all of these in one stroke. The NEP- 2020 recognizes that higher education plays an extremely important role in promoting human as well as societal well-being and in developing India as envisioned in its Constitution. It states that quality higher education must aim to develop good, thoughtful, well-rounded, and creative individuals.

The curriculum at undergraduate and FYUGP therefore, has incorporated certain new components of learning to make it relevant to contemporary society and modern practices by integrating the humanities and arts with Science, Technology, Engineering and Mathematics (STEM). It is expected that it will show positive learning outcomes, including increased creativity and innovation, problem-solving abilities, teamwork, communication skills, more in-depth learning, and increases social and moral awareness besides increased employability.

The prominent features of the NEP framework are:

1. Flexibility in choosing subjects and even disciplines for the graduate programmes
2. Vertical and horizontal mobility across subjects throughout the programme
3. Multiple entry and exit points
4. Main-streaming of skill-based courses
5. Credit-based evaluation system
6. Integration of research into 4th year of the programme leading to an Honours degree.

The Bachelor of Science in Chemistry degree of Lakhimpur Girls' College Autonomous adapted as per the recommendations of NEP 2020 will also be of either a three or four-year duration, with multiple exit options within the period with appropriate certification. After completion of one year a UG certificate, completion of two years a UG diploma, and after completion of three years, a Bachelor's degree in the programme will be provided to the students. The four-year undergraduate programme in chemistry will allow the student an opportunity to experience the full range of holistic and multidisciplinary education, along with the chosen Major and Minor choices of the students.

- **AIMS OF FOUR YEAR UNDER-GRADUATE PROGRAMME (FYUGP) IN CHEMISTRY:**

The aims of the Four Year Under-Graduate Programme (FYUGP) in Chemistry are:

1. To equip the students with the potential to contribute to academic and industrial environments.
2. To impart knowledge in fundamental aspects of various branches of Chemistry.
3. To apply the key concepts and standard methodologies to solve problems related to Chemistry.
4. To prepare students for higher education and a career in Chemistry.

5. To develop laboratory skills, *viz*. proper handling of apparatus, chemicals, and experimental techniques.
6. To make students apply chemistry in their day-to-day life.
7. To create the students as responsible citizens by creating environmental awareness.

GRADUATE ATTRIBUTES OF THE FYUGP IN CHEMISTRY

Graduate attributes in Chemistry include both Chemistry knowledge and responsibilities and qualities that Chemistry graduates should acquire and demonstrate. Graduate attributes of the FYUGP in Chemistry are:

Attribute1: Strong grip on fundamental and practical Chemistry knowledge

Attribute2: Creative and critical thinking, and problem-solving

Attribute3: Interest in research-based problem

Attribute4: Digital Fluency

Attribute 5: Teamwork and communication skills

Attribute 6: Professionalism and leadership readiness

Attribute 7: Social responsibility

Attribute8: Appreciation and adherence to Ethical integrity

PROGRAMME LEARNING OUTCOMES

By the end of the programme an undergraduate student of Chemistry should be able to:

1. Integrate traditional Indian scientific knowledge with modern chemistry.
2. Understand the basic principles of various branches of Chemistry.
3. Demonstrate a range of practical skills to conduct and infer experiments independently and in groups.
4. Apply the key concepts and standard methodologies to solve problems related to Chemistry.
5. Apply methodologies to the solution of unfamiliar types of problems.
6. Exhibit skills leading to employability in Chemistry and allied industries.
7. Comprehend the fundamental aspects of research in Chemistry.
8. Possess the level of proficiency in the subject required for post-graduation as well as for pursuing research in Chemistry and related interdisciplinary subjects.
9. Demonstrate teaching competencies required for keeping oneself professionally engaged.

TEACHING LEARNING PROCESS

The programme allows using of varied pedagogical methods and techniques both within the classroom and in laboratories.

- Lecture
- Tutorial
- Power Point presentation
- Project Work/Dissertation
- Seminars/workshops/conferences
- Industry Visits/Field Visits and Report

TEACHING LEARNING TOOLS

- White/Green/Black Board
- LCD projectors/Monitor
- Smart Board
- Model Demonstration
- Learning through lab experiments
- Industry and research visits

ASSESSMENT

- Home assignment
- Project Report
- Seminar Presentation
- Objective/MCQ test
- In semester examinations (Theory and Practical)
- End Semester examinations (Theory and Practical)
- Viva-voce

LAKHIMPUR GIRLS' COLLEGE (AUTONOMOUS)
KHELMATI, NORTH LAKHIMPUR- 787031
FYUGP Structure as per UGC Credit Framework of December, 2022

Year	Semester	Course	Title of the Course	Paper Code	Total Credit
Year 01	1st Semester	CHE-MAJ-4-101	Chemistry C1: Inorganic+ Physical + Organic	CHE-MAJ-4-101	**4**
		CHE-MIN-4-101	Fundamentals of Chemistry-1	CHE-MIN-4-101	**4**
		CHE-GEC-3-101	Chemistry in DailyLife-1	CHE-GEC-3-101	**3**
		*	**Modern Indian Language**	*	**4**
		CHE-SEC-3-101	Basic Analytical Chemistry	CHE-SEC-3-101	**3**
		*	**Understanding India**	*	**2**
	Total				**20**
	2nd Semester	**CHE-MAJ-4-201**	Chemistry C2: Inorganic+ Physical + Organic	CHE-MAJ-4-201	**4**
		CHE-MIN-4-201	Fundamentals of Chemistry-2	CHE-MIN-4-201	**4**
		CHE-GEC-3-201	Chemistry in Daily Life-2	CHE-GEC-3-201	**3**
		*	**English Language and Communication Skills**	*	**4**
		CHE-SEC-3-201	Basic Analytical Chemistry	CHE-SEC-3-201	**3**
		*	**Environmental Science**	*	**2**
		Total			**20**
Grand Total (Semester I and II)					**40**

The students on exit shall be awarded an ***Undergraduate Certificate*** (in the Field of Study/Discipline) after securing the requisite ***40 Credits in Semesters 1 and 2*** provided they secure ***4 credits in work based vocational courses*** offered ***during the summer term or internship/Apprenticeship in addition to 6 credits from skill based courses earned during 1st and 2nd Semester***

Year	Semester	Course	Title of the Course	Paper Code	Total Credit
Year 02	3rd Semester	**CHE-MAJ-4-301**	Chemistry C3: Inorganic+ Physical + Organic	CHE-MAJ-4-301	4
		CHE-MAJ-4-302	Chemistry C4: Inorganic+ Physical + Organic	CHE-MAJ-4-302	4
		CHE-MIN-4-301	Fundamentals of Chemistry-3	CHE-MIN-4-301	4
		CHE-GEC-3-301	Chemistry in Daily Life-3	CHE-GEC-3-301	3
		CHE-SEC-3-301	Inorganic Materials of Industrial Importance	CHE-SEC-3-301	3
		*	Digital Fluency	*	2
	Total				**20**
	4th Semester	**CHE-MAJ-4-401**	Chemistry C5: Inorganic	CHE-MAJ-4-401	4
		CHE-MAJ-4-402	Chemistry C6: Physical	CHE-MAJ-4-402	4
		CHE-MAJ-4-403	Chemistry C7: Organic	CHE-MAJ-4-403	4
		CHE-MAJ-4-404	Chemistry C8: Symmetry & Quantum Chemistry-I	CHE-MAJ-4-404	4
		CHE-MIN-4-401	Fundamentals of Chemistry-4	CHE-MIN-4-401	4
	Total				**20**

	Grand Total (Semester I, II, III and IV)	**80**

The students on exit shall be awarded ***Undergraduate Diploma***(in the Field of Study/Discipline) after securing the requisite ***80 Credits on completion of Semester IV*** provided ***they secure additional 4 credit in skill based vocational courses*** offered ***during First Year or Second Year summer term***

Abbreviations Used:

- **MAJ = Core/Major**
- **GEC = Generic Elective Course/ MultiDisciplinary Course**
- **AEC =Ability Enhancement Course**
- **SEC = Skill Enhancement Course**
- **VAC = Value Added Course**
- **CHE = Chemistry**
- **MIN = Minor**

Table 1:Credit Distribution matrix of FYUGP (Single Major)

Year	Semester	Core	Minor	GEC	AEC	SEC	Internship/ Community Engagement / Project	VAC	Research/ Dissertation/	Total
1	I	4	4	3	4	3		2		20
	II	4	4	3	4	3		2		20
UG Certificate										**40**
2	III	4+4	4	3		3		2		20
	IV	4+4+4+4	4							20
UG Diploma		**32**	**16**	**09**	**08**	**09**		**06**		**80**
3	V	4+4+4	4				2 +2 (I+CE) OR 4(I)/4(CE)			20
	VI	4+4+4+4	4							20
UG Degree		**60**	**24**	**-**	**-**	**-**	**-**	**-**	**-**	**120**
4	VII	4+4+4	4						4(RM)	20
	VIII	4+4	4						8(D)/ 4+4(DSE)	20
Honours Degree		**80**	**32**	**-**	**-**	**-**	**-**	**-**	**12**	**160**
5	IX	4+4+4	4						4(P)/4 (DSE)	20
	X	4+4	4						8/4+4(DSE)	20
PG Degree		**100**	**40**	**-**	**-**	**-**	**-**	**-**	**24**	**200**

FYUGP

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	**:**	**Chemistry C1: Inorganic + Physical + Organic**
Course Code	**:**	**CHE-MAJ-4-101**
Nature of the Course	**:**	**CHEMISTRY MAJOR**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) +40 (In-Sem)**

COURSE OBJECTIVES:

- To impart the ancient Indian knowledge on matter and understand the contributions of ancient Indian scholars in chemistry.
- To give idea about the basic knowledge of chemistry in different field of specializations (viz. inorganic, organic and physical chemistry)

UNITS	CONTENTS	L	T	P	Total Hours
p **I**	**IKS Contents:** Ancient Indian Concepts Related to Atomic Theory- Introduced the concept of "Paramāṇu" (atom), dravya (matter), dvyanukas (diatomic molecules) and tryanukas (triatomic molecules). **Atomic Structure:** (General concept of Bohr's Theory, de Broglie Theory, Heisenberg Uncertainty Principle) Quantum numbers, Electronic configuration of elements based upon electronic configuration in the periodic table. **Periodic properties:** Periodic properties and periodic trends of the following: a) Effective nuclear charge (screening constant – Slater's rule only), b) ionic and covalent radii, c) ionization potential, d) electron affinity e) electronegativity (Pauling, Mulliken's and Allred-Rochow Scales).	**06**	**00**	**-**	**06**
	Bonding and structure: Ionic Bonding: General characteristics and Energy consideration in ionic bonding, lattice Energy. Born - Haber cycle and its application, polarizing power and polarizability. Fajan's rule, Bond moment, dipole moment and percentage ionic character. Hydrogen Bonding. Covalent Bonding: VB	**08**	**00**	**-**	**08**

	Approach-Concept of hybridization (sp, sp^2, sp^3, sp^3d, sp^3d^2 and dsp^2). VSEPR Theory. Resonance and Resonance energy: Study of some inorganic and organic compounds (O_3, NO_3^- , CO_3^{2-}, SO_4^{2-}, $RCOO^-$, C_6H_6). Co-ordinate or Dative Bond. Bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combination of atomic orbitals non-bonding combination of orbitals, MO treatment and diagram of homo and heteronuclear diatomic molecules such as CO, NO and NO^+				
II	**Gas:** Kinetic gas equation and its derivation, Maxwell distribution of molecular speed, different types of speeds, collision properties, Mean free path, determination of collision diameter, transport phenomenon in gases, coefficient of viscosity, law of equipartition of energy, degrees of freedom and average energy of a molecule, molecular basis of heat capacity, barometric formula and its uses for determination of Avogadro number. Deviation from ideal behavior, van der Waals and Dieterici's, Virial equation of state, Boyle's temperature, Critical constants, reduced equation of state, co-efficient of compressibility and thermal expansion. **Liquid:** Qualitative treatment of structure of liquids, physical properties of liquids, vapour pressure, surface tension-Explanation of cleansing action of detergents, parachor-determination and application, viscosity, Newtonian and non-Newtonian liquid, liquid crystals.	**09** **06**	**00** **00**	**-** **-**	**09** **06**
III	**Basics of Organic Chemistry:** Organic Compounds: **IKS Contents:** Some Known organic compounds present in nature in historic and pre-historic India Classification and Nomenclature of organic compounds. Hybridization: Shape of molecules, Influence of hybridization on bond properties. Electronic displacements: Inductive, Electromeric, Resonance, Mesomeric effects and Hyper conjugation and their applications. Dipole moment. **Organic acids and bases:** Their relative strength, Homolytic and Heterolytic fission, Electrophiles	**08**	**00**	**-**	**08**

	and Nucleophiles: Nucleophilicity and basicity. **Reactive intermediates:** Carbocations, carbanions, free radicals, carbenes, nitrenes, Types, Shape and their relative Stability. Energy profile diagrams of one step, two steps and three steps reactions, Rate limiting steps. Activation Energy. Kinetically and thermodynamically controlled reactions. Mechanism of organic reactions: Types of organic reactions with examples (addition, elimination, substitution, condensation, rearrangement, oxidation, reduction)				
	Stereochemistry: Symmetry elements and their application in simple organic molecules. Definition and classification of stereoisomerism, 2-D and 3-D Representation of organic molecules in Fischer, Newman, Saw horse and flying wedge projection formula and their interconversions. **Optical isomerism**: Concepts of asymmetry, dissymmetry, optical activity, Specific rotation, Chirality, racemic mixture, racemization and Resolution, Enantiomers, Diastereomers, Threo and Erythro forms, Meso structures & Epimers. Relative and absolute configuration: D/L and R/S designations. Walden inversion. **Geometrical Isomerism**: Restricted rotation about C=C bonds, physical and chemical properties of diasteroisomers, determination of configuration of geometrical isomers: cis-trans isomerism, syn-anti and E/Z notation with CIP rules. Geometrical isomerism in oximes and alicyclic compounds.	**08**	**00**	**-**	**08**
IV	**EXPERIMENTAL WORK (A) (Any one)** (i) Determine the surface tension of various liquids by drop number method. Determination of viscosity of aqueous solutions at room temperature.	**-**	**00**	**15**	**15**
	EXPERIMENTAL WORK (B) (Any one) Purification of organic compounds by crystallization using the following solvents: a. Water b. Alcohol c. Alcohol-water and determination of the melting points of above compounds (Kjeldahl method and electrically heated melting point apparatus)	**-**	**00**	**15**	**15**

	OR (i) Separation of a mixture of *o*-and *p*-nitrophenol or *o*-and *p*-aminophenol by thin layer chromatography (TLC) (ii) Separation of binary mixtures of organic compounds by physical (cold and hot water solubility) and chemical methods (reaction with sodium bicarbonate and sodium hydroxide)				
	Total	**45**	**0**	**30**	**75**

Where, L:Lectures T:Tutorials P:Practicals

MODES OF IN-SEMESTER ASSESSMENT: 40 Marks

- Two Internal Examination - **20 Marks**
- Others - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Develop a solid understanding of fundamental concepts in periodic properties, bonding, gas and liquid properties, organic chemistry, and stereochemistry.

CO2: Apply theoretical knowledge to solve problems and predict chemical behavior.

CO3: Perform experimental techniques proficiently, analyze data, and draw accurate conclusions.

CO4: Enhance critical thinking, analytical skills, and the ability to communicate scientific information effectively.

CO5: Students will understand ancient Indian concepts of Paramāṇu and early atomic theory.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO5				
Conceptual		CO1	CO2	CO3		
Procedural					CO4	
Metacognitive						

SUGGESTED READINGS:

Text Books

1. Advanced Inorganic Chemistry**,** S. Prakash, S.K. Basu, G.D. Tuli, 17th Edition, S. Chand, 2022.
2. Principles of Inorganic Chemistry, Puri, Sharma, Kalia, 33rd edition, Vishal Publishing Co, 2017
3. Inorganic Chemistry: Principles of Structure and Reactivity, J.E. Huheey, E.A. Keiter, R.L. Keiter and O.K. Medhi, 5th Edition., Pearson Education, 2023.
4. Concise Inorganic Chemistry, J.D. Lee, 5th Edition, Chapman & Hall, 2008
5. A Text Book of Physical Chemistry – A.S. Negi & S.C. Anand, 3rd Edition, New Age International, 2022.
6. Principles of Physical Chemistry, Puri, Sharma, Pathania, 50th Edition, Vishal Publishing Co, 2025.
7. Modern Organic Chemistry – M.K. Jain, S.C. Sharma, 54th Edition, Vishal Publishing Co, 2022.
8. Organic Chemistry (Volumes 1 and 2), I.L. Finar, 6th Edition., Pearson Education, 2002
9. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, 7th Edition, Pearson Education, 2011.
10. Stereochemistry, Conformation and Mechanism, P.S. Kalsi, 11th Edition, New Age international Publisher, 2022.
11. Advanced General Organic Chemistry (Volume I & II), S.K. Ghosh, 9th Edition, NCBA, 2009.

Reference Books:

1. Selected Topics in Inorganic Chemistry**,** Wahid U. Malik, G.D. Tuli and R.D. Madan, 8th Edition, S. Chand & Co. Ltd, 2019.
2. Inorganic Chemistry, P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, 7th Edition., Oxford University Press, 2018.
3. Physical Chemistry, P. Atkins, J de Paula and J. Keeler, 11th Edition, Oxford University Press, 2018.
4. Physical Chemistry- G.W. Castellan, 3rd Edition, Narosa Publishing House, 2004.
5. Advanced Organic Chemistry, A. Bahl and B.S. Bahl, 23rd Edition, S. Chand Publication, 2025.

FYUGP

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	**:**	**Fundamentals of Chemistry-1**
Course Code	**:**	**CHE-MIN-4-101**
Nature of the Course	**:**	**CHEMISTRY MINOR COURSE-1**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To impart the ancient Indian knowledge on matter and understand the contributions of ancient Indian scholars in chemistry.
- To develop the basic knowledge of chemistry in relation to atomic structure, bonding. To emphasize on different states of matter & their mechanical treatment; to develop preliminary knowledge in basic organic chemistry, hydrocarbons, stereochemistry & conformational analysis etc

UNITS	CONTENTS	L	T	P	Total Hours
I	**IKS Contents:** Ancient Indian Concepts Related to Atomic Theory-Introduced the concept of "Paramāṇu" (atom), Matter (dravya), dvyaṇukas (diatomic molecules) and tryaṇukas (triatomic molecules). **Atomic Structure:** (General concept of Bohr's Theory, de Broglie Theory, Heisenberg Uncertainty Principle) Time independent Schrödinger wave equation (H=E). Significance of Ψ and Ψ^2 Schrodinger equation for Hydrogen atom (qualitative treatment only). Quantum numbers, Electronic configuration of elements based upon electronic configuration in the periodic table, **Periodic properties:** effective nuclear charge, ionization energy, electron affinity, electronegativity (Pauling, Mulliken's and Allred-Rochow scales).	**09**	**00**	**-**	**09**
	Chemical Bonding and Molecular Structure-1: Ionic Bonding: Energy consideration in ionic bonding, Lattice Energy and Solvation Energy and their importance in the context of Stability and Solubility of ionic compounds. Polarizing power and polarizability. Fajan's rule, dipole moment and Percentage ionic character. Hydrogen Bonding.	**06**	**00**	**-**	**06**

II	**Kinetic Theory of gases:** Derivation of Kinetic gas equation, Types of molecular velocities, deduction of simple problems on – root mean square speed, most probable speed, collision frequency, collision diameter, mean free path, heat capacity of gases, Deviation from ideal behavior, van der Waals equation, van der Waals constant, critical state of gas, critical constants, continuity of states, law of corresponding states, degree of freedom, law of equipartition of energy (derivation not required),viscosity of gases and effect of temperature and pressure on coefficient of viscosity). **Liquid state**: Qualitative treatment of the structure of liquids, Physical properties of liquids, vapour pressure. Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald Viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment) Parachor-determination and application.	**11** **04**	**00** **00**	**-** **-**	**11** **04**
III	**Introduction to Organic Chemistry:** **IKS Contents:** Ancient organic chemistry and its development (from ancient to modern era). Importance of Organic Chemistry & organic systems to human beings & society. Some Known organic compounds present in nature in historic and pre-historic India Electronic displacements: Inductive effect, Electrometric effect, Resonance and hyperconjugation. Mechanism of organic reactions: Cleavage of Bonds-Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules- Nucleophiles and electrophiles. **Reactive Intermediates**: Carbocations, carbanions, free radicals, carbenes & nitrenes. Strength of organic acids and bases: comparison. Mechanism of organic reactions: Types of organic reactions with examples (addition, elimination, substitution, condensation,	**08**	**00**	**-**	**08**

	rearrangement, oxidation, reduction)				
	Aliphatic Hydrocarbons-1: ***Alkanes*** (upto 5 carbons) Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's Synthesis, from Grignard reagent. Corey-House Synthesis. **Reactions:** Free radical, Substitution, Halogenations.	**07**	**00**	**-**	**07**
IV	**Experimental Work:** **Inorganic Qualitative Analysis** • Analysis of samples containing 4 radicals including interfering radicals, phosphate, borate and fluoride.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L:Lectures*** ***T:Tutorials*** ***P:Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Analyze and apply fundamental principles of atomic structure and chemical bonding to predict the behavior of elements and compounds.

CO2: Apply methods and procedures to solve the Schrödinger wave equation, determine electronic configurations, and analyze periodic properties.

CO3: Explain Schrödinger's wave equation, periodic properties, kinetic gas equation, and the significance of electronic displacements and mechanisms in organic reactions.

CO4: Use principles of ionic bonding, kinetic theory, and organic reaction mechanisms to solve related problems and predict outcomes in practical scenarios.

CO5: Differentiate between various types of molecular interactions, such as ionic bonds, hydrogen bonds, and van der Waals forces, and interpret the behavior of gases and liquids under different conditions.

CO6: Assess the stability and solubility of ionic compounds, the effects of temperature and pressure on physical properties of liquids, and the strength of organic acids and bases.

CO7: Conduct qualitative inorganic analysis, prepare aliphatic hydrocarbons, and utilize laboratory techniques to measure physical properties of liquids and identify various radicals in samples.

CO8: Students will understand the ancient Indian concepts of *Paramāṇu*, *dravya*, *dvyaṇuka*, and *tryaṇuka* in atomic theory.

CO9: Students will recognize the evolution and significance of organic chemistry from ancient to modern times and its impact on humans and society.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO8,CO9	CO6			
Conceptual		CO3,CO4,CO5		CO1		
Procedural			CO2		CO7	
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Principles of Inorganic Chemistry, Puri, Sharma, Kalia, 33rd edition, Vishal Publishing Co, 2017
2. General and Inorganic Chemistry, R.P. Sarkar (part 1), 3rd edition, NCBA, 2011.
3. A Text Book of Physical Chemistry – A.S. Negi & S.C. Anand, 3rd Edition, New Age International, 2022.
4. Modern Organic Chemistry – M.K. Jain, S.C. Sharma, 54th Edition, Vishal Publishing Co, 2022.
5. A Text Book of Organic Chemistry (Vol. I &II)– B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)

Reference Books

1. Selected Topics in Inorganic Chemistry**,** Wahid U. Malik, G.D. Tuli and R.D. Madan, 8th Edition, S. Chand & Co. Ltd, 2019.
2. Principles of Physical Chemistry, Puri, Sharma, Pathania, 50th Edition, Vishal Publishing Co, 2025.
3. Advanced Organic Chemistry (Volume I & II), A. Bahl and B.S. Bahl, 23rd Edition, S Chand Publication, 2025

FYUGP

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course : Chemistry in Daily Life- 1
Course Code : CHE-GEC-3-101
Nature of the Course : CHEMISTRY GEC-01
Total Credits : 3
Distribution of Marks : 60 (End Sem) +40 (In-Sem)

COURSE OBJECTIVES:

- To understand the ancient Indian knowledge about food preservation and extraction method.
- The course introduces the students to the fascinating chemistry of some food products. Keeping the importance of food industry in mind this course is aimed to introduce food packaging, processing and preservation.

UNITS	CONTENTS	L	T	P	Total Hours
I	**IKS Contents**: Ancient Indian Concepts Related food additives, adulterants, and contaminants- The concept of vikāra (change, corruption) or aparādravya (non-substances/ adulterations) in certain classical texts can analogised to adulterants/contaminants. **Dairy Products:** Composition of milk and milk product. Principles of dairy safety; Milk processing. Qualitative analysis of fat content, minerals in milk and butter. Qualitative analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy	**14**	**00**	**-**	**14**
II	**Food additives:** Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose, and sodium cyclamate. Flavors: Vanillin, alkyl esters (fruit flavors), and monosodium glutamate.	**10**	**00**	**-**	**10**
III	**Food adulterants, and contaminants:** Food processing and packaging; Food adulteration: definition and its importance, adulterants present in- coffee, tea, milk, spices, grains and food colour; Difference between food adulteration and contamination.	**10**	**00**	**-**	**10**

IV	**Artificial food colorants:** Natural and synthetic colors, fake colors, inorganic pigments, application of colors in food industry, flavoring agents, Coal tar dyes and non-permitted colors and metallic salts. Utility of coal tar dyes in Food and cosmetics and its harmful effect.	**11**	**00**	**-**	**11**
	Total	**45**	**0**	**0**	**45**

Where, L:Lectures T:Tutorials P:Practicals

MODES OF IN-SEMESTER ASSESSMENT: 40 Marks

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Identify the composition of dairy products and food additives, and recall key concepts in food safety and processing.

CO2: Explain the principles behind dairy safety, milk processing, and the roles of various food preservatives and artificial sweeteners.

CO3: Utilize methods for qualitative analysis of fat, minerals, and caffeine in dairy products and beverages, and detect common adulterants and contaminants in foods.

CO4: Compare and contrast different food additives, artificial colorants, and their applications in the food industry, including their potential health impacts.

CO5: Assess the significance of food adulteration and contamination, and evaluate the harmful effects of synthetic colorants and non-permitted substances.

CO6: Develop methods to detect food adulterants and contaminants, and innovate safer and more effective food processing and packaging techniques.

CO7: Students will understand ancient Indian concepts of vikāra and aparādravya as early ideas related to food adulteration and contamination.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	CO1	CO7				
Conceptual		CO2,CO3	CO4,CO5			
Procedural					CO6	
Metacognitive						

SUGGESTED READINGS:

1. Food Science & Quality Control, B. Poornima- Centrum Press First edition 2014.
2. Post-Harvest Management of Horticultural crops, S.Saraswathy, T.L.Preethi AGRO BIOS (India) 2013.
3. A Handbook of Agn. Food processing and marketing, S.C. Gaur, Agro Bios (India) 2012.
4. Quality Control for value edition in Food processing, by Dev Raj, Rakesh Sharma & V.K. Joshi New India Publishing Agency,2011.
5. Food processing and preservation–Subbulakshmi, G.Shobha, A.Udipi, NewAge International (P) Ltd., 2006.

FYUGP

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	**:**	**Basic Analytical Chemistry**
Course Code	**:**	**CHE-SEC-3-101**
Nature of the Course	**:**	**CHEMISTRY SEC-01**
Total Credits	**:**	**3**
Distribution of Marks	**:**	**45 (End Sem) + 30 (In-Sem)**

COURSEOBJECTIVES:

- To provide a basic understanding of chemical analysis of soil, water, food products, cosmetics and separation techniques (viz. chromatography, ion exchange, etc.)

UNITS	CONTENTS	L	T	P	Total Hours
I	**Introduction:** Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.	**03**	**0**	**-**	**03**
	IKS contents: on soil and water- Concepts like "Bhoomi Mata" (Earth as Mother) and "Jala Deva" (Water as Divine) **Analysis of soil:** Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators a. Determination of pH of soil samples. Estimation of Calcium and calcium carbonate by complexometric titration.	**05**	**0**	**-**	**05**
II	**Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. a. Determination of pH, acidity and alkalinity of a water sample. b. Determination of dissolved oxygen (DO) of a water sample.	**05**	**0**	**-**	**05**
	Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration. a. Identification of adulterants in some common food items like coffee powder, asafetida, chilli powder, turmeric powder, coriander powder and pulses, etc. b. Analysis of preservatives and colouring matter.	**05**	**0**	**-**	**05**

III	**IKS Contents:** IKS on Chromatography-The process of "Bhavana" (triturating herbs with liquids repeatedly), Different solvents (water, oil, alcohol, ghee) extracted different types of phytochemicals, much like solvent polarity in chromatography. **Chromatography:** Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. a. Paper chromatographic separation of mixture of metal ion ($Fe^{3+}$and Al^{3+}). b. To compare paint samples, food dyes or organic pigments by TLC method.	**04**	**0**	**-**	**04**
	Ion-exchange: Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion /cation exchange resin (using batch procedure if use of column is not feasible).	**04**	**0**	**-**	**04**
	Analysis of cosmetics: Major and minor constituents and their function a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.	**04**	**0**	**-**	**04**
IV	**Any one experiment:** i. Determination of dissolved oxygen (DO) in water. ii. Determination of Chemical Oxygen Demand (COD) iii. Determination of Biological Oxygen Demand (BOD) iv. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry v. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets. vi. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drinks	**-**	**-**	**15**	**15**
	Total	**30**	**0**	**15**	**45**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **30 Marks**

- Two Internal Examination - **20 Marks**
- Others (Anyone) - **10 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a thorough understanding of the principles and practices in analytical chemistry, including sampling, measurement accuracy, and data presentation.

CO2: Gain practical experience in analyzing soil, water, and food products, understanding their composition, and detecting adulterants.

CO3: Learn the techniques in chromatography and ion-exchange, and apply these techniques to real-world samples.

CO4: Acquire skills in analyzing cosmetics and conducting advanced practical experiments to measure various chemical parameters.

CO5: Enhance critical thinking and problem-solving abilities in the context of analytical chemistry applications.

CO6: Students will appreciate ancient Indian views of Bhoomi Mata and Jala Deva, emphasizing the sacredness and sustainable use of soil and water.

CO7: Students will relate the ancient process of Bhavana to modern chromatography and understand the role of solvents in extracting phytochemicals.

Cognitive map of course outcomes with Bloom'sTaxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO6, CO7		CO5		
Conceptual	CO1	CO2	CO3			
Procedural				CO4		
Metacognitive						

SUGGESTED READINGS:

1. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA,1988.
2. Skoog, D.A., Holler ,F.J. & Crouch, S. Principles of Instrumental Analysis, Cengage Learning India Edition, 2007.
3. Skoog ,D.A.; West, D.M. & Holler, F.J. Analytical Chemistry: An Introduction 6th Ed., Saunders College Publishing, Fort Worth, Philadelphia (1994).
4. Harris, D.C. Quantitative Chemical Analysis, 9th ed. Macmillan Education, 2016.
5. Dean, J.A. Analytical Chemistry Handbook, McGraw Hill, 2004.
6. Day, R.A. & Underwood, A.L. Quantitative Analysis, Prentice Hall of India, 1992.
7. Freifelder, D.M. Physical Biochemistry 2nd Ed., W.H. Freeman & Co., N.Y. USA (1982).
8. Cooper, T.G. The Tools of Biochemistry, John Wiley & Sons, N.Y. USA. 16 (1977).
9. Vogel, A.I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall, 1996.
10. Mendham, J.,A.I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
11. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., NewYork (1995).
12. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004
13. Higson, S.P.J. (2003), Analytical Chemistry, Oxford University Press.
14. Fifield, F.W.; Kealey, D. (2000), Principles and Practice of Analytical Chemistry, Wiley.
15. Harris, D.C.(2007), Exploring Chemical Analysis, W.H. Freeman and Co.

FYUGP

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	**:**	**Chemistry C2: Inorganic + Physical + Organic**
Course Code	**:**	**CHE-MAJ-4-201**
Nature of the Course	**:**	**CHEMISTRY MAJOR**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To impart knowledge of ancient concept about metallurgy, petroleum and thermodynamics.
- To give concept about the chemistry of non-transition elements, metallurgy, 1st law of thermodynamics, solid state chemistry and chemistry of aliphatic hydrocarbons.

UNITS	CONTENTS	L	T	P	Total Hours
I	**IKS Contents:** Rasashastra (Alchemy and Metallurgy) – Methods of metal purification (Shodhana) and calcinations (Marana), metallic medicines (bhasmas). Metallurgical heritage : Wootz steel, zinc smelting at Zawar, copper and bronze corrosion resistance in Indian iron pillars. **Non Transition elements:** a) Noble Gas: Compounds of Xenon only (Preparation, properties and structure) b) Boron: Borane, structure of boron hydrides (B_2H_6), carborane, metalloborane, metallocarboranes, wade's rule, nomenclature of closo, nido and arachno boranes, borazine, phosphazine, S_4N_4, $(SN)_x$ –preparation, structure and uses. c) Carbon: Fullerenes (C_{60}) Synthesis, structure and uses d) Silicon: silicones, classifications and structure of silicates. Zeolites, use of Zeolites as catalyst and molecular sieve, aluminosilicates. e) Nitrogen: Hydrazine, hydroxylamine and hydrazoic acid (Preparation, properties and structure) f) Phosphorus: Phosphines, oxy acids of phosphorus, organophosphorus compounds.	**09**	**0**	**-**	**09**

	Metals and metallurgy: Theory of reduction (Thermodynamic approach), role of carbon and other reducing agents, electrolytic reduction, roasting and calcinations. Method of purification and refining of metals including modern methods like zone refining, vacuum arc process, ion exchange, solvent extraction and electrolytic method, Van-Arkel process and hydrometallurgy. **Inorganic reagents:** Potassium dichromate, manganese dioxide, potassium permanganate, ammonium molybdate, sodium cobaltinitrite, cobalt nitrate, Ni-DMG, vanadium pentoxide.	**06**	**0**	**-**	**06**
II	**IKS Contents:** Philosophical Foundations Linking to Thermodynamics- Panchabhuta theory- Prithvi (Earth), Ap (Water), Agni/ Tejas (Fire), Vayu (Air), Akasha (Space), interaction of these elements especially Agni (heat/ energy) with Prithvi (solid substances). Spontaneity and Reaction Propensity- "Samsargaja" reactions: happen spontaneously under natural conditions, "Siddha" reactions require specific treatment. **Chemical Thermodynamics-I:** Extensive and intensive properties of a system, thermodynamic processes: cyclic, reversible, irreversible processes, thermodynamic function, complete differential, Zeroth law of thermodynamics. First law of thermodynamics- internal energy, enthalpy, molar heat capacities, relation between Cp and Cv, work of expansion in reversible and irreversible process, adiabatic process, relation between P, V, T. Variation in internal energy and enthalpy with temperature, Joule Thomson effect, calculation of Joule Thomson co-efficient for ideal and Van der Waal's gas. Thermochemistry-Hess's law, Kirchhoff's law relation of reaction enthalpy with internal energy, Bond energy and Bond dissociation energy, calculation from thermo chemical data.	**08**	**0**	**-**	**08**

	Solids: Basic laws of crystallography, crystal system, crystal lattice, Miller indices, and simple face centered and body centered cubic lattice, number of points in a unit cell. X-Ray diffraction study of crystals, Bragg's law, determination of crystal structure- introduction to powder and single crystal methods of structure analysis, crystal structure of NaCl and KCl, packing of crystals, closed packed structure, radius ratio, crystal defect-point defects, conductors, semiconductors and insulators from band theory.	**06**	**0**	**-**	**06**
III	**Carbon-Carbon sigma bonds:** **IKS Contents:** Early theories on origin of petroleum**.** **Hydrocarbon as a source of heat and energy.** Chemistry of Alkanes: Preparation of alkanes with special emphasis on Corey House Synthesis, Wurtz reaction, Wurtz-Fittig reaction. Reactions of alkanes: Free Radical substitution, Halogenations- Relative reactivities and selectivity.	**04**	**0**	**-**	**04**
	Carbon-Carbon pi bonds: Preparation of alkenes and alkynes Elimination: Mechanism of E1, E2, E1cB reactions. Saytzeff and Hoffmann elimination, special emphasis on preparation of alkenes by syn elimination:- pyrolysis of esters, Chugaev reaction and Wittig reaction. ***Reaction of alkenes***: Addition Reaction-Electrophilic and free radical additions, their mechanisms. (Markonikoff/ Anti Markonikoff addition) regioselectivity (directional selectivity), and stereoselectivity of addition reactions. Mechanism of oxymercuration–demercuration, Hydroboration-Oxidation, Ozonolysis, reduction (catalytic hydrogenation and complex metal hydride). ***Syn and Anti hydroxylation*** (oxidation), simple effect of stereo selectivity and stereo specificity. ***Reactions of Alkynes***: Acidic character of alkynes, Electrophilic and Nucleophilic additions, Hydration of alkynes to form carbonyl compounds. Alkylation of terminal alkynes	**12**	**0**	**-**	**12**

IV	**EXPERIMENTAL WORK (A):** **Oxidation-Reduction Titrimetry (any one)** 1. Estimation of Fe (II) or oxalic acid using standard $KMnO_4$ solution. 2. Estimation of Fe (II) with $K_2Cr_2O_7$ using Diphenylamine as internal indicator.	**-**	**-**	**15**	**15**
	EXPERIMENTAL WORK (B): i. Detection of elements (N, S and Halogens) ii. Detection of functional groups.	**-**	**-**	**15**	**15**
	Total	**45**	**0**	**30**	**75**

Where, L:Lectures T:Tutorials P:Practicals

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a comprehensive understanding-transition elements and metals.

CO2: Gain in-depth knowledge of chemical thermodynamics and the properties of solids, including crystallography and X-ray diffraction.

CO3: Master the formation and reactions of carbon-carbon sigma and pi bonds, with a focuson alkanes, alkenes, and alkynes.

CO4: Acquire practical laboratory skills in the purification and analysis of organic compounds, enhancing problem-solving abilities and technical expertise in analytical techniques.

CO5: Students will understand ancient Indian advancements in Rasashastra, including metal purification, bhasma preparation, and metallurgical achievements like Wootz steel and zinc smelting.

CO6: Students will relate the Panchabhuta theory to thermodynamic principles, understanding ancient ideas of energy, spontaneity, and reaction behavior.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		CO1,CO6, CO7				
Conceptual	CO2		CO3			
Procedural					CO4	
Metacognitive						

SUGGESTED READINGS:

Text Books

1. Advanced Inorganic Chemistry**,** S. Prakash, S.K. Basu, G.D. Tuli, 17th Edition, S. Chand, 2022.
2. Principles of Inorganic Chemistry, Puri, Sharma, Kalia, 33rd edition, Vishal Publishing Co, 2017
3. Inorganic Chemistry: Principles of Structure and Reactivity, J.E. Huheey, E.A. Keiter, R.L. Keiter and O.K. Medhi, 5th Edition., Pearson Education, 2023.
4. Concise Inorganic Chemistry, J.D. Lee, 5th Edition, Chapman & Hall, 2008
5. A Text Book of Physical Chemistry – A.S. Negi & S.C. Anand, 3rd Edition, New Age International, 2022.
6. Principles of Physical Chemistry, Puri, Sharma, Pathania, 50th Edition, Vishal Publishing Co, 2025.
7. Modern Organic Chemistry – M.K. Jain, S.C. Sharma, 54th Edition, Vishal Publishing Co, 2022.
8. Organic Chemistry (Volumes 1 and 2), I.L. Finar, 6th Edition., Pearson Education, 2002
9. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, 7th Edition, Pearson Education, 2011.
10. Stereochemistry, Conformation and Mechanism, P.S. Kalsi, 11th Edition, New Age international Publisher, 2022.
11. Advanced General Organic Chemistry (Volume I & II), S.K.Ghosh, 9th Edition, NCBA, 2009.

Reference Books:

1. Selected Topics in Inorganic Chemistry**,** Wahid U. Malik, G.D. Tuli and R.D. Madan, 8th Edition, S. Chand & Co. Ltd, 2019.
2. Inorganic Chemistry, P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, 7th Edition., Oxford University Press, 2018.
3. Physical Chemistry, P. Atkins, J de Paula and J. Keeler, 11th Edition, Oxford University Press, 2018.
4. Physical Chemistry- G.W. Castellan, 3rd Edition, Narosa Publishing House, 2004.
5. Advanced Organic Chemistry, A. Bahl and B.S. Bahl, 23rd Edition, S Chand Publication, 2025.

FYUGP

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	**:**	**Fundamentals of Chemistry-2**
Course Code	**:**	**CHE-MIN-4-201**
Nature of the Course	**:**	**CHEMISTRY MINOR COURSE-2**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSEOBJECTIVES:

- To understand the ancient Indian knowledge system about chelating agents, dyes, petroleum chemistry, surface chemistry etc.
- To develop the basic knowledge of chemistry in relation to atomic structure, bonding. To emphasize on different states of matter & their mechanical treatment.
- To develop preliminary knowledge in basic organic chemistry, hydrocarbons, stereochemistry & conformational analysis etc.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Coordination Chemistry:** Review of Werner's theory. Types of ligands, monodentate, bidentate ambidentate and polydentate ligands (including Acceptor and macrocyclic ligands. IUPAC nomenclature of Co-ordination compounds, Isomerism of 4-and 6- coordinate compounds. Introduction to Valence Bond and Crystal Field theory. Application of dimethyl glyoxime, EDTA, 8-hydroxyquinoline, 2,2-bipyridyl, and ethylenediamine in analysis**.**	**08**	**0**	**-**	**08**
	IKS Contents: Kaṇāda theory of bonding **(saṃyoga)** and separation **(vibhāga)** — analogous to formation andbreaking of chemical bonds. **Chemical Bonding and Molecular Structure-2** Covalent Bonding: VB Approach-Concept of hybridization, sp, sp^2, sp^3, sp^3 d, sp^3d^2 and dsp^2 VSEPR Theory. Resonance and Resonance energy: Study of some inorganic and organic compounds (O_3, NO_3^-, CO_3^{2-}, SO_4^{2-}, $RCOO^-$, C_6H_6). Molecular Orbital Approach: LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combination of atomic orbitals, non-bonding combination of	**08**	**0**	**-**	**08**

	orbitals, MO treatment of homonuclear diatomic molecules and heteronuclear Diatomic molecules such as CO, NO and NO^+				
II	**Solids** Forms of solids, unit cells, crystal systems, Bravais lattice, types and identification of lattice planes. Miller and Weiss indices. Laws of crystallography-Law of constancy of interfacial angles. Law of rational indices. X-Ray diffraction by crystals. Bragg's law. Structure of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Liquid crystals.	**07**	**0**	**-**	**07**
	Chemical Thermodynamics & First law Thermal equilibrium and zeroth law of thermodynamics- concept of temperature, Mechanical work, SI sign convention.1st law of thermodynamics, internal energy, enthalpy, reversible and irreversible processes, calculation of W, Q, ΔU, ΔH for expansion of ideal gas , isothermal work and enthalpy, relation between enthalpy change, and entropy change, molar heat capacities, relation between Cp and Cv, adiabatic processes-relation between P, V and T, Joule-Thomson effect, liquefication of gases, conversion of heat into work, efficiency of heat engine. Enthalpy of reaction, thermodynamical equation, variation of enthalpy of reaction with temperature-Kirchhoff's equation, enthalpy of different processes. Hess law, calculations based on Hess law.	**08**	**0**	**-**	**08**
	Stereochemistry: Conformation with respect to ethane, butane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). **Configuration:** Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso Compounds. Threo and erythro; D and L; Cis-trans nomenclature; CIP Rules.	**07**	**0**	**-**	**07**
	Aliphatic Hydrocarbons-2 **Alkenes:**(upto 5 carbons): *Preparation*: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl				

III	halides (Saytzeff's rule). Reactions: cis-addition (*alk*.KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti Markownikoff's addition), Hydration, Ozonolysis. **Alkynes:**(upto 5 carbons): *Preparation*: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetrahalides and dehydrohalogenation of vicinal dihalides. *Reactions*: formation of metal acetylides, addition of bromine and alkaline KMnO4 Ozonolysis and oxidation with hot alk. KMnO4.	**07**	**0**	**-**	**07**
	Experimental Work: **Surface tension /Viscosity/ pH-metry (Any one experiment)** (i) Determine the surface tension of various liquids by Drop number method. (ii) Determination of viscosity of aqueous solutions at room temperature. (iii) Study the variation of surface tension of detergent solutions with concentration. (iv) Determination of viscosity of aqueous solutions of (a) polymer (b) ethanol and (c) sugar at room (v) pH-metric titration; (a) strong acid vs. strong base (b) weak acid vs. strong base (vi) Preparation of buffer solutions of different pH (a) sodium acetate-acetic acid (b) ammonium chloride-ammonium hydroxide (c) Determination of dissociation constant of weak acid (CH_3COOH)	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L:Lectures*** ***T:Tutorials*** ***P:Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Anyone) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Apply the concepts of Werner's theory, isomerism in coordination compounds and Valence Bond and Crystal Field theories, to understand and solve problems related to the structure and function of coordination compounds.

CO2: Evaluate the bonding and structural properties of various inorganic and organic compounds by applying concepts of covalent bonding theories, including hybridization, VSEPR, resonance and MO.

CO3: Gain a clear understanding of coordination chemistry, including its theories, naming rules, and types of ligands.

CO4: Learn about chemical bonding, molecular structures, and the basics of solid-state chemistry.

CO5: Understand stereochemistry and the chemistry of aliphatic hydrocarbons, including how to make and react them.

CO6: Develop practical lab skills in measuring surface tension, viscosity, and pH, and in making buffer solutions, which will improve your problem-solving and technical abilities in analytical techniques.

CO7: Students will understand Kaṇāda's concepts of saṃyoga and vibhāga as early ideas analogous to chemical bond formation and breaking.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO3				
Conceptual	CO4	CO5	CO1			
Procedural					CO2, CO6	
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Principles of Inorganic Chemistry, Puri, Sharma & Kalia, 33rd Edition, Vishal Publishing Co, 2017.
2. General and Inorganic Chemistry, R.P. Sarkar (part 1) 3rd Edition, NCBA, 2011.
3. A Text Book of Physical Chemistry – A.S. Negi & S.C. Anand, 3rd Edition, New Age International, 2022.
4. Modern Organic Chemistry – M.K. Jain, S.C. Sharma, 54th Edition, Vishal Publishing Co, 2022
5. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)

Reference Books:

1. Selected Topics in Inorganic Chemistry**,** Wahid U. Malik, G.D. Tuli and R.D. Madan, 8th Edition, S. Chand & Co. Ltd, 2019.
2. Principles of Physical Chemistry, Puri, Sharma, Pathania, 50th Edition, Vishal Publishing Co, 2025.
3. Organic Chemistry - B.S. Bahl and A. Bahl (Vol. I & II), 23rd Edition, S. Chand Publishing , 2025.

FYUGP

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course : Chemistry in Daily Life- 2
Course Code : CHE-GEC-3-201
Nature of the Course : CHEMISTRY GEC-02
Total Credits : 3
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To introduce the students to the chemistry of some biomolecules.
- To familiarized the students with vitamins and their importance in human body.

UNITS	CONTENTS	L	T	P	Total Hours
I	**IKS Contents:** Vitamins- Dietary Principles (*Ahara*), balanced diet (*Sattvic Ahara*), *Rasa* (taste), *Guna* (quality), *Virya* (potency), *Vipaka* (post-digestive effect), Specific Herbs and Minerals **Vitamins**: Classification and Nomenclature. Sources, deficiency diseases, and structures of Vitamin A, Vitamin B, Vitamin C, Vitamin D, Vitamin E & Vitamin K.	**12**	**0**	**-**	**12**
II	**Oils and fats:** Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like argemone oil and mineral oils. **Soaps & Detergents:** Definition, classification, manufacturing of Soaps and detergents, composition and uses.	**10**	**0**	**-**	**10**
III	**Proteins:** Sources, Composition and Biological values of protein, Elementary ideas of proteins and amino acids, Essential and Non-essential amino acids. Peptide bonds, Polypeptides, Qualitative ideas of structure of proteins (Primary, secondary, Tertiary and Quaternary structure), Denaturation and coagulation of proteins; Factors contributing to denaturation and coagulation of proteins.	**12**	**0**	**-**	**12**
IV	**Nucleic Acids:** Nucleic acids and their Chemical composition. Classification, functions and structure of nucleic acids. Concept of DNA fingerprinting and its applications.	**11**	**0**	**-**	**11**
	Total	**45**	**0**	**0**	**45**

Where, L: Lectures T:Tutorials P:Practicals

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a comprehensive understanding of vitamins, including their sources, deficiency diseases, and chemical structures.

CO2: Gain in-depth knowledge of oils and fats, including detection of purity, rancidity, and the manufacturing and uses of soaps and detergents.

CO3: Understand the composition, structure, and biological significance of proteins and amino acids.

CO4: Learn about nucleic acids, their chemical composition, classification, functions, and applications such as DNA fingerprinting.

CO5: Students will understand ancient Indian dietary principles and concepts related to Ahara, Rasa, Guna, Virya, and Vipakaas foundations for vitamin and nutrition science.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	CO1,CO2	CO5				
Conceptual		CO3,CO4				
Procedural						
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Berg, J.M.; Tymoczko, J.L.; Stryer, L. (2006), Biochemistry. W.H. Freeman and Co.
2. Nelson, D.L.; Cox, M.M.; Lehninger, A.L. (2009), Principles of Biochemistry. W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A.; Rodwell, V.W. (2009), Harper's Illustrated Biochemistry. Lange Medical Books / McGraw-Hill.
4. Brown, T.A. (2018) Biochemistry, (First Indian addition 2018) Viva Books.
5. Kumar, A.; Garg, S.; Garg, N. (2012), Biochemical Tests: Principles and Protocols.
6. Finar, I. L. (2008), Organic Chemistry, Volume 2, 5th Edition, Pearson Education

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FYUGP

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	**:**	**Basic Analytical Chemistry-02**
Course Code	**:**	**CHE-SEC-3-201**
Nature of the Course	**:**	**CHEMISTRY SEC-02**
Total Credits	**:**	**3**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- The course aims to provide students with a basic scientific and technical understanding of the production, behaviour and handling of hydrocarbon fuels, petrochemicals and lubricants. This will enable them to be industry ready to contribute effectively in the field of petroleum chemistry and technology.

UNITS	CONTENTS	L	T	P	Total Hours
I	**IKS Contents:** Philosophical Basis on renewable energy-Vedic concept of *"Prakriti"* (nature) and *"Sthira"* (balance) Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.	**03**	**0**	**-**	**03**
	Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—Composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals.	**06**	**0**	**-**	**06**
II	***Petroleum and Petrochemical Industry*:** Composition of crude petroleum; Different types of petroleum products and their applications. Principle and process of fractional distillation, Cracking - Thermal and catalytic cracking; Qualitative treatment of non-petroleum fuels -LPG, CNG, LNG, bio-gas, fuels derived from biomass, fuel from waste; synthetic fuels -gaseous and liquids.	**09**	**0**	**-**	**09**
	Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene, and its derivatives Xylene.	**06**	**0**	**-**	**06**
III	***Lubricants:*** Classification of lubricants, lubricating oils (conducting and non-conducting), Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants–viscosity index, cloud point, pore point	**06**	**0**	**-**	**06**

IV	**Experimental Work (Any one Experiment)**: (i) To determine the Aniline point of a given lubricating oil. (ii) To determine the acid value of a given oil (iii) To determine the enthalpy of combustion of liquid fuels using spirit / alcohol burner. (iv) To perform the proximate analysis of coal (v) To perform the ultimate analysis of the coal sample.	**-**	**-**	**15**	**15**
	Total	**30**	**0**	**15**	**45**

Where, L:Lectures T:Tutorials P:Practicals

MODES OF IN-SEMESTER ASSESSMENT: 30 Marks

- Two Internal Examination - **20 Marks**
- Others (Anyone) - **10 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a thorough understanding of energy sources, their classification, and the calorific value of fuels.

CO2: Gain comprehensive knowledge of coal, its industrial uses, and the production and applications of its derivatives.

CO3: Learn about the petroleum and petrochemical industry, including the composition and processing of crude petroleum, and the significance of various petrochemicals.

CO4: Understand the classification, properties, and applications of lubricants.

CO5: Acquire hands-on experience in conducting experiments related to lubricants and fuel analysis, enhancing problem-solving and technical skills in analytical techniques.

CO6: Students will understand the Vedic concepts of Prakriti and Sthira as philosophical foundations for renewable energy and environmental balance.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		CO1,CO6				
Conceptual		CO2,CO3	CO4			
Procedural				CO5		
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. E. Stocchi (1990) Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
1. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
2. B. K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut

FYUGP

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**Chemistry C3: Inorganic + Physical + Organic**
Course Code	**:**	**CHE-MAJ-4-301**
Nature of the Course	**:**	**CHEMISTRY MAJOR**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To understand the Indian knowledge system about plant based ligands, green chemistry and thermodynamics chemistry.
- To develop the basic knowledge of chemistry in relation to *d* and *f* block elements and coordination compounds
- To develop the basic knowledge of chemistry in relation to chemical thermodynamics and ionic equilibrium
- To develop the basic knowledge of chemistry in relation to cycloalkanes and conformational analysis and chemistry of halogenated hydrocarbons.

UNITS	CONTENTS	L	T	P	Total Hours
I	***d* block elements:** General group trends with special reference to electronic configuration, colour, variable valency, magnetic, spectral and catalytic properties, ability to form complexes. ***f* block elements**: Electronic configuration, oxidation states, colour, spectral and magnetic properties of lanthanides and actinides. Lanthanide contraction, separation of Lanthanides (ion-exchange method only).	**06**	**0**	**-**	**06**
	Coordination compounds: Types of ligands: monodentate, bidentate, ambidentate, polydentate and macro cyclic ligand. IUPAC Nomenclature of coordination compounds, Effective atomic number (EAN) rule, valence bond theory (VBT), crystal field theory (CFT), MOT and introduction to ligand field theories (LFT) and their applications. *Magnetic properties:* paramagnetism, diamagnetism, magnetic properties of octahedral complexes, ferromagnetism, antiferromagnetism and ferrimagnetism.	**09**	**0**	**-**	**09**

	IKS Contents: Second Law and Entropy: Sāmkhya philosophy's concept of dynamic balance among Gunas (Sattva, Rajas, Tamas) as a natural move toward equilibrium. Gibbs Free Energy: The Ayurvedic notion of Ojas as usable energy or vitality within a system. **Chemical Thermodynamics II:** Second law of thermodynamics, Carnot's theorem, Carnot cycle, efficiency of heat engines, thermodynamic scale of temperature, concept of entropy, entropy change in a cyclic, reversible, irreversible processes, calculation of entropy changes of an ideal gas with change in P, V, T, entropy change in physical transformation, entropy of mixing. Helmholtz free energy (A) and Gibb's free energy (G), variation of A and G with P,V,T, criteria for spontaneity and equilibrium, Maxwell's relationship, Gibb's–Helmholtz equation. Nernst heat theorem-consequence of the theorem, third law of thermodynamics, and its verification. Determination of absolute entropies of pure substance.	**10**	**0**	**-**	**10**
II	**Ionic equilibrium:** Strong and weak electrolyte with modern classification of electrolytes (true and potential electrolyte), degree of ionization, factors affecting degree of ionization, ionization constant, ionic product of water, ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts, buffer solution, derivation of Henderson equation and its applications, buffer capacity, buffer range, buffer action. Solubility and solubility product of sparingly soluble salts-application of solubility product principle in salt analysis. Qualitative treatment of acid-base titration curves. Theory of acids- base indicators, selection of indicators and their limitations.	**06**	**0**	**-**	**06**

III	**Cyclo alkanes and conformational analysis:** Synthesis and reactions of three, four, five and six membered cycloalkanes, Their relative stability, Baeyer strain theory. Conformational analysis of Alkanes: (ethane & butane) Relative stability, Energy diagram. Cyclohexane: Chair, Boat and Twist boat forms, Relative stability with energy diagram, axial and equatorial bonds including perspective representation and Newman projections. Conformation & conformational analysis monosubstituted cyclohexane derivatives.	**07**	**0**	**-**	**07**
	Chemistry of Halogenated Hydrocarbons Alkyl halides: Methods of preparation including Hunsdiecker reaction from silver or lead (IV) salts of carboxylic Acid). **Nucleophilic substitution reactions:** SN_1, SN_2, and SN_i Mechanisms with stereochemical aspects and effect of solvent. Nucleophilic substitution vs elimination. Haloform reaction. **Aryl halides:** Preparation from diazonium salts. Nucleophilic Aromatic Substitution SNAr, Benzyne intermediates. Relative reactivity of alkyl, allyl/ benzyl, vinyl and aryl halides towards Nucleophilic substitution reactions.	**07**	**0**	**-**	**07**
IV	**EXPERIMENTAL WORK (Any one):** (i) Determine the surface tension of various liquids by drop number method. (ii) Determination of viscosity of aqueous solutions at room temperature. (iii) Study the variation of surface tension of detergent solutions with concentration. (iv) Determination of viscosity of aqueous solutions of (a) Polymer (b) ethanol and (c) sugar at room temperature.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, L:Lectures T:Tutorials P:Practicals

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSEOUTCOMES:

At the end of this programme, students will be able to-

CO1: Develop a solid understanding of the properties and behaviors of d and f block elements and coordination compounds.

CO2: Gain comprehensive knowledge of chemical thermodynamics and ionic equilibrium.

CO3: Learn the concepts and applications of cycloalkanes, conformational analysis, and halogenated hydrocarbons.

CO4: Acquire practical laboratory skills in measuring surface tension and viscosity, enhancing analytical and problem-solving abilities.

CO5: Students will relate the Sāmkhya concept of Gunas and the Ayurvedic idea of Ojas to modern principles of entropy and Gibbs free energy.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO5				
Conceptual	CO1	CO2,CO3				
Procedural					CO4	
Metacognitive						

SUGGESTED READINGS:

Text Books

1. Advanced Inorganic Chemistry, S. Prakash, S.K. Basu, G.D. Tuli, 17th Edition, S. Chand, 2022.
2. Principles of Inorganic Chemistry, Puri, Sharma, Kalia, 33rd Edition, Vishal Publishing Co, 2017
3. Inorganic Chemistry: Principles of Structure and Reactivity, J.E. Huheey, E.A. Keiter, R.L. Keiter and O.K. Medhi, 5th Edition., Pearson Education, 2023.
4. Concise Inorganic Chemistry, J.D. Lee, 5th Edition, Chapman & Hall, 2008
5. A Text Book of Physical Chemistry – A.S. Negi & S.C. Anand, 3rd Edition, New Age International, 2022.
6. Principles of Physical Chemistry, Puri, Sharma, Pathania, 50th Edition, Vishal Publishing Co, 2025.
7. Modern Organic Chemistry – M.K. Jain, S.C. Sharma, 54th Edition, Vishal Publishing Co, 2022.
8. Organic Chemistry (Volumes 1 and 2), I.L. Finar, 6th Edition., Pearson Education, 2002
9. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, 7th Edition, Pearson Education, 2011.
10. Stereochemistry, Conformation and Mechanism, P.S. Kalsi, 11th Edition, New Age international Publisher, 2022.
11. Advanced General Organic Chemistry (Volume I & II), S.K.Ghosh, 9th Edition, NCBA, 2009.

Reference Books:

1. Selected Topics in Inorganic Chemistry, Wahid U. Malik, G.D. Tuli and R.D. Madan, 8th Edition, S. Chand & Co. Ltd, 2019.
2. Inorganic Chemistry, P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, 7th Edition., Oxford University Press, 2018.
3. Physical Chemistry, P. Atkins, J de Paula and J. Keeler, 11th Edition, Oxford University Press, 2018.
4. Physical Chemistry- G.W. Castellan, 3rd Edition, Narosa Publishing House, 2004.
5. Advanced Organic Chemistry, A. Bahl and B.S. Bahl, 23rd Edition, S. Chand Publication, 2025.

FYUGP

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**Chemistry C4: Inorganic + Physical + Organic**
Course Code	**:**	**CHE-MAJ-4-302**
Nature of the Course	**:**	**CHEMISTRY MAJOR**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To understand the Indian knowledge system about acid, base and traditionally known alcoholic beverage
- To understand the concepts of acids and bases, including Brönsted-Lowry and Lewis theories, and the application of HSAB principles.
- To learn about inorganic reaction mechanisms, conductance, and electrochemistry, including substitution reactions in complexes, conductometric titrations, and the principles of electrochemical cells.
- To explore aromatic hydrocarbons, electrophilic aromatic substitution, and the chemistry of C-O bonds in alcohols, phenols, ethers, and epoxides,
- To conduct experimental work in conductometry, thermochemistry, and qualitative organic analysis.

UNITS	CONTENTS	L	T	P	Total Hours
I	**IKS Contents:** Acidic and basic herbs- Sour (acidic) herbs → stimulate digestion (Pitta), Bitter/ alkaline herbs → detoxification (Kapha) **Acids and Bases:** Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, classification of Lewis acids, hard and soft acids and bases (HSAB), Application of HSAB principle.	**06**	**0**	**-**	**06**
	Inorganic reaction mechanism: Introduction to inorganic reaction mechanism, inert and labile complexes, association, dissociation and concerted paths. Acid and base hydrolysis (with reference to cobalt complexes only). Substitution reaction in octahedral and square planar complexes. Trans effect, Irving-William series.	**10**	**0**	**-**	**10**

	Conductance: Arrhenius theory of electrolytic dissociation, conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes, molar conductivity at infinite dilution, Kohlrausch law of independent migration of ions, Debye-Huckel-Onsagar equation, Wien effect, Debye-Falkenhagen effect, Walden's rule. Ionic mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and moving boundary methods (principle only , calculations not required), anomalous transference number, application of conductance measurement: i) degree of dissociation of weak electrolytes ii) ionic product of water iii) solubility and solubility product of sparingly soluble salts iv)Hydrolysis constant of aniline hydrochloride, v) Conductometric titration (Acid-Base and precipitation).	**06**	**0**	**-**	**06**
II	**Electrochemistry:** Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions Based on half-cell potentials, applications of electrolysis in metallurgy and industry. Electrochemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) Free energy, enthalpy and entropy of a cell reaction, (ii) Equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation)	**07**	**0**	**-**	**07**
III	**Aromatic Hydrocarbons** **Aromaticity:** Huckel's rule, aromatic characters of arenes, benzenoid, non-benzenoid- aromatic compounds and heterocyclic and polynuclear hydrocarbons with suitable examples.				

	Synthesis and properties of naphthalene and anthracene. Antiaromaticity and nonaromaticity Electrophilic Aromatic Substitution: Halogenation, nitration, sulphonation and Friedel-craft's alkylation / acylation with their mechanism. Activation/ Deactivation of aromatic ring and directing effects of groups. Partial rate factor (O/P ratio)	**08**	**0**	**-**	**08**
	IKS Contents: Chemistry of C-O Bond Alcohols: traditionally known alcoholic beverage such as sugarcane juice other fruit juice or fermented fruit juice during historic and pre historic India **Preparation and properties of Glycol:** Oxidation by OsO_4, alkaline, KMnO4, periodic acid and lead tetracetate. Pinacol Pinacolone rearrangement with mechanism. ***Trihydric alcohol:*** Glycerol: preparation & properties. ***Phenols:*** Preparation and properties: acidity- comparison with alcohol. Substitution reaction, Reimer- Tiemann and Kolbe-Schmidt reaction, Fries rearrangement with mechanism. **Other aromatic Hydroxy compounds:** Cresol, nitrophenols, picric acid, benzyl alcohol, dihydric phenols. **Ethers and Epoxides:** Preparation and reactions with acids.	**08**	**0**	**-**	**08**
IV	**EXPERIMENTAL WORK(A):** **Conductometry and Thermochemistry** **(Any one experiment)** (i) Determination of cell constant and hence the specific conductance of an electrolyte. (ii) Conductometric titrations: a) strong acid vs. strong base (b) weak acid vs strong base (iii) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide. (iv)Calculation of the enthalpy of ionization of ethanoic acid.	**-**	**-**	**15**	**15**

	EXPERIMENTAL WORK (B): Detection of functional groups in unknown organic compounds (alcohols, carboxylic acid , nitro, amine, phenols and carbonyl compounds)	**-**	**-**	**15**	**15**
	Total	**45**	**0**	**30**	**75**

Where, L:Lectures T:Tutorials P:Practicals

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Anyone) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this programme, students will be able to-

CO1: Develop a solid understanding of the properties and behaviors of acids, bases, and inorganic reaction mechanisms.

CO2: Gain comprehensive knowledge of conductance, electrochemistry, aromatic hydrocarbons, and the chemistry of the C-O bond.

CO3: Learn the concepts and applications of theoretical principles in practical contexts.

CO4: Acquire practical laboratory skills in inorganic synthesis, enhancing analytical and problem-solving abilities.

CO5: Students will understand the traditional classification of herbs based on taste and effect, linking acidic herbs with Pitta and alkaline herbs with Kapha balance.

CO6: Students will recognize traditional knowledge of alcohol preparation in ancient India through fermentation of sugarcane and fruit juices.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO5,CO6				
Conceptual		CO1,CO2		CO3		
Procedural					CO4	
Metacognitive						

SUGGESTED READINGS:

Text Books

1. Advanced Inorganic Chemistry, S. Prakash, S.K. Basu, G.D. Tuli, 17th Edition, S. Chand, 2022.
2. Principles of Inorganic Chemistry, Puri, Sharma, Kalia, 33rd Edition, Vishal Publishing Co, 2017
3. Inorganic Chemistry: Principles of Structure and Reactivity, J.E. Huheey, E.A. Keiter, R.L. Keiter and O.K. Medhi, 5th Edition., Pearson Education, 2023.
4. Concise Inorganic Chemistry, J.D. Lee, 5th Edition, Chapman & Hall, 2008
5. A Text Book of Physical Chemistry – A.S. Negi & S.C. Anand, 3rd Edition, New Age International, 2022.
6. Principles of Physical Chemistry, Puri, Sharma, Pathania, 50th Edition, Vishal Publishing Co, 2025.
7. Modern Organic Chemistry – M.K. Jain, S.C. Sharma, 54th Edition, Vishal Publishing Co, 2022.
8. Organic Chemistry (Volumes 1 and 2), I.L. Finar, 6th Edition., Pearson Education, 2002
9. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, 7th Edition, Pearson Education, 2011.
10. Stereochemistry, Conformation and Mechanism, P.S. Kalsi, 11th Edition, New Age international Publisher, 2022.
11. Advanced General Organic Chemistry (Volume I & II), S.K.Ghosh, 9th Edition, NCBA, 2009.

Reference Books:

1. Selected Topics in Inorganic Chemistry, Wahid U. Malik, G.D. Tuli and R.D. Madan, 8th Edition, S. Chand & Co. Ltd, 2019.
2. Inorganic Chemistry, P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, 7th Edition., Oxford University Press, 2018.
3. Physical Chemistry, P. Atkins, J de Paula and J. Keeler, 11th Edition, Oxford University Press, 2018.
4. Physical Chemistry- G.W. Castellan, 3rd Edition, Narosa Publishing House, 2004.
5. Advanced Organic Chemistry, A. Bahl and B.S. Bahl, 23rd Edition, S. Chand Publication, 2025.

FYUGP
DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**Fundamentals of Chemistry - 3**
Course Code	**:**	**CHE-MIN-4-301**
Nature of the Course	**:**	**CHEMISTRY MINOR COURSE-3**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To understand the ancient concept of matter and thermodynamics
- To give the concept of physico-chemical methods involved in metallurgy; first and second law thermodynamics; aromatic hydrocarbons and reactions involved etc.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Chemistry of non-metals:** **Boron:** Preparation, structure and bonding of diborane **Silicon:** Structure, properties and use of silicon carbide and silicon polymers (linear). **Nitrogen:** Hydroxylamine, Hydrazine, Hydrazoic acid; preparation, properties, uses and electronic structure. **Rare gases:** Xenon compounds. **Phosphorous:** Structures of oxides and oxyacids.	**08**	**0**	**-**	**08**
	General principles of metallurgy: Physico-Chemical methods involved in metallurgy (concentration, calcinations, reduction, roasting, zone refining, solvent extraction, hydrometallurgy and electrochemical methods) with reference to gold, nickel, thorium, uranium and manganese (whichever is applicable).	**07**	**0**	**-**	**07**
	Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts –	**08**	**0**	**-**	**08**

	applications of solubility product principle.				
II	**Second law of thermodynamics** Second law of thermodynamics, Spontaneous and Non-Spontaneous processes cyclic process- Carnot cycle, Entropy, Entropy change in reversible and irreversible processes and for ideal gas, concept of Work function and free energy.	**08**	**0**	**-**	**08**
III	**IKS Contents:** Applications of Aromatic Compounds in IKS-Rituals **(Yajna)** and Perfumery (***Gandha Shastra***) **Aromatic Hydrocarbons:** Preparation (only benzene) from phenol by decarboxylation, from acetylene, from benzenesulphonic acid. Reactions- Electrophilic substitution in benzene-nitration, halogenations, sulphonation, Fridel-Craft alkylation and acylation with mechanism.	**06**	**0**	**-**	**06**
	Alkyl halides Nucleophilic Substitution Reactions (SN_2, SN_1, &SN_i) Preparation: from alkenes and alcohols Reactions; Hydrolysis, nitrite and nitro formation, nitrile and isonitrile formation. Williamson's Synthesis: elimination vs Substitution	**08**	**0**	**-**	**08**
IV	**Experimental Work:** **Organic Qualitative Analysis** Detection of elements (nitrogen, sulphur and halogens) and functional groups of organic compound containing one functional group.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L:Lectures*** ***T:Tutorials*** ***P:Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a clear and comprehensive understanding of non-metal chemistry, metallurgical principles, thermodynamics, and organic chemistry.

CO2: Gain detailed knowledge of the properties, preparation methods, and reactions of important chemical compounds.

CO3: Apply theoretical principles in practical scenarios, including laboratory experiments.

CO4: Acquire practical skills in qualitative analysis, enhancing analytical and problem solving abilities in chemical investigations.

CO5: Students will understand the traditional applications of aromatic compounds in rituals (Yajna) and perfumery (Gandha Shastra).

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual		CO1,CO5				
Conceptual		CO2				
Procedural				CO3,CO4		
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Principles of Inorganic Chemistry, Puri, Sharma, Kalia , 33rd Edition, Vishal Publishing Co, 2017.
2. General and Inorganic Chemistry, R.P. Sarkar (part 1) 3rd Edition, NCBA, 2011.
3. A Text Book of Physical Chemistry, A.S. Negi & S.C. Anand, 3rd Edition, New Age International, 2022.
4. Modern Organic Chemistry , M.K. Jain, S.C. Sharma, 54th Edition, Vishal Publishing Co, 2022
5. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)

Reference Books:

1. Selected Topics in Inorganic Chemistry--Wahid U. Malik, G. D. Tuli and R. D. Madan. (S. Chand & Co. Ltd.)
2. Principles of Physical Chemistry, Puri, Sharma, Pathania, 50th Edition, Vishal Publishing Co, 2025.
3. Organic Chemistry - B.S. Bahl and A. Bahl (Vol. I & II), 23rd Edition, S. Chand Publishing , 2025.

FYUGP

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course : Chemistry in Daily Life- 3
Course Code : CHE-GEC-3-301
Nature of the Course : CHEMISTRY GEC-03
Total Credits : 3
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSEOBJECTIVES:

- To understand the ancient Indian practices about cosmetics, pigments etc.
- To understand the learners about the applications of polymers, fertilizers, cosmetics and perfumes in everyday life.

UNITS	CONTENTS	L	T	P	Total Hours
I	**IKS Contents:** Philosophical Basis on renewable energy- Vedic concept of ***"Prakriti"*** (nature) and ***"Sthira"*** (balance),R enewable energy concepts align with **Ahimsa (non-destructive use)** **Chemical and Renewable Energy Sources**: Principles and applications of primary & secondary batteries and fuel cells. Basics of solar energy, future Energy storer.	**11**	**0**	**-**	**11**
II	**Polymers:** Basic concept of polymers, classification and characteristics of polymers. Applications of polymers as plastics in electronic, automobile components, medical fields, and aerospace materials. Problems of plastic waste management. Strategies for the development of Environment friendly polymers.	**11**	**0**	**-**	**11**
III	**Chemistry of Cosmetics & Perfumes** A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, sun tan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.	**12**	**0**	**-**	**12**

IV	**Fertilizers:** Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.	**11**	**0**	**-**	**11**
	Total	**45**	**0**	**-**	**45**

Where, L:Lectures T:Tutorials P:Practicals

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a thorough understanding of chemical and renewable energy sources, polymers, cosmetics, perfumes, and fertilizers.

CO2: Gain detailed knowledge of the principles, applications, and manufacturing processes related to each unit's content.

CO3: Apply theoretical knowledge to practical scenarios, such as the development of environmentally friendly polymers and the use of essential oils in cosmetics.

CO4: Acquire practical skills in analyzing and evaluating the environmental and industrial implications of chemical substances and processes.

CO5: Students will understand the Vedic concepts of Prakriti, Sthira, and Ahimsa as philosophical foundations for sustainable and non-destructive use of renewable energy.

Cognitive map of course outcomes with Bloom'sTaxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO1,CO5				
Conceptual	CO2		CO3			
Procedural			CO4			
Metacognitive						

SUGGESTED READINGS:

1. Barel, A.O.; Paye, M.; Maibach, H.I.(2014),Handbook of Cosmetic Science and Technology, CRC Press.
2. Garud, A.; Sharma, P.K.; Garud, N. (2012),Text Book of Cosmetics, Pragati Prakashan.
3. Gupta, P.K.; Gupta, S.K.(2011),Pharmaceutics and Cosmetics, Pragati Prakashan
4. Butler, H. (2000), Poucher's Perfumes, Cosmetic and Soap, Springer.
5. Kumari, R. (2018),Chemistry of Cosmetics, Prestige Publisher.
6. Gopalan, R. Venkappayya, D.; Nagarajan, S. (2004), Engineering Chemistry, Vikas Publications.
7. Sharma, B. K. Engineering Chemistry, Goel Publishing House, Meerut, 2006
8. Carraher,C. E. Jr. (2013), Seymour's Polymer Chemistry, Marcel Dekker, Inc.
9. Ghosh, P. (2001), Polymer Science & Technology, Tata Mcgraw -Hill.

FYUGP

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**Inorganic Materials of Industrial Importance**
Course Code	**:**	**CHE-SEC-3-301**
Nature of the Course	**:**	**CHEMISTRY SEC-03**
Total Credits	**:**	**3**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- The course introduces the students to the diverse roles of inorganic materials in the industry. It gives an insight into how these raw materials are converted into products used in day-to-day life. Students learn about silicates, fertilizers, surface coatings and batteries. The course helps develop the interest of students in the frontier areas of inorganic and material chemistry.

UNITS	CONTENTS	L	T	P	Total Hours
I	**IKS Contents:** Philosophical & Empirical Basis on ceramics-Pottery (***Kumbhakarana / Kumbhika***), ***Silpasastra***, Evidence is found in archaeological sites **(Harappan Civilization, Mohenjo-Daro, Taxila)** **Silicate Industries**: *Glass*: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass. *Ceramics*: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre. *Cements*: Classification of cement, ingredients and their role, Manufacture of cement and the Setting process, quick setting cements.	**09**	**0**	**-**	**09**
II	**Fertilizers:** Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium	**05**	**0**	**-**	**05**

	sulphate.				
III	**Surface Coatings:** Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings, metal spraying and anodizing.	**08**	**0**	**-**	**08**
	Batteries: Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.	**08**	**0**	**-**	**08**
IV	**Experimental Work (Any One):** i) Estimation of free phosphoric acid in superphosphate fertilizers. ii) Estimation of CaO in cement. iii) Laboratory synthesis of the pigments ; Prussian blue, Malachite green, chrome yellow, etc	-	-	**15**	**15**
	Total	**30**	**0**	**15**	**45**

Where, L:Lectures T:Tutorials P:Practicals

MODES OF IN-SEMESTER ASSESSMENT: 30 Marks

- Two Internal Examination - **20 Marks**
- Others (Any one) - **10 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Develop a comprehensive understanding of silicate industries, fertilizers, surface coatings, and battery technology.

CO2: Apply theoretical knowledge to analyze and evaluate the production processes, properties, and applications of materials used in these industries.

CO3: Assess the effectiveness, environmental impact, and technological advancements in silicate industries, fertilizer production, surface coatings, and battery technology.

CO4: Apply critical thinking skills to address challenges related to material production, environmental sustainability, and technological innovation in these industries.

CO5: Conduct experiments to determine free phosphoric acid in fertilizers and CaO in cement

and create pigments like Prussian blue, Malachite green, and chrome yellow, and evaluate their properties.

CO6: Students will understand the philosophical and empirical foundations of ceramics in ancient India through pottery traditions and archaeological evidence from sites like Harappa and Taxila.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO6	CO2			
Conceptual		CO1	CO4	CO3		
Procedural					CO5	
Metacognitive						

SUGGESTED READINGS:

1. E. Stocchi: Industrial Chemistry,Vol-I, Ellis Horwood Ltd.UK.
2. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
3. W.D. Kingery, H.K. Bowen, D.R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi.
4. J.A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, NewDelhi.
5. P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai &Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
7. B.K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut.

FYUGP

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course : Chemistry C5: Inorganic
Course Code : CHE-MAJ-4-401
Nature of the Course : CHEMISTRY MAJOR
Total Credits 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

OBJECTIVES:

- To develop the knowledge of chemistry in relation to nuclear chemistry.
- To develop the knowledge of chemistry in relation to various statistical methods of analysis
- To develop the preliminary idea on organometallic chemistry
- To introduce various organic reagents and their applications in inorganic analysis

UNITS	CONTENTS	L	T	P	Total Hours
I	**IKS Cotents:** Philosophical Insights into nuclear chemistry (**Rasayana and Alchemy**), Atomic Theory (***Vaisheshika***) **Nuclear Chemistry**: Nuclear structure, mass defect, binding energy, packing fraction and stability of nuclei. Group displacement law, Law of radioactive disintegration, Expression of rate constant of radioactive disintegration. Artificial transmutations and artificial radioactivity, fundamentals of radioactive decay, nuclear reactions including fission and fusion reactions, nuclear reactor and its components, measurement of radioactivity, analytical applications of nuclear reactions and radioactive tracers - in **s**tudying reaction mechanism, in diagnosis and treatment of diseases, in industry, in agriculture, in analytical chemistry, in determination of the age of the earth by rock dating method and determination of the age of recent objects by radiocarbon dating method.	**16**	**0**	**-**	**16**
II	**Statistical Methods of Analysis**: Accuracy, precession, deviation, standard deviation, classification of errors, minimization of errors, significant figures. **Indicators:** choice of indicators in neutralization, redox, adsorption and complexometric reactions.	**10**	**0**	**-**	**10**

III	**Organometallic Chemistry-I:** Definition and classification of organometallic compounds. Concept of hapticity of organic ligands. **Metal carbonyls:** 18 electron rule, Determination of M-M bonds, electron count of mononuclear, polynuclear and substituted metal carbonyls. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. Oxidative addition and reductive elimination reaction, π-acceptor behavior of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding. **Zeise's salt:** preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.	**11**	**0**	**-**	**11**
IV	**Organic Reagents in Inorganic Analysis**: Cupferron, dithizone, benzoin-α-oxime, 1-nitroso-2-naphthol, diphenyl carbazide, diphenyl carbazone, salicylaldoxime,1,10-phenanthroline, magneson, thiourea, zincuranylacetate, oxine.	**08**	**0**	**-**	**08**
V	**Experimental Work (Any One):** a) Estimation of Ca^{2+} and Mg^{2+} by EDTA b) Estimation of Cu^{2+} by iodometric method	-	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, L:Lectures T:Tutorial P:Practical

MODES OF IN-SEMESTER ASSESSMENT: 40 Marks

- **Two Internal Examination- 20 Marks**
- **Others - 20 Marks**
  - Assignment/Seminar
  - Lab notebook/Attendance
  - Group Discussion

COURSE OUTCOMES:

At the end of this programme, students will be able to-

CO1: To *define* mass defect, binding energy, accuracy, precession, etc.

CO2: To *identify* different organic reagents in inorganic analysis

CO3: To *distinguish* nuclear fission and fusion reactions

CO4: To *explain* 18 electron rule

CO5: To *elucidate* the structures of mononuclear and binuclear carbonyls using VBT

CO6: To *apply* organic reagents in inorganic analysis

CO7: To *estimate* of Ca^{2+} and Mg^{2+} by EDTA and Cu^{2+} by iodometric method

CO8: Students will understand ancient Indian philosophical insights into nuclear chemistry through Rasayana, Alchemy, and the Vaisheshika atomic theory.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	CO1	CO8				
Conceptual		CO2,CO3	CO4,CO5,CO6			
Procedural					CO7	
Metacognitive						

Recommended Books:

Text Books:

1. Advanced Inorganic Chemistry**,** S. Prakash , S.K. Basu, G.D. Tuli, 17th Edition, S. Chand, 2022.
2. Principles of Inorganic Chemistry, Puri, Sharma, Kalia, 33rd Edition, Vishal Publishing Co, 2017.
3. General and Inorganic Chemistry, R.P. Sarkar (part 1) 3rd Edition, NCBA, 2011.
4. Concise Inorganic Chemistry, J.D. Lee, 5th Edition, Chapman & Hall, 2008.
5. Inorganic Chemistry: Principles of Structure and Reactivity, J.E. Huheey, E.A. Keiter, R.L. Keiter and O.K. Medhi, 5th Edition., Pearson Education, 2023.

Reference Books:

1. Selected Topics in Inorganic Chemistry**,** Wahid U. Malik, G.D. Tuli and R.D. Madan, 8th Edition, S. Chand & Co. Ltd, 2019.
2. Vogel's Qualitative Inorganic Analysis, G. Svehla, B Sivasankar, 7th Edition, Pearson, 2012.

FYUGP

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course : Chemistry C6: Physical
Course Code : CHE-MAJ-4-402
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To acquaint students in details on chemical kinetics, catalysis and surface chemistry.

UNITS	CONTENTS	L	T	P	Total Hours
I	**IKS Contents:** IKS on Chemical Kinetics- Philosophical Insights **Anupana theory** (vehicle of action in Ayurveda) **Chemical Kinetics:** Order and Molecularity of a reaction, elementary and complex reactions rate laws, differential and integral forms of rate equations of zero,1st, 2nd order reactions, half life periods of 1st and 2nd order reactions, determination of order of reaction by method of integration, half life period, differential method, isolation method, evaluation of rate constant, integrated equation method, graphical method, Guggenheim method (1st order reaction), rate laws and mechanism, steady state approximation. Rate equation of first order, opposite, parallel, consecutive reaction, chain reactions, chain branching, explosion limit, Hydrogen – Bromine thermal reaction. Temperature dependence of reaction rates, Arrhenius equation, energy of activation, collision theory of bimolecular reactions, its limitation. Introduction to activated complex theory, Lindeman's Theory of unimolecular gas phase reaction.	**20**	**0**	**-**	**20**
II	**Surface Chemistry** Physical and chemical adsorption of gases on solid surface, adsorption isotherms, types of adsorption isotherm, Freundlich equation, Langmuir adsorption equation. Determination of surface area. Gibbs adsorption equation, application of adsorption in chemical analysis and in industry.	**15**	**0**	**-**	**15**

III	**Catalysis** Criteria of catalysis, homogeneous and heterogeneous catalysis, introduction to acid base catalysis. Mechanisms of catalyzed reactions at solid surfaces, effect of temperature on surface reactions, nano particles as catalysts, autocatalysis, catalytic poison, Michaelis-Menten equation.	**10**	**0**	**-**	**10**
IV	**EXPERIMENTAL WORK (Any one)** a) To determine the rate constant of hydrolysis of methyl acetate catalyzed by hydrogen ion concentration at room temperature. b) To determine the rate constant of Saponification of ethyl acetate. c) Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate. d) To study the kinetics of iodination of propanone in acidic medium. e) To study the rate constant of hydrolysis of Sucrose by polarimeter.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, L:Lectures T:Tutorials P:Practical

MODES OF IN-SEMESTER ASSESSMENT: 40 Marks

- **Two Internal Examination- 20 Marks**
- **Others - 20 Marks**
  - Assignment/Seminar
  - Lab notebook/Attendance
  - Group Discussion

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Develop a comprehensive understanding of chemical kinetics, surface chemistry, and catalysis principles and their applications.

CO2: Apply theoretical knowledge and experimental techniques to analyze reaction mechanisms, rate laws, and surface phenomena.

CO3: Evaluate the factors influencing reaction rates, adsorption processes, and catalytic mechanisms using kinetic data and experimental results.

CO4: Apply critical thinking skills to design experiments, interpret experimental data, and solve problems related to reaction kinetics and surface chemistry.

CO5: Students will relate the Ayurvedic concept of Anupana to the principles of chemical kinetics and reaction facilitation

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	CO1	CO5				
Conceptual			CO2,CO3			
Procedural					CO4	
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Physical Chemistry- G.W. Castellan, 3rd Edition, Narosa Publishing House, 2004.
2. Physical Chemistry - P.C. Rakshit, 7th Edition, Science Book Agency, 2020.
3. Physical Chemistry Vols. I (6th ed), II (6th ed.), III (5th ed.) and IV (6th ed.), K.L. Kapoor, MacMillan (India) Ltd, 2019.
4. Advanced Physical Chemistry, J.N. Gurta & H. Snehi, 24th edition, Pragati Prakashan, 2021.

Reference Books:

1. Physical Chemistry, P. Atkins, J de Paula and J. Keeler, 11th Edition, Oxford University Press, 2018.
2. Principles of Physical Chemistry, Puri, Sharma, Pathania, 50th Edition, Vishal Publishing Co, 2025.
3. Physical Chemistry, I.N. Levine, 6th Edition, McGraw Hill, 2009.

FYUGP

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course : Chemistry C7: Organic
Course Code : CHE-MAJ-4-403
Nature of the Course : CHEMISTRY MAJOR
Total Credits : 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

OBJECTIVES:

- To make the students familiar about chemistry of carbonyl compounds, carboxylic acids, thiols and amines.
- To provide knowledge about natural as well as synthetic polymers.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Carbonyl Compounds: (Aliphatic and Aromatic) Part A:** Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Clemmensen, Wolff-Kishner, MPV reduction Addition reactions of unsaturated carbonyl compounds: Michael addition. Unsaturated Aldehydes (Acrolein, Crotonaldehyde, Cinnamaldehyde) Unsaturated Ketone (MVK).	**10**	**0**	**-**	**10**
	Part B Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate, malanonitrile.	**04**	**0**	**-**	**04**
II	**Carboxylic Acids and their Derivatives: (Aliphatic and Aromatic):** **IKS Contents:** Some known acidic fruit juices mentioned in ancient literature. Preparation, physical properties, and reactions of monocarboxylic acids (Acidity and factors affecting it) Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky	**10**	**0**	-	**10**

	reactions, Hofmann bromamide degradation Dicarboxylic acids: Oxalic acid, malonic acid, and succinic acid Hydroxy acids: lactic acid, tartaric acid, citric acid and salicylic acid.				
III	**Sulphur containing compounds:** Preparation and reactions of thiols, thioethers and sulphonic acids.	**03**	**0**	**-**	**03**
IV	**Nitrogen Containing Functional Groups (Aromatic and Aliphatic)** Preparation and important reactions of nitro compounds, nitriles and isonitriles **Amines:** Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid. **Diazonium Salts:** Preparation and their synthetic applications. Diazomethane & Diazoacetic Ester with Synthetic application.	**10**	**-**	**0**	**10**
V	**Polymers** **IKS Contents:** Natural polymers and their use in ancient India. Introduction and classification of polymers; Polymerisation reactions -Addition and condensation Mechanism of cationic, anionic and free radical addition polymerization; Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene); Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives; Biodegradable polymers with examples.	**08**	**-**	**-**	**08**
VI	**EXPERIMENTAL WORK (Any one)** **EXPERIMENTAL WORK (A)** Systematic qualitative analysis of organic compounds having -OH, $-NH_2$, $-NO_2$, $-CONH_2$, -CHO, -COOH, $CONH_2$ groups.	**-**	**-**	**30**	**30**

	EXPERIMENTAL WORK (B) Purification and determination of melting point i. Acetylation - Preparation of Aspirin from Salicylic acid, Acetanilide from aniline. ii. Nitration - Preparation of *p*-nitro acetanilide from acetanilide. iii. Benzoylation – preparation of benzanilide from aniline. iv. Diazocoupling - preparation of methyl orange.				
	Total	**45**	**0**	**30**	**75**

Where, L:Lectures T:Tutorials P:Practicals

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

After the end of the course students will be able to

CO1: Learn preparation and properties aldehyde, ketone, carboxylic acid, thiols, amines, etc.

CO2: Understand and analyze the mechanisms of key name reactions involving organic compounds, such as Aldol condensation, Cannizzaro reaction, and Hofmann rearrangement.

CO3: Perform systematic qualitative analysis of organic compounds containing functional groups such as -OH, $-NH_2$, $-NO_2$, $-CONH_2$, -CHO, and -COOH.

CO4: Students will identify acidic fruit juices and natural polymers mentioned in ancient Indian literature and understand their traditional uses.

Cognitive map of course outcomes with Bloom'sTaxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO4				
Conceptual	CO1		CO2			
Procedural					CO3	
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Organic Chemistry, R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, 7th Edition, Pearson Education, 2011.
2. Organic Chemistry (Volumes 1 and 2), I.L. Finar, 6th Edition., Pearson Education, 2002.
3. A Textbook of Organic Chemistry, K.S. Tiwari & N.K. Vishnoi, 4th Edition, Vikash Publishing, 2022.
5. Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, J. March & Michael B. Smith, 9th Edition, Wiley, 2025.
6. Modern Organic Chemistry – M.K. Jain, S.C. Sharma, 54th Edition, Vishal Publishing Co, 2022.
7. Mechanism and Theory in Organic Chemistry, S.K. Ghosh, New Central Book Agency, 2022
8. Advanced General Organic Chemistry (Volume I & II), S.K.Ghosh, 9th Edition, NCBA, 2009.

Reference Books:

1. Advanced Organic Chemistry (Volume I & II), A. Bahl and B.S. Bahl, 23rd Edition, S Chand Publication, 2025.
2. Organic Chemistry, P. Y. Bruice, 8th Edition, Pearson, 2020.
3. Organic Chemistry, J. Clayden, N. Greeves, S. Warren, 2nd Edition, Oxford, 2012.

FYUGP

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course : Chemistry C8: Symmetry & Quantum Chemistry-I
Course Code : CHE-MAJ-4-404
Nature of the Course : CHEMISTRY MAJOR
Total Credits 4
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURSE OBJECTIVES:

- To make the students familiar with symmetry elements & point groups and the various aspects of basic quantum mechanics with special reference to classical mechanics.

UNITS	CONTENTS	L	T	P	Total Hours
I	**Symmetry & Group Theory-I** Symmetry elements and symmetry operations. Definition of group, symmetry group, point group. Perspective sketch and point group of some common molecules (H_2, HF, CO_2, C_2H_2, C_2H_4, $CHCl_3$, PCl_5, NH_3, BF_3, $[PtCl_4]^{2-}$, BrF_5). Symmetry and mathematical tools, matrix algebra, reducible and irreducible representation, great orthogonality theorem (deduction not necessary), Character table for C_{2v} and C_{3v} point groups.	**15**	**0**	**-**	**15**
II	**IKS Contents:** Philosophical Insights into quantum chemistry- ***Vaisheshika Sutras***, Upanishadic & Sankhya thoughton discrete elements ***(tattvas)*** and subtle energies **Quantum Chemistry-I** Background of quantum mechanics; Black body radiation – Planck's hypothesis, photoelectric effect, de Broglie hypothesis and Heisenberg's uncertainty principle. Postulates of quantum mechanics, quantum mechanical operators (Linear and Hermitian operators), Wave functions, Normalized and Orthogonal Wave Functions. Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy; wave functions, probability distribution functions, nodal properties, separation of variables, two- and three-dimensional boxes, degeneracy. Qualitative treatment of simple harmonic	**30**	**0**	**-**	**30**

	oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. 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 molecule: Schrödinger equation and its solution. Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, energy (only final energy expression). Average and most probable distances. Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).				
III	**EXPERIMENTAL WORK:** **pH-metry and Polarimetry (Any one experiment)** (i) pH metric titration (a) strong acid vs. strong base (b) weak acid vs. strong base (c) strong acid vs. weak base (ii) Preparation of buffer solutions of different pH (a) sodium acetate-acetic acid (b) ammonium chloride-ammonium hydroxide (c) Determination of dissociation constant of weak acid (CH_3COOH) / base (NH_4OH) (iii) To determine the concentration of an optically active substance by polarimetric method.	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, L:Lectures T:Tutorials P:Practical

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
  - Home Assignment
  - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO1: Develop a comprehensive understanding of symmetry and group theory principles, quantum mechanics foundations, and experimental techniques in analytical chemistry.

CO2: Apply theoretical knowledge and experimental skills to identify molecular symmetries ,analyze quantum mechanical systems, and conduct analytical experiments.

CO3: Evaluate molecular structures, wave functions, and experimental data to assess symmetry elements, energy levels, and chemical concentrations.

CO4: Apply critical thinking skills to solve problems related to molecular symmetry, quantum mechanics, and experimental analysis in chemistry.

CO5: Perform pH metric titrations, prepare buffer solutions to analyze the interaction between different types of acids and bases, including strong acid vs. strong base, weak acid vs. strong base, and strong acid vs. weak base.

CO6: Determine the concentration of optically active substances through polarimetric methods, enhancing the understanding of optical activity and its applications in chemical analysis.

CO7: Students will understand ancient Indian philosophical insights from VaisheshikaSutras, Upanishads, and Sankhya thought related to discrete elements and subtle energies in quantum chemistry.

Cognitive map of course outcomes with Bloom'sTaxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual		CO1, **CO7**			CO3	
Conceptual			CO2, CO4			
Procedural		CO5,	CO6			
Metacognitive						

SUGGESTED READINGS:

Text Books:

1. Quantum Chemistry, I.N. Levine, 7th Edition., Pearson, 2013.
2. Introductory Quantum Mechanics, A.K. Chandra, 4th Edition., Tata McGraw Hill Publishing Company, 2017.
3. Chemical Application of Group Theory, F.A. Cotton, 3rd Edition, John Wiley & Sons, 2008.

Reference Books:

1. Quantum Chemistry, R.K. Prasad, 4th Revised Edition, New Age International, 2020.
2. Quantum Chemistry Including Spectroscopy, B.K. Sen, 5th Edition, Kalyani publishers, 2017.

FYUGP

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course	**:**	**Fundamentals of Chemistry-4**
Course Code	**:**	**CHE-MIN-4-401**
Nature of the Course	**:**	**CHEMISTRY MINOR COURSE-4**
Total Credits	**:**	**4**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

COURSE OBJECTIVES:

- To develop the knowledge about industrial chemistry like-glass, ceramics and cements.
- To develop the knowledge about nuclear chemistry.
- To study the principles of chemical kinetics and the properties of different types of solutions.
- To study the preparations and the properties of aryl halides, alcohols, phenols and ethers.

UNITS	CONTENTS	L	T	P	Total Hours
I	**IKS Contents:** Philosophical & Empirical Basis on ceramics-Pottery (***Kumbhakarana / Kumbhika***), ***Silpasastra***, Evidence is found in **archaeological sites (Harappan Civilization, Mohenjo-Daro, Taxila)** **Introduction to Industrial Chemistry:** **Glass**: Glassy state and its properties, classification (silicate and non silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, safety glass, borosilicate glass, coloured glass, **Ceramics**: Important clays and feldspar, ceramic, their types and manufacture. Fullerenes carbon nanotubes and carbon fibre. **Cements**: Classification of cement ,ingredients and their role, Manufacture of cement and the setting process, quick setting cements	**07**	**0**	**-**	**07**

	Nuclear Chemistry: Nuclear structure, Mass defect, Binding energy and stability of nuclei, Nuclear transmutations and Artificial radioactivity, Fundamentals of radioactive decay, Nuclear reactions including fission and fusion reactions, Analytical applications of Nuclear Reactions and Radioactive tracers	**06**	**0**	**-**	**06**
II	**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 and second order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).	**08**	**0**	**-**	**08**
	Solutions Types of solutions, concentration units, Solution of gases in liquids-Henry's law. Solution of liquids in liquids: Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule, Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids-Principle of steam distillation. Nernst distribution law and its applications, solvent extraction. Solutions of solids in liquids: the solubility curves.	**07**	**0**	**-**	**07**
III	**Aryl Halides**: Preparation (Chloro, Bromo & Iodo benzene only): From phenol, Sandmeyer and Gattermann reaction Reactions: (Chlorobenzene) Aromatic Nucleophilic substitution (replacement by–OH) and effect of Nitro Substituent. Reactivity and relative strength of Carbon-halogen Bond in alkyl, allyl, vinyl and Aryl Halide.	**08**	**0**	**-**	**08**

	Alcohols, Phenols and Ethers: **Alcohols:** Preparation: Preparation of 1°, 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$,acidic dichromate, conc. HNO_3). Diols: oxidation of diols. Pinacol-Pinacolone rearrangement. **Phenols:** Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenations and Sulphonation .Reimer Tiemann Reaction **Ethers (aliphatic and aromatic):** Cleavage of ethers with HI.	**09**	**0**	**-**	**09**
IV	**Experimental Work:** **Inorganic Volumetric Analysis: (any one)** i. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator. ii. Estimation of oxalic acid by titrating it with $KMnO_4$ iii. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$ iv. Estimation of Fe (II) ions by titrating it with $KMnO_4$ v. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$	**-**	**-**	**30**	**30**
	Total	**45**	**0**	**30**	**75**

Where, ***L:Lectures*** ***T:Tutorials*** ***P:Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **40 Marks**

- Two Internal Examination - **20 Marks**
- Others (Any one) - **20 Marks**
    - Home Assignment
    - Seminar presentation on any of the relevant topics

COURSE OUTCOMES:

At the end of this course, students will be able to-

CO1: Recall key concepts in industrial chemistry, nuclear chemistry, chemical kinetics, and solution chemistry.

CO2: Develop a comprehensive understanding of the principles underlying industrial chemistry, nuclear chemistry, chemical kinetics, and solution chemistry.

CO3: Apply theoretical knowledge and experimental skills to analyze and solve problems related to industrial processes, reaction kinetics, and solution behavior.

CO4: Analyze reaction mechanisms, solution properties, and experimental data to draw conclusions and make predictions.

CO5: Evaluate the effectiveness of reaction mechanisms, solution properties, and experimental procedures to assess their reliability and accuracy.

CO6: Design experiments, propose solutions, and develop new methodologies to address challenges in chemistry and enhance understanding of chemical phenomena.

CO7: Students will understand ancient Indian knowledge of ceramics through Silpa sastra and pottery traditions, supported by archaeological evidence from Harappa, Mohenjo-Daro, and Taxila.

Cognitive map of course outcomes with Bloom's Taxonomy:

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual	CO1	CO7	CO3	CO4		
Conceptual		CO2			CO5	
Procedural					CO6	
Metacognitive						

SUGGESTED READINGS:

Text Books

1. Principles of Inorganic Chemistry, Puri, Sharma, Kalia, 33rd Edition, Vishal Publishing Co.,., 2017
2. Fundamentals of Inorganic Chemistry, Vol. I, Asim. K. Das, 2nd Edition ,CBS Publications, 2010.
3. Physical Chemistry, G.W. Castellan, 3rd Edition, Narosa Publishing House, 2004.
4. Physical Chemistry, P.C. Rakshit, 7th Edition, Science Book Agency, 2020.
5. Physical Chemistry Vols. I (6th ed), II (6th ed.), III(5th ed.) and IV(6th ed.), K.L. Kapoor, MacMillan (India) Ltd, 2019.
6. Advanced Physical Chemistry, J.N. Gurta & H. Snehi, 24th edition, Pragati Prakashan, 2021.
7. Advanced Organic Chemistry, A. Bahl and B.S. Bahl, 23rd Edition, S. Chand Publication, 2025.
8. A Text Book of Organic Chemistry (Vol. I & II) – B.K. Sharma, G.P. Pokhriji and S.K. Sharma, (S. Chand & Co.)

Reference Books:

1. Physical Chemistry, P Atkins, J de Paula and J Keeler, 11th Edition, Oxford University Press, 2018.
2. Principles of Physical Chemistry, Puri, Sharma, Pathania, 50th Edition, Vishal Publishing Co, 2025.
3. Physical Chemistry, I.N. Levine, 6th Edition, McGraw Hill, 2009
4. Modern Organic Chemistry, M.K. Jain, S.C. Sharma, 54th Edition, Vishal Publishing Co, 2022.