DEPARTMENT OF CHEMISTRY

CHOICE BASED CREDIT SYSTEM (CBCS)

B.Sc (Chemistry)
Learning Outcome-based Curriculum Framework (LOCF) SYLLABUS

Effective from 2023 – 2024 onwards

MADRAS CHRISTIAN COLLEGE (AUTONOMOUS)
Affiliated to University of Madras
Tambaram
Chennai – 600 059

July 2023

MADRAS CHRISTIAN COLLEGE

VISION

Madras Christian College aspires to be an Institution of excellence transforming lives through education with a commitment to service.

MISSION

The Madras Christian College (MCC), with the inspiration of the love of God, offers to people of all communities education of the whole person, which is congruous with God's revelation in Christ of the true nature of humanity and is appropriate to the needs of India and of the world.

Graduate Attributes

The Madras Christian College defines the philosophy underpinning its academic programmes and student life experience on campus through the Graduate Attributes (GA), that describe the knowledge, competencies, values and skills students imbibe for holistic development and contribution to society. These attributes encompass characteristics that are transferable beyond the domain of study into the national and international realm fostered through curricular, co-curricular and extra-curricular engagements.

GA 1: Intellectual Competencies

- Graduates of MCC have a comprehensive and incisive understanding of their domain of study as well as the capability for cross-disciplinary learning.
- They have the ability to apply the knowledge acquired through the curriculum as well as self-directed learning to a broad spectrum ranging from analytical thinking to synthesise new knowledge through research.
- Forming independent individual opinions regarding academic cores and socially relevant issues

GA 2: Professional Ethics

- Graduates of MCC develop ethical and professional behaviour, which will be demonstrated in their chosen careers and constructive citizenship roles.
- They imbibe intellectual integrity and ethics in scholarly engagement and develop a spirit of inclusiveness through interactions with people of special needs and diversity.

GA3: Leadership Qualities

- Graduates of MCC inculcate leadership qualities & attitudes, and team behaviour along democratic lines through curricular, co-curricular and extra-curricular activities

- They develop managerial and entrepreneurial skills to ideate and create new opportunities along with career readiness and capacity to take up various competitive exams.

GA 4: Holistic Skill Development

- Graduates of MCC develop critical thinking, problem-solving, effective communication, emotional and social skills
- They develop digital competency to live, learn and serve in society.

GA 5: Cross-Cultural Competencies

- Graduates of MCC imbibe cross-cultural competencies through engaging with diverse linguistic, ethnic and religious communities providing scope to understand, accept and appreciate individuals at local, national and international levels.
- They develop a global perspective through contemporary curriculum, culture, language and international exchange programmes

GA 6: Service-Oriented Focus

- Graduates of MCC have sensitivity to social concerns and a conviction toward social justice through a commitment to active social engagement.
- They are endowed with a strong sense of environmental awareness through the curriculum and campus eco-system.

GA 7: Value-Based Spiritual Development

- Graduates of MCC are rooted in the principles of ethical responsibility and integrity permeated with Christian values leading to the building of character.
- They develop virtues such as love, courage, unity, brotherhood, industry and uprightness.

Programme Outcomes

Programme Outcomes (POs) of Madras Christian College define the minimum level that students are expected to do, achieve and/or accomplish in order to graduate from a particular programme. These Outcomes are a framework to assess the nature of learning activity experienced within the programme.

POs for Under Graduate Programmes

UG Programmes are designed to have the following outcomes:

On successful completion of the Undergraduate programme, the students will be able to

PO	PO	Descripton of PO	Mapped with GA
PO 1	Language Skills	• Demonstrate oral and written skills to effectively communicate in English and Languages of their choice • Apply reading and listening skills to facilitate access to knowledge resources and understanding	GA1, GA4, GA5
PO 2	Domain Knowledge	• Acquire knowledge of basic concepts, theories and processes through study of core courses in respective programmes • Apply and Analyze domain specific knowledge to emerging areas of academia and industry • Assess, adapt and develop domain specific transferrable skills to new/unfamiliar context	GA1, GA3, GA4, GA5
PO 3	Interdisciplinary knowledge	• Identify and determine relationships across disciplines • Acquire and apply interdisciplinary knowledge for holistic academic development	GA1, GA4
PO 4	Digital Skills	• Acquire computer skills and their application relevant to classroom and self-directed web-based learning • Familiarize with and use domain-related software resources, computational skills and digital tools for data analysis, visualization and interpretation • Ethically apply digital skills to creatively communicate a wide range of ideas and issues related to academic experiences	GA1, GA2, GA3, GA4, GA6
PO 5	Analytical skills	• Develop the ability to think critically and relate learning to academic, professional and real-life problem solving	GA1, GA2, GA4, GA6

		• Apply empirical knowledge and skills to identify and collect quantitative and qualitative data to analyze and formulate evidence-based suggestions and solutions	
PO 6	Academic writing & Presentation skills	• Formulate and document results obtained in laboratory, case studies, project work, field work and internships • Effectively communicate through engaging presentations using methodologies appropriate to the discipline	GA1, GA4, GA5
PO 7	Innovation and Creativity	• Demonstrate transferable capabilities and intrapreneurial skills that are relevant to the industry and other employment opportunities • Develop entrepreneurial skills and generate intellectual property	GA1, GA2, GA3
PO 8	Social Engagement and Responsibility	• Demonstrate the ability to link classroom learning with social concerns through service learning and outreach programmes. • Enhance positive personality traits to adapt to changing circumstances and demonstrate leadership qualities as an individual and a member of cross-cultural and multi-disciplinary teams. • Appreciate environmental consciousness and sustainability • Draw valuable insights from one's own spiritual tradition and that of others for peaceful coexistence and general wellbeing	GA1, GA2, GA5, GA6, GA7

PROGRAM SPECIFIC OUTCOMES (PSO's) of B.Sc. Chemistry

At the time of graduation they would be able to

PSO #	Statement	Mapped with PO#
PSO 1	Understand various fundamental concepts in physical, organic and inorganic chemistry.	PO2
PSO 2	Recognize various structural characteristics of the chemical compounds	PO2
PSO 3	Analyze and solve qualitative and quantitative problems in chemistry.	PO2
PSO 4	Recognize the importance of various chemical concepts and apply in biological, environmental & industrial processes and in everyday life.	PO3
PSO 5	Acquire logical approach to a given concept in chemistry for comprehension and to express it coherently.	PO5
PSO 6	Learn to design (build, modify, evaluate and screen) molecules using open-source computational tools for property prediction and apply the gained knowledge to design drugs.	PO4
PSO 7	Use bench skills and psychomotor skills to translate the theoretical knowledge to experimental chemistry.	PO5
PSO 8	To develop content knowledge, creative thinking, collaboration, creativity and communication skills from the available literature and experimentation.	PO7

Weightage correlation of POs/PSOs to each CO for Course Articulation Table

Weightage for Correlation		
0 ≦C ≦ 5%	No correlation	-
5% <C ≦ 40%	Low / Slight	1
40% <C < 60%	Moderate	2
60% ≦C < 100%	Substantial / High	3

Curriculum Template for B.Sc. Chemistry

Effective from – 2023-24

SEM	PART	COURSE CODE	TITLE	WEEKLY HOURS	EXAM HOURS	MARKS		CREDITS
						CA	ESE	
I	IV	GC01	Chemistry in Everyday Life	4	3	50	50	2
	III	BC01	Basic Chemistry I	3	3	50	50	4
	III	BC02	Basic Chemistry II	3	3	50	50	4
	III	BC03	Practical I – Volumetric Analysis	4	-	-	-	-
II	IV	GC02	Philosophy and History of Science	4	3	50	50	2
	III	BC04	Basic Chemistry III	3	3	50	50	4
	III	BC05	Chemistry of Non-metals	3	3	50	50	4
	III	BC03	Practical I – Volumetric Analysis	4	3	50	50	4
III	III	BC06	Organo-Oxygen Chemistry	3	3	50	50	4
	III	EC01	Applied Chemistry	3	3	50	50	3
	III	BC07	Practical II – Inorganic Qualitative Analysis	4	-	-	-	-
	IV	IC01	Interdisciplinary – Biological Chemistry	4	3	50	50	3
	III	AC01	Allied Chemistry I (for Physics and Mathematics students)	4	3	50	50	3
	III	AC02	Allied Chemistry I (for Botany and Zoology students)	4	3	50	50	3
	III	AC03	Allied Chemistry Practical	2	-	-	-	-
IV	III	BC08	Classical Thermodynamics	3	3	50	50	4
	III	EC02/EC03	Food and Cosmetics Chemistry / Green and Nano Chemistry	3	3	50	50	3
	III	BC07	Practical II – Inorganic Qualitative Analysis	4	3	50	50	4
	III	IC02	Environmental Studies – UGC	4	3	50	50	
	III	AC04	Allied Chemistry II (for Physics and Mathematics students)	4	3	50	50	3
	III	AC05	Allied Chemistry II (for Botany and Zoology students)	4	3	50	50	3

	III	AC03	Allied Chemistry Practical	2	3	50	50	4
V	III	BC09	Coordination Chemistry	3	3	50	50	4
	III	BC10	Organo-Nitrogen Chemistry	3	3	50	50	4
	III	BC11	Chemical Kinetics and Surface Chemistry	3	3	50	50	4
	III	BC12	Basic Analytical Techniques in Chemistry	5	3	50	50	5
	III	BC13	Practical III – Organic Analysis, Gravimetry& Preparation	6	-	-	-	-
	III	BC14	Practical IV – Physical Chemistry practical	4	-	-	-	-
	IV	SC01	Computer Aided Chemistry	2	3	50	50	3
	IV	SC02	Environmental Chemistry	4	3	50	50	3
VI	III	BC15	Chemistry of Metals and Nuclear chemistry	5	3	50	50	5
	III	BC16	Natural Products, Pharmaceuticals and Spectroscopy	5	3	50	50	5
	III	BC17	Phase Rule and Electrochemistry	5	3	50	50	5
	III	EC04/EC05	Entrepreneurship skill for chemist / Advanced Chemistry	3	3	50	50	3
	III	EC06	Project Based Learning	2	-	25	-	2
	III	BC13	Practical III – Organic Analysis, Gravimetry& Preparation	6	6	50	50	6
	III	BC14	Practical IV – Physical Chemistry Practical	4	3	50	50	4

Curriculum Overview Table		
Part	Credits	Hours
I Tamil / Other languages	12	16
II English	12	16
III – Core theory + Practical	74	83
III – Core Elective	11	11
III – Internship / Field work	NIL	NIL
III – Project	NIL	NIL
III – Allied theory	12	16
III – Allied Practical	8	8
IV – GC	4	8
IV - GE	3	4
IV – ID	3	4
IV – EVS	2	4
IV – Computer Training	3	2
IV – Value Education	2	4
IV – Personlaity Development	3	4
V – Extension Activity	1	0
Total	**140**	**180**

CHEMISTRY IN EVERY DAY LIFE

Course Code			
Credits	**2**		
Hours / Cycle	**4**		
Category	**Part IV**	**General Course**	**Theory**
Semester	**I**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	□ To introduce the importance / role of chemistry in the materials / compounds of everyday life to non-chemistry students.		

CO#	Course Outcome(s)	PO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	List the common chemicals in materials of everyday life such as building materials, plastics, fertilises, food, cosmetics, fuel, drugs, and explosives in relation to the environment	PO3	K1
CO2	Outline the i) preparation and application of chemicals used in everyday life ii) role of chemicals involved in water and air pollution	PO3	K2
CO3	Identify the i) reasons for the water pollution and air pollution ii) various nutrients present in the food iii) general formulation of cosmetics. iv) chemicals present in the fuels v) chemicals of plastics, building materials and pharmaceutical drugs	PO3	K3

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	1.1. General survey of chemicals used in everyday life. 1.2 Air-Components and their importance; photosynthetic reaction, air pollution, green house effect and their impact on our life style. 1.3 Water – Sources of water, qualities of potable water, soft and hard water, methods of removal of hardness − water pollution.	12	CO1-CO3	K1 – K3

II	2.1 Building materials – cement, ceramics, glass and refractories – definition, composition and application only. 2.1 Plastics: Polythene, PVC, bakelite, polyesters, melamine formaldehyde resins – preparation, structures and uses.	12	CO1- CO3	K1 – K3
III	3.1 Food and Nutrition: Carbohydrates, Proteins, Fats – definition and their importance as food constituents; balanced diet; Calorie; minerals and vitamins (sources and their physiological importance). 3.2 Cosmetics: Tooth pastes, face powder, soaps and detergents, shampoos, nail polish, perfumes – general formulation and preparations – possible hazards of cosmetics use.	12	CO1- CO3	K1 – K3
IV	4.1 Chemicals in food production – fertilizers – need, natural sources; urea, NPK fertilizers and super phosphate. 4.2 Fuel – classification – solid, liquid and gaseous; nuclear fuel – examples and uses; fuel cells – principle and uses only.	12	CO1- CO3	K1 – K3
V	5.1 Pharmaceutical drugs – analgesics and antipyretics - paracetamol and aspirin. 5.2 Colour chemicals – pigments and dyes – examples and applications. 5.3 Explosives – classification and examples.	12	CO1- CO3	K1 – K3

Textbooks

1. Chemical Process Industries, R. Norris Shreve and Joseph A.Brink,Jr.,4th Edition, McGraw Hill, 1977
2. Perfumes, Cosmetics and Soaps, W.A.Poucher (Vol.3), 9th Edition, Springer Science Business Media, 1993
3. Environmental Chemistry, A.K.De, 6th Edition, New Age International, New Delhi, 2006

References

1. Engineering Chemistry by Jain and Jain; Dhanpat Rai Publication Co. 2014.
2. A Text Book of Environmental Chemistry and Pollution Control, S.S. Dara–S. Chand Publication 2012.

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K1
CO 2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K2
CO 3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K3
Wt. Avg.	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	
Overall Mapping of the Course															PO-3		

BASIC CHEMISTRY I

Course Code			
Credits	**4**		
Hours / Cycle	**3**		
Category	**Part III**	**Core**	**Theory**
Semester	**I**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To impart the knowledge on stoichiometric calculations and the principles of volumetric analysis • To strengthen the fundamental knowledge of the students in concepts related to periodic table, atomic spectra, quantum numbers and elementary thermodynamics • To provide insight to the students on the utility of various types of conventions in representing chemical reactions • To educate the students on the fundamental aspects of forces and concepts to comprehend the molecular interactions and reactivity.		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	(i) Relate mass, moles, concentrations, and various titrations and (ii) Recall the basic concepts of organic chemistry and the first law of thermodynamics, models of atomic structure and periodic changes in properties.	PSO1, PSO2	K1
CO2	(i) Compare and contrast the theories of titrations, atomic models and periodic properties, (ii) Classify the organic reactions and (iii) illustrate the principles of thermodynamics with day-to-day examples.	PSO1, PSO2	K2
CO3	Apply (i) the principles of stoichiometry, atomic structure and periodic properties to solve numerical and analytical problems, and (ii) fundamentals of thermodynamics and organic reactions to solve related numerical and analytical problems.	PSO1, PSO2, PSO3	K3
CO4	(i) Analyse the suitability of indicators, conclusions of atomic models, position of the elements in the periodic table and (ii) Examine the laws of thermodynamics (iii) analyse the organic reactions and derive inferences.	PSO3, PSO4	K4
CO5	Evaluate (i) the advantage and disadvantages of various titrations (ii) the recent models of atomic structure, (iii) the properties of elements with periodic table, (iv) laws of thermodynamics, and (v) the criteria for organic reactions.	PSO3, PSO4	K5

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	1.1 Stoichiometry: Mole concept, Molality, Molarity, Equivalent weight and Normality (Numerical problems) 1.2 Principles of volumetric analysis: Standard solution, Requirements of primary standard and Standardization; Types of titrations; Principles of acid-base titration, different types of acid-base titrations and theories of acid – base indicators; Principle of complexometric titrations and theory of metallochromic indicators.	9	CO1-CO5	K1 – K5
II	2.1 Periodic Properties: Effective nuclear charge and Slater's rule; Trends in periodic properties (atomic, covalent and ionic radii, ionization energy, electron affinity and electronegativity); Iso-electronic species; 2.2 Factors affecting ionization potential, electron affinity and electronegativity; Different approaches to electronegativity scale.	9	CO1-CO5	K1 – K5
III	3.1 Atomic spectra and quantum theory of energy – black body radiation – photoelectric effect – Compton effect. 3.2 Bohr model of the hydrogen atom – wave particle duality – Heisenberg uncertainty principle. 3.3 Quantum numbers – shapes of atomic orbitals – degenerate energy states. 3.4 Pauli's exclusion principle – singlet and triplet electronic states – Aufbau principle – electronic configuration of atoms.	9	CO1-CO5	K1 – K5
IV	4.1 Definition of thermodynamic terms: system, surrounding; types of systems, intensive and extensive properties. State and path functions and their differentials (exact and inexact).Thermodynamic process (Isothermal, Adiabatic, Isobaric, Isochoric, cyclic, reversible and irreversible processes). Zeroth law of thermodynamics. 4.2 Concept of heat (q), work (w), internal energy(U), and statement of first law, enthalpy(H); mathematical formulation concept of internal energy(U) & enthalpy(H) (numerical problems). 4.3 Heat capacity, relation between Cp and Cv (numerical problems).	9	CO1-CO5	K1 – K5
V	5.1 Types of organic reactions – substitution, elimination, addition and rearrangement (mechanism not required); 5.2 various types of arrows in organic chemistry, electron pushing/arrow pushing – rules, common mistakes in electron pushing;	9	CO1-CO5	K1 – K5

	5.3 Energy profile diagram for a one step and two step reactions; 5.4 Electronegativity and bond polarity, calculation of formal charges, molecular dipole moments, intermolecular forces - dipole–dipole, London dispersion and hydrogen bonding, polarity effects on solubility; 5.5 Resonance – rules for resonance forms.			

Textbooks

1. Principles of Inorganic Chemistry, Puri B.R, Sharma L.R & Kalia K.C., Milestone Publishers and Distributors, New Delhi, 2008
2. Text Book of Physical Chemistry, P.L. Soni, O. P. Dharmarha, U. N. Dash, Sultan Chand & Sons, 2011
3. Essential of Physical Chemistry, Arun Bahl, B.S. Bahl, G.D. Tuli, S. Chand Publishers, 2009
4. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma, M.S. Pathania, 47th edition, Vishal Publishing Co, 2016
5. Organic chemistry, Leroy G. Wade, 8th Edition, Pearson Education Inc., 2019.

References

1. Concise Inorganic Chemistry, Lee, J.D., 5th Edition, New Delhi, Oxford University Press, 2008.
2. Physical Chemistry, Peter Atkins, Julio De Paula, 9th edition, W. H. Freeman, 2009.
3. Organic Chemistry, W.H. Brown, C.S. Foote, B.L. Iverson, E.V. Anslyn, 6th Edition, Cengage Learning, 2012.

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	2	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	3	2	-	-	-	-	-	-	K2
CO 3	-	3	-	-	-	-	-	-	3	2	3	-	-	-	-	-	K3
CO 4	-	3	1	-	-	-	-	-	-	-	3	3	-	-	-	-	K4
CO 5	-	3	1	-	-	-	-	-	-	-	3	3	-	-	-	-	K5
Wt. Avg.	-	3	1	-	-	-	-	-	3	2	3	3	-	-	-	-	
Overall Mapping of the Course															PO: 2.00 PSO: 2.75		

BASIC CHEMISTRY II

Course Code			
Credits	**4**		
Hours / Cycle	**3**		
Category	**Part III**	**Core**	**Theory**
Semester	**I**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To learn the various types of bonds and related theories to comprehend properties • To learn the failures of classical mechanics and the birth of quantum mechanics • To study the chemistry of alkanes and alkenes leading to an understanding of few fundamental concepts such as reactivity-selectivity, ring strain, orientation in addition and elimination reactions. • To study the chemistry of alkynes and aromatic hydrocarbons. • To have an insight into the concept of aromaticity to appreciate the stability of aromatic compounds.		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	To recall and relate the (i) types of bonding and their theories in inorganic, organic and physical chemistry domains (ii) Molecular properties (iii) nomenclature of alkanes and alkenes	PSO 1	K1
CO2	To compare and contrast (i) different theories in bonding, quantum mechanics and (ii) various theories in understanding the structure and properties of aliphatic and aromatic hydrocarbons	PSO 3	K2
CO3	To apply (i) the bonding theories in arriving at the structure and reactivity of the molecules and (ii) quantum mechanical theories to derive Schrodinger wave equation	PSO 4	K3
CO4	To analyse the nature, stability, chemical bonding and properties of molecules	PSO 2	K4
CO5	To solve analytical and numerical problems related to the basic concepts in chemistry	PSO 3, PSO 4	K5

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	1.1 Hydrogen bond: Types and its effect on the boiling point and solubility. 1.2 Electrovalent bond: General characteristics of electrovalent compounds; Polarising power and polarisability: Fajan's rules, Applications of Fajan's rules- Acidic nature of oxides and melting point, solubility, hydration energy; lattice energy and thermal stability of ionic compounds - Born - Haber cycle.	9	CO1-CO5	K1 – K5
II	2.1 Covalent bond: Formation of σ and π bonds; Hybridization and shapes of molecules − VB and VSEPR theory. 2.2 MO theory: Bonding, antibonding and nonbonding orbitals; MO configurations of diatomic molecules (H_2, He_2, N_2, O_2, C_2, B_2, F_2, CO, NO and their ions). Comparison of VB and MO theories. 2.3 Effect of molecular structure on dipole moment based on electronegativity, planarity and geometrical isomerism.	9	CO1-CO5	K1 – K5
III	3.1 Classical mechanics – Limitations; Quantum mechanics – Postulates; Eigen function and eigen values (definitions only); Comparison between classical and quantum mechanics 3.2 Operators and their properties (problems) – Derivation of Schrodinger wave equation (time dependent, time independent). 3.3 Particle in a one-dimensional box (simple numerical problems).	9	CO1-CO5	K1 – K5
IV	4.1 Alkane: IUPAC nomenclature, sources, mechanism of halogenation of alkanes – reactivity-selectivity principle; Cycloalkanes – Baeyer's strain theory – Quantification of ring strain (heats of combustion measurements). 4.2 Alkene: IUPAC nomenclature; stability of alkenes – Quantification (heats of hydrogenation);preparation −dehalogenation and dehydrohalogenation (Zaitsev rule), reduction of alkenes and Wittig reaction; Electrophilic addition to alkenes –addition of hydrogen halides (Markovnikov and anti-Markovnikov orientation), addition of halogens, epoxidation of alkenes,*syn*-dihydroxylation of alkenes, ozonolysis and free radical polymerization of alkenes.	9	CO1-CO5	K1 – K5
V	5.1 Alkynes: IUPAC nomenclature; preparation – alkylation of acetylide ion, addition of acetylide ions to carbonyl groups, double dehydrohalogenation of alkyl dihalides; properties - hydrogenation of alkyne to alkane and cis/trans alkene, addition of hydrogen halides.	9	CO1-CO5	K1 – K5

	5.2 Aromatic hydrocarbons: structure of benzene – Kekule and resonance representation, criteria for aromaticity – Huckel's rule; Electrophilic aromatic substitution reactions of benzene (halogenation, sulphonation, nitration and alkylation); anisole and nitrobenzene – reactivity and orientation (elementary ideas), side chain reactions of benzene derivatives; preparation and properties of naphthalene.			

Textbooks

1. Principles of Inorganic Chemistry, Puri B.R, Sharma L.R &Kalia K.C., Milestone Publishers and Distributors, New Delhi, 2008.
2. Principles of Physical chemistry, B.R. Puri, L.R. Sharma, M.S. Pathania, 47th edition, Vishal Publishing Co, 2016.
3. Text Book of Physical Chemistry, P.L. Soni, O. P. Dharmarha, U. N. Dash, Sultan Chand & Sons, 2011.
4. Essentials of Physical Chemistry, Arun Bahl, B.S. Bahl, G.D. Tuli, S. Chand publishers, 2009
5. Advanced Organic Chemistry, B.S. Bahl and ArunBahl, 2nd Edition, S. Chand publications, 2010.

References

1. Concise Inorganic Chemistry, Lee, J.D., 5th Edition, New Delhi, Oxford University Press, 2008
2. Physical Chemistry, Peter Atkins, Julio De Paula, 9th edition, W. H. Freeman, 2009
3. Organic Chemistry, Leroy G. Wade, 8th Edition, Pearson Education Inc., 2019
4. Organic Chemistry, 5th edition, John E. McMurry, 7th Edition, Asian Books Private Limited, 2012
5. Organic Chemistry, Janice Gorzynski Smith, 2nd Edition, Tata McGraw Hill Education Private Limited, 2008

Suggested Readings

1. J. E. Huheey, E. A. Kieter and R. L. Keiter, Inorganic Chemistry, 4th ed., Harper Collins, New York, 1993
2. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rd ed., W. H. Freeman and Co, London, 1999.
3. Jerry March, Advanced Organic Chemistry, 4th Edition, John Wiley And Sons, New York, 1992.
4. R.K. Prasad , Quantum chemistry, New age international(P) Ltd., 1997.
5. http://www.chem.uiuc.edu/GenChemReferences/nomenclature_rules.html
6. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Advanced_Theoretical_Chemistry_(Simons)/01%3A_The_Basics_of_Quantum_Mechanics

B.Sc. Course Articulation Matrix

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	KL
CO 1	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	-	-	3	-	-	-	-	-	K2
CO 3	-	-	2	-	-	-	-	-	-	-	-	2	-	-	-	-	K3
CO 4	-	3	-	-	-	-	-	-	-	3	-	-	-	-	-	-	K4
CO 5	-	1	3	-	-	-	-	-	-	-	1	3	-	-	-	-	K5
Wt. Avg.	-	2.5	2.5						3	3	2	2.5	-	-	-	-	
														Overall Mapping of the Course	PO: 2.5 PSO: 2.62		

PRACTICAL – VOLUMETRIC ANALYSIS

Course Code			
Credits	**4**		
Hours / Cycle	**4**		
Category	**Part III**	**Core**	**Practical**
Semester	**I**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	To train the students for the laboratory practices To provide hands-on experience for the concepts learned in the classroom.		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall the fundamental principles of volumetric analysis	PSO1, PSO3	K1
CO2	Understand the fundamental principles of volumetric analysis	PSO1, PSO3	K2
CO3	Apply the principles of volumetric analysis to determine the amount of a chemical substance in the given sample solution.	PSO1, PSO7	K3
CO4	Analyse the given sample solution based on the volumetric method	PSO1, PSO7	K4
CO5	Estimate the amount of the given analyte in the whole of the given solution accurately and communicate the results through scientific reports	PSO1, PSO7 & PSO8	K5

CONTENT

I Acidimetry Alkalimetry:
Estimation of sodium hydroxide and sodium carbonate in a mixture. Estimation of sodium carbonate and sodium bicarbonate in a mixture. Estimation of borax. Estimation of boric acid.

II Permanganimetry:
Estimation of a mixture containing ferrous and ferric irons. (reduction by Zn/H_2SO_4) Estimation of calcium. Estimation of nitrite ion. Estimation of H_2O_2 . Estimation of manganese dioxide in pyrolusite.

III Dichrometry:
Estimation of ferrous and ferric irons in a mixture (internal indicator).

IV Iodometry and Iodimetry:
Estimations of copper, arsenious oxide, potassium permanganate potassium dichromate, tin and hypochlorite. Sodium thiosulphate versus iodine titration.

V Complexometric Titrations:
EDTA titrations Estimations of calium, magnesium and zinc.

VI Demonstration experiments :
Argentimetry Mohr and Volhard methods.

Textbooks

Vogel's Textbook of Quantitative Chemical Analysis, G H Jeffery, J Bassett, J Mendham and R C Denney, 5th Edition, John Wiley & Sons, New York, USA, 1989

References

https://youtu.be/Yb9CR7Ecs-Y?si=HaYVNODeKTlmdIlr

B.Sc. Course Articulation Matrix																	
Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	2	2	-	-	2	-	-	2	-	2	-	-	-	-	-	K1
CO 2	-	2	2	-	-	2	-	-	2	-	2	-	-	-	-	-	K2
CO 3	-	2	-	-	2	2	-	-	2	-	-	-	-	-	3	-	K3
CO 4	-	2	-	-	2	2	-	-	2	-	-	-		-	3	-	K4
CO 5	-	2	-	-	2	2	2	-	2	-	-	-	-	-	3	2	K5
Wt. Avg.	-	2	2	-	2	2	2	-	2	-	2	-	-	-	3	2	
														Overall Mapping of the Course	PO: 2.0 PSO: 2.25		

PHILOSOPHY AND HISTORY OF SCIENCE

Course Code			
Credits	**2**		
Hours / Cycle	**4**		
Category	**Part IV**	**General Course**	**Theory**
Semester	**II**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To acquire a comprehensive idea on the history of scientific thought • To accurately summarise the debates encountering the Philosophers of Science today • To encourage critical and analytical thinking to the claims, arguments and development of science • To introduce scientific and philosophical methods to the students		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	List the common terminologies used in philosophy and history of science	PSO2, PSO3, PSO5	K1
CO2	Explain the (i) philosophy of scientific theories (ii) serendipity in scientific discoveries (iii) contribution of torch bearers to modern science in India.	PSO2, PSO3, PSO5	K2
CO3	Identify the (i) different periods of scientific history (ii) various scientific theories (iii) difference between modern science and aboriginal science (iv) serendipity involved in certain scientific discoveries (v) role of scientists in developing modern science in India.	PSO2, PSO3, PSO5	K3

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Introduction to Philosophy of Science: Terminologies and definitions: Philosophy, Philosophy of science, Worldview and science. Difference between science and technology- Origins of science and Overview of key periods in its history- Introduction to Greek Scientific Thought: Anaximander and Pythagoras, Aristotle& Plato's Science	12	CO1-CO3	K1 – K3

II	Philosophy of Scientific theories: Inductive and Deductive Reasoning; Theories of reductionism, replacement and progress of science; Examples; Cell theory, Theory of evolution, atomic theory, big bang theory – Theories as axioms or models, Hypothesis as reasonable speculation, Difference between hypothesis and Theory – role of Analogy and Metaphor in scientific thinking	12	CO1-CO3	K1 – K3
III	Introduction to history of Science: *Modern Science:* Science in action during First World War – Contributions of Fritz Haber, Thomas Edison, Alfred Nobel - Science in action during Second World War – Radar science and its post-war influence on astronomy *Aboriginal science*: Indigenous weather knowledge, Aboriginal Astronomy: Science of constellations, Aboriginal star mapping and navigation, Indigenous land management, knowledge of medicinal plants	12	CO1-CO3	K1 – K3
IV	Serendipity in scientific discoveries: Penicillin, Nylon, Teflon, Vulcanization of rubber, Archimede's principle, Kekule's structure, dynamite, X-rays, Anti-malarial drug Quinine	12	CO1-CO3	K1 – K3
V	Torch bearers of Modern Science in India: Ashutosh Mukherjee and Calcutta mathematical society, Prafulla Chandra Ray (The father of Indian Chemistry), Premathanath Bose and industrialization, Sir C.V. Raman the first Indian Noble Laureate in Science, J.C. Bose,S.N. Bose, VikramSarabai and the genesis of space research, Homi J. Bhabha and the origin of Nuclear research, G.N. Ramachandran and emergence of biophysics research	12	CO1-CO3	K1 – K3

Textbooks

1. Timothy McGrew, Marc Alspector-Kelly, and Fritz Allhoff (eds.), Philosophy of Science: An Historical Anthology (Wiley - Blackwell, 2009)
2. Richard DeWitt, Worldviews: An Introduction to the History and Philosophy of Science, 2nd Edition (Wiley - Blackwell, 2010)

References

1. Gorham, Geoffrey - Philosophy of Science: A Beginner's Guide. (Oxford: One World Books, 2009.)

B.Sc. Course Articulation Matrix																	
Course Outcomes	Program Outcomes								Program Specific Outcomes								K L
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO 7	PS O8	
CO 1	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K1
CO 2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K2
CO 3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K3
Wt. Avg.	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	
Overall Mapping of the Course															PO- 3		

BASIC CHEMISTRY III

Course Code			
Credits	**4**		
Hours / Cycle	**3**		
Category	**Part III**	**Core**	**Theory**
Semester	**II**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To acquire the conceptual knowledge on the dynamics of gaseous and solid state • To familiarize the students with stereochemistry of organic compounds		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall the fundamentals of (i) gaseous state (ii) stereochemistry (iii) solid state	PSO1, PSO2, PSO3	K1
CO2	Outline the (i) behaviour of ideal and real gases (ii) concepts and properties of stereoisomers (iii) structure and properties of materials in solid state	PSO1, PSO2, PSO3	K2
CO3	(i) Apply ideal gas equation and van der Waals equation to gaseous systems (ii) Identify the effect of chirality on structure and reactions (iii) Identify laws and theories governing structure of solids	PSO1, PSO2, PSO3	K3
CO4	Analyse the (i) behaviour of ideal and real gases (ii) relation between structure and properties of stereoisomers and materials in solid state	PSO1, PSO2, PSO3	K4
CO5	Evaluate the (i) properties of gases (ii) stereochemical features of molecules and their mechanistic pathways (iii) properties of solids based on structure	PSO1, PSO2, PSO3, PSO8	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Gaseous state – I 1.1 Gas laws – postulates of kinetic theory – collisions – gas pressure. 1.2 Average kinetic energy of translational – Absolute scale of temperature. 1.3 Maxwell distribution law of molecular speeds (no derivation) molecular speeds and energy distribution as a function of temperature – most probable – average – root mean square speeds of molecules (numerical problems). 1.4 Degrees of freedom of motion – principle of equipartition energy – molecular basis of heat capacity – mean free path – viscosity of gases.	9	CO1-CO5	K1 – K5
II	Gaseous state – II 2.1 Real gases – compressibility factor – deviation from ideality – van der Waals' equation 2.2 Boyle temperature – critical phenomena – critical constants – law of corresponding states and reduced equation of state – intermolecular forces and liquefaction of gases.	9	CO1- CO5	K1 – K5
III	Stereochemistry I Chirality and Enantiomerism in organic molecules, (R) and (S) nomenclature of asymmetric carbon atoms, optical activity, specific rotation, racemic mixtures, optical purity, enantiomeric excess (simple problems); resolution of racemic mixtures– chemical and chromatographic methods, Diastereoisomerism, Meso compounds.	9	CO1- CO5	K1 – K5
IV	Stereochemistry II 4.1 Geometrical isomerism in double bonded and cyclic compounds, (E) and (Z) nomenclature. 4.2 Conformational analysis of ethane, n-butane, cyclohexane and mono/di-substituted cyclohexane. 4.3 S_N1, S_N2, E1 and E2 reactions: Mechanistic and stereo-chemical features.	9	CO1-CO5	K1 – K5
V	Solid state 5.1 Crystal systems, crystal lattice, unit cell, crystallographic axes; Law of crystallography; Miller indices; Packing of ions in crystals, packing efficiency and density from cubic lattice dimension; radius ratio and its limitations; Diffraction of X-rays by crystals – Bragg's Law; Structure of NaCl, CsCl, diamond and graphite.	9	CO1- CO5	K1 – K5

	5.2 Qualitative ideas of free electron and band theories; defects in solid state (stoichiometric defects only); p-type and n-type semiconductors.			

Textbooks

1. Principles of Inorganic Chemistry, Puri B.R, Sharma L.R &Kalia K.C., Milestone Publishers and Distributors, New Delhi, 2008
2. Principles of Physical chemistry, B.R. Puri, L.R. Sharma, M.S. Pathania, 47th edition, Vishal Publishing Co, 2016
3. Text Book of Physical Chemistry, P.L. Soni, O. P. Dharmarha, U. N. Dash, Sultan Chand & Sons, 2011
4. Essentials of Physical Chemistry,Arun Bahl, B.S. Bahl, G.D. Tuli, S. Chand publishers, 2009
5. Advanced Organic Chemistry, B.S. Bahl and ArunBahl, 2nd Edition, S. Chand publications, 2010

References

1. Concise Inorganic Chemistry, Lee, J.D., 5th Edition, New Delhi, Oxford University Press, 2008
2. Physical Chemistry, Peter Atkins, Julio De Paula, 9th edition, W. H. Freeman, 2009
3. Organic Chemistry, Leroy G. Wade, 8th Edition, Pearson Education Inc., 2019
4. Organic Chemistry, 5th edition, John E. McMurry, 7th Edition, Asian Books Private Limited, 2012
5. Organic Chemistry, Janice Gorzynski Smith, 2nd Edition, Tata McGraw Hill Education Private Limited, 2008.

B.Sc. Course Articulation Matrix																	
Course Outcomes	Program Outcomes								Program Specific Outcomes								Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	3	3	1	-	-	-	-	-	K2
CO 3	-	3	-	-	-	-	-	-	3	3	1	-	-	-	-	-	K3
CO 4	-	3	-	-	1	-	-	-	3	3	2	-	-	-	-	-	K4
CO 5	-	3	-	-	1	-	2	-	3	3	2	-	-	-	-	1	K5
Wt. Avg.	-	3	-	-	1	-	2	-	3	3	1.5	-	-	-	-	1	
Overall Mapping of the Course															PO -2.0 PSO - 2.1		

CHEMISTRY OF NON METALS

Course Code			
Credits	**4**		
Hours / Cycle	**3**		
Category	**Part III**	**Core**	**Theory**
Semester	**II**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	To understand and appreciate the chemistry of main group elements including their preparation, properties, classification, applications, relationship with elements of neighbouring groups in the periodic table and the concepts to understand their properties		

CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO1	Recall (i) the fundamental properties of main group elements and (ii) structure and reactivity of main group compounds	PSO1, PSO2	K1
CO2	Understand (i) the fundamental properties of main group elements and (ii) structure and reactions of main group compounds	PSO1, PSO3	K2
CO3	Apply the fundamental concepts of main group elements and compounds to understand their reactivity	PSO3, PSO4	K3
CO4	(i) Compare (i) the trends in the properties among main group elements (ii) Analyze the anomalous behaviour of first row elements of main group block (iii) Categorize the structural features and properties of main group elements (oxides, halides, oxyacids and interhalogen compounds)	PSO3, PSO4	K4
CO5	Justify (i) the behaviour of the main group elements and (ii) geometry and behaviour of the main group compounds based on the fundamental concepts	PSO2, PSO4	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	1.1 Comparative study of the following properties of p-block elements: Electronic configuration, Oxidation state, Inert pair effect, Electropositive/metallic character, Redox property, Diagonal relationship and anomalous behaviour of the first element in each group.	9	CO1-CO5	K1 – K5

	1.2 Comparative study of the oxides, halides and hydrides of Group 13, 14 and 15 on structure, stability, nature and reactivity (action of heat, action of water, redox property). 1.3 Hydrides, carbides and nitrides – classification, examples and general characteristics.			
II	2.1 Group 13 (Boron family): Reaction of boron with oxygen, water, acids and alkali. Preparation, properties, bonding and structure of borazole, borax, boric acid, diborane, boron trioxide and boron nitride. 2.2 Boranes and carboranes – types only. 2.3 Group 14 (Carbon family): Preparation, properties and uses of carbon suboxide and carbon disulphide; Catenation and Heterocatenation. 2.4 Silicon: Preparation, properties, structure and uses of silicon dioxide, silicones, silicon carbide; Silicates (classification and structure only); Hydrolysis of $SiCl_4$.	9	CO1- CO5	K1 – K5
III	3.1 Group 15 (Nitrogen family): Properties, structure and uses of: a. Hydrides – hydrazine, hydroxyl amine, hydrazoic acid and phosphine. b. Halides – tri and penta chlorides of phosphorus. c. Oxides – dinitrogentetraoxide, dinitrogenpentoxide, tri and penta oxides of phosphorus 3.2 Oxoacids of nitrogen and phosphorus- Oxidation state and structure; Preparation and properties of nitrous acid, nitric acid, phosphorous acid and phosphoric acid. 3.3 Liquid ammonia as solvent; Fixation of atmospheric nitrogen. 3.4 Allotropes of phosphorus.	9	CO1- CO5	K1 – K5
IV	4.1 Group 16 (Oxygen family): oxidation state and structure of oxides and oxoacids of sulphur; Preparation and properties of sulphurous acid, sulphuric acid, Caro's and Marshall's acids. Sodium thio sulphate as reducing agent in volumetric analysis. 4.2 Heavy water – preparation, properties and uses. 4.3 Group 17 (Halogen family): A comparative study on oxides and oxyacids of halogens with respect to oxidation state, oxidizing power, acidic nature and structure.	9	CO1- CO5	K1 – K5
V	5.1 Pseudo halogens: cyanide, thiocyanate, and azide − structure and properties. 5.2 Inter-halogen compounds: AB, AB3, AB5 and AB7 − structure based on VSEPR theory.	9	CO1- CO5	K1 – K5

	5.3 Inert gas compounds: Preparation, properties and structure of compounds of Xenon − XeF2, XeF6, XeO3, XeOF4. Clathrate compounds and their applications.			

Self-study

- Halides of thallium, Applications of BF3 compounds, Ethyl borate test.
- Stannous chloride as reducing agent.
- Sodium arsenite in volumetric analysis; Sodium thiosulphate in photography.
- Distinction between sulphides, sulphites, sulphates and thiosulphates.
- Basic nature of iodine.
- Position of noble gas in periodic table, occurrences and uses of noble gases.

Textbooks

1. Principles of Inorganic Chemistry, Puri B.R, Sharma L.R &Kalia K.C., Milestone Publishers and Distributors, New Delhi, 2008.
2. Concise Inorganic Chemistry, Lee, J.D., 5th Edition, New Delhi, Oxford University Press, 2008.

References

1. Modern Inorganic Chemistry, Madan R.D., Satyaprakash"s , Sultan Chand & Company, New Delhi, 2004.
2. Inorganic Chemistry, Shriver and Atkins, San Francisco. W.H. Freeman & Company, 2006.

B.Sc. Course Articulation Matrix

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	KL
CO 1	-	3	-	-	-	-	-	-	3	3	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	2	-	3	-	-	-	-	-	K2
CO 3	-	3	3	-	-	-	-	-	-	-	3	3	-	-	-	-	K3
CO 4	-	3	3	-	-	-	-	-	-	-	3	3	-	-	-	-	K4
CO 5	-	3	2	-	-	-	-	-	-	1	-	3	-	-	-	-	K5
Wt. Avg.	-	3	2.75	-	-	-	-	-	2.5	2	3	3	-	-	-	-	
Overall Mapping of the Course															PO: 2.88 PSO: 2.63		

ORGANO OXYGEN CHEMISTRY

Course Code			
Credits	**4**		
Hours / Cycle	**3**		
Category	**Part NA**	**Core**	**Theory**
Semester	**III**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To understand the fundamental concepts connected with oxygen containing organic compounds and their reactions • To study the various reaction mechanisms of name reactions • To identify electrophilic and nucleophilic centres in oxygen containing organic compounds and propose a reasonable mechanism		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall the fundamental concepts, definitions and reactions of organo oxygen compounds	PSO1, PSO2	K1
CO2	Understand (i) the core concepts of organo oxygen chemistry (ii) the IUPAC nomenclature of organo oxygen compounds	PSO1, PSO2	K2
CO3	Apply (i) fundamental concepts in the preparation of oxygen based organic compounds (ii) fundamental concepts in the reactions and their mechanisms of organo oxygen compounds	PSO2, PSO3, PSO4	K3
CO4	Analyse the behaviour and reactivity of organic compounds containing oxygen based on the fundamental concepts	PSO2, PSO4	K4
CO5	Compare and evaluate the behaviour of chemical processes involving organo oxygen compounds	PSO2, PSO3, PSO4	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	1.1 Alcohols: IUPAC Nomenclature; preparation from alkene (acid-catalyzed hydration, oxymercuration-demercuration, Hydroboration-oxidation),*via* hydrolysis of alkyl halides, reduction of carbonyl compounds by hydride reducing agent, by catalytic hydrogenation of aldehydes and ketones and using Grignard reagent. 1.2 Preparation of specific alcohols: allyl alcohol,	9	CO1-CO5	K1 – K5

	benzyl alcohol, ethylene glycol and glycerol. 1.3 Chemical properties of alcohols: reaction with alkali metal, acid chloride, phosphorous halides, thionyl chloride; dehydration (Zaitsev's rule),Victor Meyer and Lucas test for distinguishing 1˚, 2˚ and 3˚ alcohols, reaction of ethylene glycol (with aldehydes and ketones, with Pb(OCOCH3)4 and HIO4), reaction of glycerol with HIO4 and KHSO4.			
II	2.1 Aldehydes and kekones: IUPAC nomenclature; preparation - oxidation of alcohols, hydration of alkynes, Friedel-Crafts acylation, Gatterman-Koch reaction, from acid chlorides, from carboxylic acids and nitriles (for ketones) 2.2 Preparation of specific carbonyl compounds: salicylaldehye via Reimer-Tiemann reaction, synthesis of acrolein, p-quinone from quinol. 2.3 Chemical properties of aldehydes and ketones: Structural features of carbonyl group and its nature of reactivity; Nucleophilic addition – hydration, formation of cyanohydrin, imine and acetal, reaction with hydroxylamine, hydrazine, phenyl hydrazine and semicarbazide, aldol and Michael reaction, Benzoin condensation- oxidation of aldehydes, reduction - Clemmensen and Wolff-Kishner reduction, Cannizzaro, Claisen-Schmidt and Knoevenagel condensation, Perkin and Reformatsky reaction.	9	CO1- CO5	K1 – K5
III	3.1 Carboxylic acids: IUPAC nomenclature; preparation - oxidation of primary alcohols using $K_2Cr_2O_7$ and $KMnO_4$, Haloform reaction. 3.2 Preparation of specific carboxylic acids: Benzoic acid (from benzyl alcohol, phenyl nitrile, phenylmagnesium bromide), Phthalic acid (from naphthalene, o-xylene). 3.3 Derivatives of Carboxylic acids: IUPAC nomenclature, ester – synthesis (Fischer Esterification and Tischenko reaction) and reactions - with $LiAlH_4$, Grignard reagent, Bouveault-Blanck reduction, transesterification); acid chloride – synthesis (from carboxylic acid) reactions (R_2CuLi and $Li[t\text{-}BuO]_3AlH$, Rosenmund's reduction); amide – synthesis (pyrolysis of ammonium salts of carboxylic acids, Schotten-Baumann reaction) and reactions (hydrolysis and dehydration); acid anhydride – synthesis (dehydration of carboxylic acids) and reactions (hydrolysis, alcoholysis, Friedel-Crafts acylation)	9	CO1- CO5	K1 – K5
IV	4.1 Preparation and properties of phenols: synthesis from cumene, aniline and chlorobenzene	9	CO1- CO5	K1 – K5

	(Dow's process); reactions of phenols – oxidation – Electrophilic aromatic substitution – coupling, Kolbe's, Gattermann, Reimer-Tiemann reaction; Preparation and reactions of o-cresols and α-naphthols. 4.2 Ethers: IUPAC nomenclature; preparation and properties of ethers: synthesis - dehydration of alcohols and Williamson synthesis; Cleavage of ether by HI and BBr_3. 4.3 Preparation and chemical properties of epoxides: synthesis – peroxyepoxidation, base promoted cyclization of halohydrins; chemical properties – reaction with H^+/H_2O and RMgX.			
V	5.1 Rearrangement reactions-Claisen, Fries and Pinacol-Pinacolone, Bayer-viliger oxidation. 5.2 Ester hydrolysis – $B_{AC}2$ and $A_{AC}2$ mechanisms. 5.3 Acidity of phenols and Carboxylic acids – simple problems based on electronic effects. 5.4 Preparation of acetoacetic ester and malonic ester, Synthetic uses of acetoacetic and malonic ester.	9	CO1- CO5	K1 – K5

Textbooks

1. Organic chemistry, 5th edition, John E. McMurry, 7th Edition, Asian Books Private Limited, 2012.
2. Advanced organic chemistry, B.S. Bahl and ArunBahl, 2nd Edition, S. Chand publications, 2010.

References

1. Organic chemistry, Janice Gorzynski Smith, 2nd Edition, Tata McGraw Hill Education Private Limited, 2008.
2. Organic chemistry, Leroy G. Wade, 8th Edition, Pearson Education Inc., 2019

Suggested Reading

1. V K Ahluwalia and Rakesh Kumar Parashar, Organic Reaction Mechanism, 4th Edition, Alpha Narosa Publishing House, India, 2019
2. S. H. Pine, Organic Chemistry, 5th Edition, Tata McGraw Hill, Special Indian Edition, India, 2007.

Online Resources (accessed on 20 May 2024)

1. https://www.organic-chemistry.org/namedreactions/

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes							Program Specific Outcomes								Cognitive Level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	3	2	-	-	-	-	-	3	3	-	-	-	-	-	-	K1
CO 2	3	2	-	-	-	-	-	3	3	-	-	-	-	-	-	K2
CO 3	2	3	1	-	-	-	-	-	3	2	3	-	-	-	-	K3
CO 4	2	3	1	-	-	-	-	-	3	-	2	-	-	-	-	K4
CO 5	2	3	2	-	-	-	-	-	3	2	2	-	-	-	-	K5
Wt. Avg.	2.4	2.6	1.3	-	-	-	-	3	3	2	2.3					
Overall Mapping of the Course														PO: 2.1 PSO: 2.58		

APPLIED CHEMISTRY

Course Code			
Credits	**3**		
Hours / Cycle	**3**		
Category	**Part III**	**Elective**	**Theory**
Semester	**III**		
Year of Implementation	**From 2023-24 onwards**		
Course Objectives	To explore industrial, technological and commercial dimensions of chemistry To understand and appreciate different types of fuel, traditional and modern building materials, , various water treatment methods, polymers, their types and methods of preparation, and the manufacturing processes of common products like soap, perfume, paper and paints.		

CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO1	Recall the terminologies and fundamental principles of (i) fuel (ii) building materials, (iii) water treatment methods, (iv) polymers and (v) industrial processes for the products such as soaps, pulp & paper, perfumes and paints & pigments.	PSO1, PSO2	K1
CO2	Understand the terminologies and fundamental principles of (i) fuel (ii) building materials, (iii) water treatment methods, (iv) polymers and (v) industrial processes for the products such as soaps, pulp & paper, perfumes and paints & pigments.	PSO1, PSO3	K2
CO3	Apply the fundamental chemical principles to (i) fuel (ii) building materials, (iii) water treatment methods, (iv) polymers and (v) industrial processes for the products such as soaps, pulp & paper, perfumes and paints & pigments.	PSO3, PSO4	K3
CO4	Analyze, compare and comprehend the fundamental chemical principles of (i) fuel (ii) building materials, (iii) water treatment methods, (iv) polymers and (v) industrial	PSO3, PSO4	K4

	processes for the products such as soaps, pulp & paper, perfumes and paints & pigments.		
CO5	Justify the applied chemistry facts, principles and processes based on the fundamental chemical principles	PSO3, PSO4	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**Cos**	**BLOOM'S TAXONOMY LEVEL**
I	Unit I: Fuels 1.1 Energy: Non-Renewable, Classification of fuels, Solid, Liquid and Gaseous. 1.2 Solid fuels: Coal − classification by rank, proximate and ultimate analysis, low and hightemperature carbonisation; Otto-Hoffmann's byproduct Method. 1.3 Liquid fuels: Refining of crude petroleum and uses of fractions; Cracking − thermal andcatalytic (fixed bed and fluidized bed catalysis); Octane number and Cetane number 1.4 Gaseous fuels: Natural gas and gobar gas: production, composition and uses.	9	CO1-CO5	K1 – K5
II	Unit II: Building Materials 2,1 Portland Cement: Composition, manufacture, setting and hardening of cement; Modern cement industry − Rapid Hardening Cement; White Cement; Air Entraining Cement and Hydro- graphic cement. 2.2 Glass: Manufacture; types − soda lime glass, flint glass, borosilicate glass, alumino silicate glass, vitreosil, photochromic glass and safety glass, Bioactive glass ceramics-properties and applications in healthcare 2.3 Future construction materials: 3D graphene, modular bamboo, transparent aluminium, spider silk, aluminum foam, wool brick, nanocrystal, hydroceramics and biochar.	9	CO1- CO5	K1 – K5
III	3.1 Sources of water; temporary hardness and permanent hardness – Units of hardness – Disadvantage of hard water in domestic, industry and steam generation in boilers; effect of iron and manganese in water; estimation of	9	CO1- CO5	K1 – K5

	hardness – EDTA method, estimation of total hardness. 3.2 Water softening methods: Industrial purpose – Lime-soda process , zeolite process , Ion exchange – Demineralisation – Deionization process – Mixed bed deionization – Domestic purpose – Removal of suspended impurities – Removal of microorganism – Chlorination – Breakpoint chlorination – reverse osmosis – Desalination, Solar powered desalination units			
IV	4.1 Polymers: Classification; types of polymerization, Mw and PDI. 4.2 Natural polymers: polysaccharides (starch and cellulose); polyhydrocarbons (natural rubber)and proteins 4.3 Synthetic polymers: Polyhydrocarbons (polythene, synthetic rubber), polychlorohydrocarbons(PVC, neoprene), polyamides (nylon) and polyphenols (phenolformaldehyde resin) – synthesis and uses. 4.4 Addition and condensation polymerization, step growth and chain growth polymers; Comparison and properties of thermoplastics and thermosetting polymers; copolymers. 4.5 Plastics: polythene, polypropene (isotactic structure), Ziegler-Natta polymerization, PVC,PVA, Polystyrene and Bakelite – synthesis and uses, Bioplastics from microorganisms 4.6 Fibres: rayon, terylene and nylon – synthesis and uses. .	9	CO1-CO5	K1 – K5
V	<u>Unit V: Industrial Products and Process</u> 5.1 Soap and its manufacture - batch and continuous process; types − laundry, toilet, transparent soap floating soap - soap powders, 5.2 Pulp and paper: manufacture of pulp - sulphate, soda and sulphite pulp - beating, refining, filling, sizing and colouring – manufacture of paper. 5.3 Basic chemicals of perfumes: vehicles − animal, resinous essential oil and synthetic fixatives fragrances - synthetic and semi	9	CO1- CO5	K1 – K5

	synthetic chemicals - cosmetic formulations, environmental impacts of perfumes 5.4 Pigments, paints: constituents of paints, manufacture of paints; varnishes - spirit and oleoresinous – lacquers, Superhydrophobicity and self cleaning paints			

Self-study

- Comparison between solid, liquid and gaseous fuels.
- Bioceramics – types; Abrasives – classification
- Recent trends in waste water treatment: Super critical water oxidation
- Synthetic rubber: neoprene and Buna-S, vulcanization of rubber.
- Self cleaning paints and nanochemistry
- Cleansing action of detergents
- Recycling of paper

Textbooks

1. Biswas, A.K., Frontiers in Applied Chemistry, Narosa publishing house, 1989
2. Textbook of Applied Chemistry, Thangamma Jacob, Macmillian India Ltd. Mumbai, 1990
3. Fundamental Concepts of Applied Chemistry, Jayashree Ghosh S.Chand & Company Ltd.,New Delhi, 2008.
4. Perfumes, Cosmetics and Soaps, W.A.Poucher (Vol.3), 9th Edition, Springer ScienceBusiness Media, 1993.

References

1. Vermain, O.P and Narula A.C., Applied chemistry: Theory and practice, 1995.
2. Chemical Process Industries, R. Norris Shreve and Joseph A.Brink,Jr.,4th Edition, McGrawHill, 1977

B.Sc. Course Articulation Matrix

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	K levels
CO 1	-	3	-	-	-	-	-	-	3	3	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	2	-	3	-	-	-	-	-	K2
CO 3	-	3	3	-	-	-	-	-	-	-	3	3	-	-	-	-	K3
CO 4	-	3	3	-	-	-	-	-	-	-	3	3	-	-	-	-	K4
CO 5	-	3	2	-	-	-	-	-	-	-	3	3	-	-	-	-	K5
Wt. Avg.	-	3	2.67	-	-	-	-	-	2.5	3	3	3	-	-	-	-	
															Overall Mapping of the Course		PO: 2.84 PSO: 2.88

PRACTICAL II – INORGANIC QUALITATIVE ANALYSIS

Course Code			
Credits	**4**		
Hours / Cycle	**4**		
Category	**Part III**	**Core**	**Practical**
Semester	**III and IV**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	To apply physical and inorganic chemistry concepts in the identifying the anions and cations through qualitative analysis		

CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO1	Recall (i) the underlying concepts of semi-micro analysis of inorganic compounds such as common ion effect and solubility product and (ii) the semimicro qualitative analysis techniques like filtration, centrifugation, etc. (iii) the procedure for semi-micro analysis of inorganic ions	PSO1, PSO2	K1
CO2	Comprehend the principles and concepts behind semimicro qualitative analysis & chemical reactions involved in the preparation of complexes.	PSO1, PSO2	K2
CO3	(i) Apply the underlying principles and concepts of semimicro qualitative analysis for identifying the anions and the cations and (ii) Demonstrate the skills of semi-micro qualitative analysis like sodium carbonate extract, group separation, flame test etc.	PSO3, PSO4, PSO5 PSO7	K3
CO4	Analyse the anions and cations in the given inorganic salt mixture	PSO3, PSO7	K4
CO5	Evaluate the accuracy of the identified ions based on the confirmatory tests	PSO7	K5

Inorganic Qualitative Analysis

- Reactions of the following ions:

➢ Cations: mercury, lead, copper, bismuth, cadmium. antimony, tin, ferrous and ferric iron, aluminium, zinc, manganese, cobalt, nickel, calcium, strontium, barium, magnesium, and ammonium

➢ Anions: sulphide, carbonate, nitrate, sulphate, chloride, bromide, iodide, fluoride, oxalate, arsenite, phosphate, chromate and borate radicals.

• Semimicro analysis of a mixture containing two cations and two anions of which one is an interfering ion.

Textbooks

1. Semimicro qualitative analysis of inorganic ions by V. V. Ramanujam

2. Vogel's textbook of Macro and Semimicro qualitative analysis, 5th Edition, Revised by G. Svehla, Longman GroupLimited, London, 1979

References

1. Experimental Inorganic Chemistry, W.G. Palmer, Cambridge University Press, Cambridge, 1965

Online Resources

https://pubs.rsc.org/en/content/articlelanding/1953/an/an9537800356

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	3	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	3	3	-	-	-	3	-	-	K2
CO 3	-	3	2	-	2	-	-	-	-	-	3	3	2	-	3	-	K3
CO 4	-	-	-	2	2	-	-	-	-	-	-	-	-	3	3	-	K4
CO 5	-	-	-	-	2	-	-	-	-	-	-	-	-	-	3	-	K5
Wt. Avg.	-	3	2	2	2	-	-	-	3	3	3	3	2	3	3	-	
													Overall Mapping of the Course		PO: 2.25 PSO: 2.85		

BIOLOGICAL CHEMISTRY

Course Code			
Credits	**4**		
Hours / Cycle	**3**		
Category	**Part III**	Inter-disciplinary	**Theory**
Semester	**III**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To enable the students to understand the concepts in physical and chemical processes in living systems • To appreciate the chemistry aspect of biological molecules		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall (i) the definition, classification, biological role of carbohydrates, amino acids, proteins, lipids, sterols, nucleic acids, enzymes and vitamins (ii) the structure and reactivity of biologically important compounds	PSO1 PSO2	K1
CO2	Understand (i) the fundamental structural aspects, reactions and biological functions of carbohydrates, amino acids, proteins, lipids, sterols, nucleic acids, enzymes and vitamins	PSO2 PSO3	K2
CO3	Apply the theoretical concepts to comprehend the functions of biologically important compounds and to rationalize their reactivity	PSO2 PSO3 PSO4	K3
CO4	Compare and contrast properties/types of carbohydrates, amino acids and proteins, lipids, sterols, nucleic acids, enzymes and vitamins at a basic level.	PSO3 PSO4	K4
CO5	Synthesise the knowledge gained through study of this course to have a comprehensive understanding of the fundamentals of chemistry	PSO5	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	**Chemistry of Carbohydrates:** 1.1 Definition, classification and biological role of carbohydrates. 1.2 Monosaccharides: Linear and ring structures (Haworth formula) of ribose, glucose, fructose and mannose (structural determination not required); physical and chemical properties (reduction, hydrolysis and oxidation) of glucose and fructose.	12	CO1-CO5	K1 – K5

	1.3 Disaccharides: Ring structures (Haworth formula), occurrence, physical and chemical properties of lactose and sucrose. 1.4 Polysaccharides: Starch, glycogen and cellulose – structure and properties.			
II	**Chemistry of amino acids and proteins** 2.1 Amino acids: classifications, physical properties (amphoteric nature and isoelectric point); reactions of Glycine. 2.2 Proteins: classification, properties-denaturation and renaturation of protein molecules. 2.3 Separation and purification of proteins: dialysis – electrophoresis. 2.4 Primary structure- End group analysis (N-terminal analysis – Edman's method, Enzymatic method; C-terminal analysis – hydrazinolysis and bio-chemical methods) 2.5 Catabolism of amino acids: Transamination, oxidative deamination, decarboxylation.	12	CO1- CO5	K1 – K5
III	**Chemistry of Lipids** 3.1 Definition, classification- simple lipids (fatty acids), compound lipids and derived lipids; properties – saponification, rancidity, oxidation, hydrogenation, halogenation reactions – Iodine number, Saponification number, Acetyl number. 3.2 Sterols: Cholesterol (elucidation of structure not needed), biological importance and chemical properties; Bile acids − functions. 3.3 Biological functions of lipids.	12	CO1- CO5	K1 – K5
IV	**Chemistry of Nucleic acids** 4.1 Purine and pyrimidine bases, nucleosides, nucleotides, polynucleotides, difference between DNA and RNA, DNA structure – various types, DNA repair, DNA sequencing and PCR, recombinant DNA technology, DNA polymorphism (elementary ideas). RNA structure and its types 4.2 Biological functions of DNA and RNA, Genetic code-mutations and mutants (elementary ideas).	12	CO1- CO5	K1 – K5
V	**Chemistry of Enzymes and Vitamins** 5.1 Enzymes: Definition, nomenclature, sources, classification and specificity; isoenzymes; factors affecting enzyme activity − substrate, pH, temperature, enzyme concentration. 5.2 Vitamins: Definition, classification – water soluble vitamins (B1,B2,B3,B6,B12 and vitamin C)and fat soluble vitamins (A,D,E and K)– source, deficiency diseases, and daily requirements.	12	CO1- CO5	K1 – K5

Self study

- Detoxification of ammonia
- Polenske number, Reichert-Meissl number
- Lock and Key model and induced fit models.
- Mechanism of inhibition (competitive, non- and uncompetitive and allosteric).
- Immobilization of enzymes and its applications.

Textbooks

1. Essential of Bio-Chemistry U.Sathyanarayana, 3rd edition, Books & Allied Pvt. Ltd., 2019.
2. Elementary Bio-Chemistry J.L.Jain, 2nd Revised edition, S. Chand & Company, 2007.

References

1. Principles of Biochemistry, Lehninger A.L. ,CBS Publishers, Delhi 2006.
2. Biochemistry, Stryer Lubert, W.H. Freeman and Co., New York, 2007.
3. Fundamentals of Biochemistry, Jain J.L., S. Chand & Co. New Delhi, 2007.

B.Sc. Course Articulation Matrix

CO	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO1	3	3	-	-	-	-	-	-	3	3	-	-	-	-	-	-	K1
CO2	-	1	3	-	-	-	-	-		2	3	-	-	-	-	-	K2
CO3	-	3	3	-	-	-	-	-	-	1	3	3	-	-	-	-	K3
CO4	-	2	3	-	-	-	-	-	-	-	3	3	-	-	-	-	K4
CO5	-	-	2	2	3	-	-	-	-	-	-	2	3	-	-	-	K5
Wt. Avg.	3	2.25	2.75	2	3	-	-	-	3	2	3	2.66	3	-	-	-	
Overall Mapping of the Course															PO: 2.60 PSO: 2.73		

Allied Chemistry I (for Mathematics and Physics)

Course Code			
Credits	**4**		
Hours / Cycle	**3**		
Category	**Part IV**	**Allied**	**Theory**
Semester	**III**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	To acquire fundamental knowledge in conceptual chemistry		

CO#	**Course Outcome(s)**	**PO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO1	Recall the basic principles physical, organic and inorganic chemistry.	PO3	K1
CO2	Have a basic understanding of the principles of volumetric analysis and the relation between chemical structure and properties. Gain introductory knowledge on electrochemistry, chemical kinetics, surface chemistry and physical organic chemistry.	PO3	K2
CO3	Investigate polymer properties, amino acid nature, electrochemical performance of systems, reaction kinetics, catalytic activity and stereochemistry of reactions at a basic level.	PO3	K3
CO4	Compare and contrast properties/types of polymers, amino acids, electrochemical systems, kinetic models, catalytic behaviour and stereochemical reactions at a basic level.	PO3	K4
CO5	Synthesise the knowledge gained through study of this course to have a comprehensive understanding of the fundamentals of chemistry.	PO3	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	1.1 Mole concept, Molality, Molarity, Equivalent weight and Normality (numerical problems). 1.2 Principles of volumetric analysis: Types of titrations; Acid – base titration − Principle, different types and theory of acid – base indicators (Quinonoid theory and Ostwald theory)	12	CO1-CO5	K1 – K5
II	2.1 Polymer Chemistry: Types of polymerization; Thermosetting and thermoplastics; Natural fibres – rubber, cellulose and starch (structural description and biomedical applications); 2.2 Aminoacids, polypeptides and proteins: Classification of amino acids; Preparation and properties of glycine; Zwitter ion and Isoelectric point; Peptides −	12	CO1-CO5	K1 – K5

	Synthesis of dipeptide; End group analysis; Primary, secondary and tertiary structures of proteins.			
III	3 3.1 Acid – Base theories: Arrhenius, Lowry – Bronsted and Lewis theories; Dissociation constants of acids and bases, pKa, pKb and their significance; Buffer solutions and Buffering action 3.2 Chemical Kinetics: Order and Molecularity; Zero, first and second order reactions; Experimental methods for the determination of orderof a reaction; Activation energy – Effect of temperature on reaction rates and Arrhenius equation. (numerical problems) 3.3 Catalysis: Homogeneous and heterogeneous catalysis; Enzyme catalysis –Michaelis – Menten equation; General mechanism for heterogeneous catalysis.	12	CO1-CO5	K1 – K5
IV	4.1 Electrochemistry: Specific and equivalent conductance; Kohlrausch's law – measurement of dissociation constant; Conductometric titrations for Acid – Base reactions only. 4.2 Galvanic cells: Standard electrode potential, Electrochemical series and Representation of cells and determination of cell potential and cell reactions. 4.3 Conducting polymers: Definition, examples, n- and p-type doping; Application of conducting polymers in batteries (basic aspects only)	12	CO1-CO5	K1 – K5
V	5.1 Identification of positive and negative centres in common functional groups and types of reagents. 5.2 Physical organic chemistry: Energy profile diagram of chemical reactions – endothermic and exothermic reactions, transition state, intermediate and activation energy. 5.3 Stereochemistry: Molecular chirality, diastereomers, meso compound and racemic mixture; optical purity, enantiomeric excess, specific rotation and diastereomeric excess (Definitions only); Stereoisomerism in maleic acid, fumaric acid and tartaric acid.	12	CO1-CO5	K1 – K5

Self-study

Textbooks

1. Elements of Analytical Chemistry by R. Gopalan, P.S. Subramaninam and K. Rengarajan, 3rd Ed., Sultan Chand and Sons, 2003.
2. Fundamental concepts of Applied Chemistry by Jayashree Gosh, S. Chand & Co. Ltd., 2006.
3. Principles of Physical Chemistry by B.R. Puri, L.R. Sharma and M.S. Pathania, Vishal Publishing House Pvt. Ltd., 2008
4. S. Ramakrishnan, Conducting Polymers – From a Laboratory Curiosity to the Market Place, Resonance, 2 (1997) 48 – 58. 5. A textbook of organic chemistry by K.S. Tewari and N.K. Vishnoi, 3rd Ed., Vikas Publishing House Pvt. Ltd., 2009.

REFERENCES

1. Pharmaceutical Applications of Polymers for Drug Delivery by David Jones, Rapra Technology Pvt. Ltd., 2004.

2. Industrial polymers, Speciality polymers and their applications by M. Chanda and S.K. Roy, CRC Press, 2009. 3. Chemistry for the Life Sciences by Raul Sutton, Bernard Rockett, and Peter G. Swindells,Second Edition, CRC Press, 2009.

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K1
CO 2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K2
CO 3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K3
CO 4	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K4
CO 5	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K5
Wt. Avg.	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	
															Overall Mapping of the Course		PO: 3.0 PSO: -

ALLIED CHEMISTRY – I [FOR BOTANY & ZOOLOGY]

Course Code			
Credits	**3**		
Hours / Cycle	**4**		
Category	**Part III**	**Allied**	**Theory**
Semester	**III**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	To understand the chemistry of Amino acids, carbohydrates including their preparation, properties, classification and appreciate their biological significance. To comprehend the role of basic organic and physical chemistry concepts in day to day life.		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall the fundamental concepts and principles of (i) Stoichiometric and volumetric analysis, (ii) Aminoacids and carbohydrates, (iii) thermodynamics, (iv) Electrochemistry, Colloids and theories of acids & Bases and (v) Elimination and Substitution reactions, Stereochemistry and heterocyclic compounds	PO3	K1
CO2	Understand the fundamental concepts and principles of (i) Stoichiometric and volumetric analysis, (ii) Aminoacids and carbohydrates, (iii) thermodynamics, (iv) Electrochemistry, Colloids and theories of acids & Bases and (v) Elimination	PO3	K2

	and Substitution reactions, Stereochemistry and heterocyclic compounds		
CO3	Apply the fundamental concepts and principles of (i) Stoichiometric and volumetric analysis, (ii) Aminoacids and carbohydrates, (iii) thermodynamics, (iv) Electrochemistry, Colloids and theories of acids & Bases and (v) Elimination and Substitution reactions, Stereochemistry and heterocyclic compounds, to simple analytical and numerical problems	PO2, PO3	K3
CO4	Compare the fundamental concepts and principles of (i) Stoichiometric and volumetric analysis, (ii) Aminoacids and carbohydrates, (iii) thermodynamics, (iv) Electrochemistry, Colloids and theories of acids & Bases and (v) Elimination and Substitution reactions, Stereochemistry and heterocyclic compounds	PO3	K4
CO5	Justify the simple chemical facts based on the fundamental concepts and principles of (i) Stoichiometric and volumetric analysis, (ii) Aminoacids and carbohydrates, (iii) thermodynamics, (iv) Electrochemistry, Colloids and theories of acids & Bases and (v) Elimination and Substitution reactions, Stereochemistry and heterocyclic compounds	PO3	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	1.1 Stoichiometry: Mole concept, Molality, Molarity, Equivalent weight and Normality (numerical problems). 1.2 Principles of volumetric analysis: Types of titrations; Acid – base titration − Principle, different types and theory of acid – base indicators (Quinonoid theory and Ostwald theory).	12	CO1-CO5	K1 – K5
II	2.1 Aminoacids, polypeptides and proteins:Classification of amino acids; Preparation and properties of glycine; Zwitter ion and Isoelectric point; Peptides − Synthesis of dipeptide; End group analysis; Primary, secondary and tertiary structures of proteins. 2.2 Carbohydrates: Classification – sugars and polysaccharides; Basic structural description of glucose, fructose, sucrose, starch and cellulose (open, cyclic and Haworth structures); Mutarotation – Definition and illustration using glucose; Osazone formation reaction of glucose and fructose.	12	CO1-CO5	K1 – K5
III	3.1 Terminologies in thermodynamics: System and surroundings, State and Path functions, Intensive and extensive properties – definition and examples. 3.2 Laws of Thermodynamics: Zeroth, First and Second Law of Thermodynamics (statements only).	12	CO1-CO5	K1 – K5

	Concepts of heat, work, internal energy, enthalpy, entropy and free energy. Exergonic and endergonic processes. 3.3 Bioenergetics: Definition, relationship between standard free energy change (ΔGo) and equilibrium constant (Keq), standard free energy changes at pH 7.0 (ΔGo′), difference between ΔGo and ΔGo′, ATP as universal currency of free energy in biological system; Shift of equilibria of coupled reactions in ATP hydrolysis			
IV	4.1 Electrochemistry: Electrolytic and metallic conduction; Specific and equivalent conductances; Measuring electrical conductance in biological molecules (Nucleic acids and proteins) and its applications. 4.2 Colloids: Types (based on dispersion medium/dispersed phase and affinity towards solvent); Origin of charge on colloidal particles with illustrations; Schematic representation of electrical double layer; Coagulation of colloids by the addition of electrolyte and flocculation value; Protective colloids and gold number; Electrophoresis and electro-osmosis; Separation of proteins by Gel electrophoresis. 4.3 Acid – Base theories: Arrhenius, Lowry – Bronsted and Lewis theories; Definition of dissociation constants of acids and bases, pKa, pKb and their significance; Buffer solutions: Definition and Henderson equation (derivation not required); Significance of pH and buffer solutions in biological system (carbonate and phosphate buffers).	12	CO1-CO5	K1 – K5
V	5.1 Identification of positive and negative centres in common functional groups and types of reagent; Nucleophilic substitution reactions − SN1 and SN2; Elimination reactions − E1 and E2; Nucleophilic addition to carbonyl group (hydrolysis of peptide bond) 5.2 Stereochemistry: Molecular chirality, diastereomers, meso compound and racemic mixture; optical purity, enantiomeric excess, specific rotation and diastereomeric excess (Definitions only); Stereoisomerism in maleic acid, fumaric acid and tartaric acid. 5.3 Heterocyclic compounds: Preparation and Electrophilic aromatic substitution of furan, pyrrole, thiophene and pyridine; Uses of ranitidine and atorvastatin.	12	CO1- CO5	K1 – K5

Self-study

- Role of EDTA in complexometric titrations.
- Quaternary structure of proteins and chemical reactions of Glucose and fructose.

- Applications of zeroth, first and second law of thermodynamics in every day life.
- Applications of colloids in cosmetics and paint industry.
- Optical activity of Glucose and fructose.

Textbooks

1. Elements of Analytical Chemistry by R. Gopalan, P.S. Subramaninam and K. Rengarajan, 3rd Ed., Sultan Chand and Sons, 2003.
2. Organic chemistry of natural products, Volume I by Gurdeep R Chatwal, Edited by M. Arora, Himalaya Publishing House, 2010.
3. Principles of Physical Chemistry by B.R. Puri, L.R. Sharma and M.S. Pathania, Vishal Publishing House Pvt. Ltd., 2008
4. Biological Thermodynamics by D.T. Haynie, 2nd Ed., Cambridge University Press, 2008.
5. A textbook of organic chemistry by K.S. Tewari and N.K. Vishnoi, 3rd Ed., Vikas Publishing House Pvt. Ltd., 2009.

References

1. Biochemistry by L. Stryer, 2nd edition, W.H. Freeman & Co., 1981.
2. Chemistry for the Life Sciences by Raul Sutton, Bernard Rockett, and Peter G. Swindells, 2nd Ed., CRC Press, 2009.

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	KL
CO 1	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K1
CO 2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K2
CO 3	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K3
CO 4	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K4
CO 5	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K5
Wt. Avg.	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	
														Overall Mapping of the Course		PO: 2.5 PSO: -	

ALLIED CHEMISTRY PRACTICAL

Course Code			
Credits	**4**		
Hours / Cycle	**2**		
Category	**Part III**	**ALLIED**	**PRACTICALS**
Semester	**III & IV**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To understand the principles of quantitative analysis (volumetric method) and estimate the amount of sample present in the given solution. • To understand the principles of qualitative analysis of organic compounds and identify i) aliphatic / aromatic ii) saturated / unsaturated iii) presence of nitrogen iv) functional group by systematic qualitative analysis of given organic compound.		

CO#	Course Outcome(s)	PO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall the experimental procedure for the volumetric analysis and qualitative organic analysis.	PO3	K1
CO2	Compile the report of the experiments in an organized way.	PO3, PO5	K2
CO3	Tabulate/Record the experimental observations in a systematic manner related to quantitative and qualitative analysis.	PO3, PO5	K3
CO4	Determine (quantitative) and infer (qualitative) the observations made during the experiment and present the report with systematic procedure during regular laboratory classes.	PO3, PO5	K4
CO5	Determine (quantitative) and infer (qualitative) the observations made during the experiment and present the report with systematic procedure during ICA.	PO3, PO5	K5

SYLLABUS

CONTENT

I. VOLUMETRIC ANALYSIS (Semester III)

A. Acid – Base Titration

1. Estimation of sodium hydroxide
2. Estimation of sodium carbonate
3. Estimation of sodium carbonate and sodium bicarbonate in a mixture
4. Estimation of hydrochloric acid

B. Redox Titration

5. Permanganometry: Estimation of ferrous sulphate /ferrous ammonium sulphate
6. Permanganometry: Estimation of Oxalic acid

7. Iodometry: Estimation of copper
8. Iodometry: Estimation of potassium dichromate

C. Complexometric Titrations

9. Estimation of magnesium

II. ORGANIC QUALITATIVE ANALYSIS (Semester IV)

Functional Groups

• Aldehyde (aromatic) • Ketone (aliphatic and aromatic)* • Carbohydrate
• Carboxylic acid (mono and dicarboxylic) • Phenol • Aromatic primary amine
• Amide and diamide • Aromatic Nitro Compound

Systematic analysis of organic compounds containing one functional group and characterization by confirmatory tests. *Need Not be given for examination - ketone

Textbooks

1. Gnanapragsam and Ramamurthy. *Organic chemistry: Lab manual*. Viswanathan S Printers and Publishers Pvt Ltd, 2009.
2. Ahluwalia, V. K., and Sunita Dhingra. *College practical chemistry*. Universities Press, 2005.

References

1. Vogel, Arthur Israel, and B. V. Smith. *Elementary practical organic chemistry*. Wiley, 1966

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K1
CO 2	-	-	3	-	2	-	-	-	-	-	-	-	-	-	-	-	K2
CO 3	-	-	3	-	3	-	-	-	-	-	-	-	-	-	-	-	K3
CO 4	-	-	3	-	3	-	-	-	-	-	-	-	-	-	-	-	K4
CO 5	-	-	3	-	3	-	-	-	-	-	-	-	-	-	-	-	K5
Wt. Avg.	-	-	3	-	2.75	-	-	-	-	-	-	-	-	-	-	-	
Overall Mapping of the Course															PO: 2.875 PSO: -		

CLASSICAL THERMODYNAMICS

Course Code			
Credits	**4**		
Hours / Cycle	**3**		
Category	**Part NA**	**Core**	**Theory**
Semester	**IV**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	1. To expose the students to various concepts and laws of thermodynamics 2. To study the heat changes occurring in chemical reactions 3. To recognize the mathematical interpretations of various thermodynamic parameters		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall and define the basic principles and terminology used in classical thermodynamics.	PSO1	K1
CO2	(i) Outline the laws of thermodynamics and demonstrate its applications (ii) Investigate thermodynamic properties of different types of systems.	PSO1	K2
CO3	Apply thermodynamic principles to envisage chemical/physical changes with reference to various thermodynamic parameters.	PSO3, PSO4	K3
CO4	Examine thermodynamic behaviour of different types of systems and ascertain the relationship between various thermodynamic parameters.	PSO3, PSO4, PSO5	K4
CO5	Critically evaluate the thermodynamic concepts in the context of change in thermodynamic parameters for different spontaneous processes and systems in equilibrium.	PSO3, PSO4, PSO5	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	1.1 1.1 First law of thermodynamics – internal energy – enthalpy – Hess's law of heat summation. 1.2 1.2 Applications of I law: Expansion and work done of an ideal gas in thermodynamic properties (q, w, ΔU and ΔH) for reversible and irreversible processes including free expansion: (i) Isothermal expansion (ii) Adiabatic expansion; Joule-Thomson effect, Joule-Thomson coefficient and its significance; inversion temperature	9	CO1 - CO5	K1 – K5

	(numerical problems); Limitations of I law; Need for the II law			
II	2.1 Thermochemistry: Measurement of heat changes: Heat of reaction. Calculation of change in internal energy and enthalpy, relation between ΔH and ΔU of a reaction, standard states and standard enthalpy changes of reactions (combustion, neutralization and formation), determination of enthalpies of reactions (numerical problems). 2.2 Variation of enthalpy change of reaction with temperature (Kirchoff's equation), Hess's law − applications. Determination of calorific value using Bomb calorimeter, bond energy and its applications. 2.3 Spontaneous processes, cyclic process, heat engine, Carnot cycle and its efficiency, Carnot theorem, various statements of second law,	9	CO1 - CO5	K1 – K5
III	3.1. 3.1 The concept of entropy, Entropy change in Isothermal expansion (ideal gas), Entropy change in reversible and irreversible processes, Entropy change accompanying phase change, calculation of Entropy change of an ideal gas with P, V and T, Entropy of mixing and its physical significance. 3.2. Helmholtz work function-Gibbs free energy -Criteria of spontaneity. Maxwell's equations and thermodynamics of open system (partial molar properties).Gibbs-Helmholtz equation and its applications. 3.3. 3.3 Chemical potentials of a component in an ideal mixture, thermodynamic functions of mixing of ideal gases, Gibbs-Duhem equation, variation of chemical potential with T and P	9	CO1 - CO5	K1 – K5
IV	4.1 Chemical equilibrium: Law of mass action, various forms of equilibrium constants (Kp, Kc and Kx), relation between Kp and Kc, significance of equilibrium constants, derivation of thermodynamic equilibrium constant, and its relationship with change in standard free energy (van't Hoff isotherm), van't Hoff isochore, de Donder's concept of equilibrium, chemical affinity. 4.2 Le-Chatelier-Braun principle: Factors affecting the state of the equilibrium. 4.3 Application of Le-Chatelier-Braun principle to homogeneous gaseous reactions: Dissociation of N_2O_4, NH_3, HI and PCl_5.	9	CO1 - CO5	K1 – K5
V	5.1 Nernst heat theorem − formulation of third law, determination of absolute entropy of solids, liquids and gases, residual entropy, exceptions of third law. 5.2 Solutions: Thermodynamics of ideal solutions − Raoult's law and Henry's law. 5.3 Colligative properties: Depression of freezing point, elevation of boiling point; osmotic pressure −	9	CO1 - CO5	K1 – K5

	experimental methods, laws of osmotic pressure and analogy between dilute solutions and gaseous systems; abnormal molecular weights − van't Hoff factor (i).			

Textbooks

1.Principles of Physical Chemistry, B.R. Puri, L.R. Sharma and M.S. Pathania, Vishal Publishing Co.; 47th edn., (2017)

. 2. Physical chemistry, Keith J. Laidler and John H. Meiser, CBS Publishers, 2nd Indian edn.,2006.

3. Thermodynamics, G. Rajaram, J.C. Kuriacose, ShobanLal Nagin Chand & Co., 2006.

References

1. Physical Chemistry, P. Atkins, 7 thedn.,Oxford university press, 2001
2. Physical Chemistry, G. W. Castellan, 3 rd Edition, Narosa publishing house, 1985.

Suggested Reading

1. M.W. Zemansky, R.H. Dittman, Heat and Thermodynamics, Tata McGraw Hill, 1981.
2. M. F .Granville, Student Misconceptions in Thermodynamics, J. Chem. Edu. 62 (1985) 847.
3. L. S. Bartell, Stories to Make Thermodynamics and Related Subjects More Palatable, J. Chem. Edu. 78 (2001) 1059.
4. D. N. Hague, Fast Reactions, Wiley- Interscience, New York, 1971.
5. J. W. Moore and R. G. Pearson, Kinetics and Mechanisms, John Wiley & Sons, New York, 1981.
6. M. R. J. Dack, The Influence of Solvents on Chemical Reactivity, J. Chem. Educ. 51 (1974) 231

Online Resources (accessed on)

1. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=13G8VouhmrFfuhs6rkiyTA==
2. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=13G8VouhmrFfuhs6rkiyTA==
3. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=13G8VouhmrFfuhs6rkiyTA==

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	2	-	-	-	-	-	-	-	K2
CO 3	-	3	3	-	-	-	-	-	-	-	3	2	-	-	-	-	K3
CO 4	-	3	3	-	2	-	-	-	-	-	3	3	3	-	-	-	K4
CO 5	-	3	3	-	3	-	-	-	-	-	3	3	3	-	-	-	K5
Wt. Avg.	-	3	3	-	2.5	-	-	-	2.5	-	3	2.7	3	-	-	-	
Overall Mapping of the Course															PO: 2.8 PSO: 2.8		

GREEN AND NANO CHEMISTRY

Course Code			
Credits	**3**		
Hours / Cycle	**3**		
Category	**Part III**	**ELECTIVE**	**Theory**
Semester	**IV**		
Year of Implementation	**From 2023-24 onwards**		
Course Objectives	To understand and appreciate the chemistry of main group elements including their preparation, properties, classification, applications, relationship with elements of neighbouring groups in the periodic table and the concepts to understand their properties		

CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO1	Recall the functional and working principles of (i) green chemistry and (ii) nano chemistry	PSO1, PSO2	K1
CO2	Understand (i) several real-world examples of green chemistry in improving the sustainability performance of their products (ii) various synthetic methods for nanomaterials and (iii) various characterization techniques for nanomaterials	PSO1, PSO3, PSO4	K2
CO3	Apply (i) the principles of green chemistry for synthesis of few organic compounds (ii) the various methods of synthesis and characterization techniques for selective nanomaterials	PSO3, PSO4	K3
CO4	(i) Compare the various green chemistry principles and green methods of synthesis and (ii) compare the various synthesis and characterization methods of nanomaterials.	PSO3, PSO4	K4
CO5	(i) Evaluate the green synthetic methods based on green chemistry principles and (ii) Explain the various principles and techniques of synthesis and characterization of nanomaterials	PSO4, PSO5	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Introduction to Green Chemistry - Green Chemistry – Definition, Need for Green Chemistry, Goals of Green Chemistry; Twelve principles of green chemistry, Limitations/Obstacles in the pursuit of the goals of Green Chemistry; Tools of green chemistry- Alternative feed stocks starting material, Alternative Reagents, Alternative Solvents, Alternative products	9	CO1-CO5	K1 – K5

	/Target molecules, Process Analytical Chemistry, Alternative Catalysts; Green analytical chemistry – introduction, basis and a green evaluation of existing analytical methods.			
II	Unit II: Designing of Green Synthesis - Designing a green synthesis – Atom economy - evaluating the effects of chemistry – Examples of synthesis involving basic principles of Green Chemistry: methyl methacrylate, paracetamol and Ibuprofen; Microwave Assisted Reactions in Water- Hofmann elimination, Diels Alder reactions and deacetylation; Sonochemical reactions - Saponification and Simmons-Smith Reaction; Supercritical water oxidation (SCWO).	9	CO1- CO5	K1 – K5
III	Unit III: Introduction to Nanochemistry The science of nano- Significance of nano-sized materials − Size effect properties 1.2 Types of nanostructures- 0D, 1D. 2D, 3D and nano composites – Definition and examples. Carbon based nanomaterials: graphene, fullerene, carbon nanotubes(CNTs). 1.3 Synthetic methods: Top-down methods (physical methods) – Ball milling, Lase ablation, sputtering and physical vapour deposition method; Bottom-up methods (Chemical methods) – Co-precipitation, reduction, sol-gel, hydrothermal and surfactant-assisted methods.	9	CO1- CO5	K1 – K5
IV	Unique properties and applications of nanomaterials 2.1 Metal nanoparticles- Au, Ag, Pt – Size and shape control of metal nanoparticles and study of their optical, electronic properties. 2.2 Metal oxides nanomaterials- semiconducting property and bandgap energy, application as photocatalyst for pollution degradation and in bio-medical applications (anti-microbial agent, bio-imaging and drug delivery) . 2.3 Nanowires – Applications (MEMS and NEMS). 2.4 Nanosensors: CO2 sensor, electrochemical sensor, optical nanosensor and biosensor.	9	CO1- CO5	K1 – K5
V	Unit V – Morphological study (9 hours) Electron microscopy: Basics of Electron scattering and Electron-Atom Interaction (Auger electron emission, Back scattered electron, Secondary electrons and Characteristic X-ray emission); SEM and TEM – Principle and Schematic representation of ray path of light for SEM and TEM; Instrumentation of SEM and TEM	9	CO1- CO5	K1 – K5

Self-study

- Synthesis of nanoparticles by using plant extracts (green method)
- Mechanism of photocatalytic activity of metal oxides towards water splitting
- Comparison between SEM and TEM; description of STEM
- Recent advances in Supercritical fluid extraction

Textbooks

1. Nano: The essentials, T Pradeep, Tata McGraw-Hill publishing company Ltd, 2007.
2. Introduction to nanotechnology, C.P. Poole and F.J. Owens, Wiley Interscience, 2003.
3. P. T. Anastas and j. C. Warner, Green Chemistry- Theory and Practice (Indian Edition), Oxford University Press, 2008.
4. Miguel de la Guardia, Sergio Armenta - Green Analytical Chemistry(Comprehensive Analytical Chemistry 57), Theory and Practice, Volume 57, Elsevier 2010.
5. V.K. Ahluwalia& M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005)

References

1. Nanoscale materials in chemistry, Kenneth, J. Klabunde, Wiley Interscience, 2001.
2. Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition,2010.
3. https://www.acs.org/content/acs/en/greenchemistry/research-innovation/tools-for-greenchemistry.html (accessed on 10 May 2019).

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								K level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	2	-	-	-	-	-	-	K1
CO 2	-	3	2	-	-	-	-	-	3	-	2	3	-	-	-	-	K2
CO 3	-	3	2	-	-	-	-	-	-	-	2	3	-	-	-	-	K3
CO 4	-	3	2	-	-	-	-	-	-	-	3	3	-	-	-	-	K4
CO 5	-	-	2	-	2	-	-	-	-	-	-	2	2	-	-	-	K5
Wt. Avg.	-	3	2	-	-	-	-	-	3	2	2.3	2.75	2	-	-	-	-
Overall Mapping of the Course															PO: 2.5 PSO: 2.41		

FOOD AND COSMETICS CHEMISTRY

Course Code			
Credits	**3**		
Hours / Cycle	**3**		
Category	**Part III**	**ELECTIVE**	**Theory**
Semester	**IV**		
Year of Implementation	**From 2023-24 onwards**		
Course Objectives	• To expose the students to the chemistry involved in food and cosmetics • To gain knowledge on the adulterants in food and methods to detect them • To study the regulatory control of food composition, quality and safety		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall (i) the functional role of various constituents of food and cosmetics, (ii) the food adulterants and preliminary methods to detect them, (iii) regulations and laws enforced for food safety and (iv) hazards of food additives and cosmetics	PSO1, PSO2	K1
CO2	Understand (i) the functional role of various constituents of food and cosmetics, (ii) the food adulterants and preliminary methods to detect them, (iii) regulations and laws enforced for food safety and (iv) hazards of food additives and cosmetics	PSO1, PSO3, PSO4	K2
CO3	Apply the fundamental concepts related to food and cosmetic constituents to understand the properties and hazardous of food and cosmetic products	PSO3, PSO4	K3
CO4	Analyze (i) the roles of food and cosmetic constituents and (ii) hazards of food additives and cosmetics, based on the related fundamental concepts	PSO3, PSO4	K4
CO5	Comment on (i) the roles of food and cosmetic constituents and (ii) hazards of food additives and cosmetics, based on the related fundamental concepts	PSO4, PSO5	K5

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	1.1 Food Chemistry: Introduction; Constituents of food: Carbohydrates, proteins, fats and lipids & vitamins – classification, examples their functional role.	9	CO1-CO5	K1 – K5

	1.2 Classification of alteration occurring at handling, processing or storage - Change of texture, nutritional value and safety. 1.3 Water: Types of water, Interaction of water with food components and its influence on food quality and stability; removal of water from foods (concentration and dehydration).			
II	Food Additives: Acids, bases, buffer systems and salts, sequestrants, antioxidants, antimicrobial agents, sweeteners, texturizers, colourants, stabilizers and emulsifiers – definition / meaning, examples and their functions; Hazards of food additives.	9	CO1- CO5	K1 – K5
III	3.1 Detection of food adulterants : Common adulterants in vegetable oils, fats, spices, cereals and pulses, coffee, tea, spices, milk and milk products; principles involved in the detection of food adulteration. 3.2 Regulatory control of food composition, quality and safety: Overview of safety, US food laws, Canadian food laws, EU food laws, International food law, WHO standards; Indian food laws: ISI specifications, packing and label requirements, Essential commodities act, AGMARK.	9	CO1- CO5	K1 – K5
IV	4.1 Perfumes, antiperspirants and deodorants – Active ingredients and their functions. 4.2 Lipsticks, eyebrow pencils, eye shadow, eyeliners, mascara, eye makeup removers – Active ingredients and functions 4.3 Cold creams, foundation creams, moisturising creams, bleachers, Anti ageing creams, sunscreen lotions, Depilatories, face and skin powders – Active ingredients and their functions	9	CO1- CO5	K1 – K5
V	5.1 Hair cosmetics: Permanent and cold hair waving preparations – dry and liquid shampoos, dandruff shampoos, conditioners, hair colourants (temporary, semi-permanent and permanent), hair lighteners, hair lotions, hair tonics, hair oils, hair creams, shaving creams and after shave preparations – Active ingredients and their functions. 5.2 Cosmetics for teeth: tooth pastes, tooth powders, liquid preparations, mouth washes, fillers, antiplaque agents; Teeth whiteners. 5.3 Cosmetics for nail, manicure preparations, cuticle creams, nail bleach, nail enamel, enamel removers, nail strengthener's and nail elongators.	9	CO1- CO5	K1 – K5
Self-Study • Heterocyclic compounds in cosmetics • One method of analysis of carbohydrates and proteins in food • Care and hazards in the use of cosmetics. • Nanotechnology for the food and bioprocessing industries				

- Chemistry of cosmetics in antiquity
- Trends in Natural cosmetics

Textbooks

1. Mechanism and Theory in Food Chemistry, Dominic W.S. Wong, 2nd Edition, Springer International Publishing, 2018
2. FENNEMA'S Food Chemistry, Srinivasan Damodaran, Kirk L. Parkin (edited), 5th edition, CRC Press, Taylor & Francis Group, 2017.
3. W.A. Poucher, Perfumes, cosmetics and soaps – Vol 3, 9th Edition

References

1. Principles of Food Chemistry, John M. deMan, 3rd Edition, Aspen Publishers Inc. USA, 1999
2. Harry's cosmeticology, J.B. Wilkinson and R.J. Moore,8th Edition.

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								K level
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PSO 7	PSO 8	
CO 1	-	3	-	-	-	-	-	-	3	2	-	-	-	-	-	-	K1
CO 2	-	3	2	-	-	-	-	-	3	-	2	3	-	-	-	-	K2
CO 3	-	3	2	-	-	-	-	-	-	-	2	3	-	-	-	-	K3
CO 4	-	3	2	-	-	-	-	-	-	-	3	3	-	-	-	-	K4
CO 5	-	-	2	-	2	-	-	-	-	-	-	2	2	-	-	-	K5
Wt. Avg.	-	3	2	-	-	-	-	-	3	2	2.3	2.75	2	-	-	-	-
Overall Mapping of the Course															PO: 2.5 PSO: 2.41		

ALLIED CHEMISTRY II (FOR MATHEMATICS AND PHYSICS)

Course Code			
Credits	**3**		
Hours / Cycle	**4**		
Category	**Part III**	**Allied**	**Theory**
Semester	**IV**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	To acquire the knowledge of chemistry in comprehending various physical processes		

CO#	Course Outcome(s)	PO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall the fundamental concepts and principles of (i) Coordination chemistry, (ii) Solid State, (iii) nanochemistry, (iv) Cheminformatics and (v) Photochemistry	PO3	K1
CO2	Understand the fundamental concepts and principles of (i) Coordination chemistry, (ii) Solid State, (iii) nanochemistry, (iv) Cheminformatics and (v) Photochemistry	PO3	K2
CO3	Apply the fundamental concepts and principles of (i) Coordination chemistry, (ii) Solid State, (iii) nanochemistry, (iv) Cheminformatics and (v) Photochemistry, to simple analytical and numerical problems	PO2, PO3	K3
CO4	Analyze / Compare the fundamental concepts and principles of (i) Coordination chemistry, (ii) Solid State, (iii) nanochemistry, (iv) Cheminformatics and (v) Photochemistry	PO3	K4
CO5	Justify the simple chemical facts based on the fundamental concepts and principles of (i) Coordination chemistry, (ii) Solid State, (iii) nanochemistry, (iv) Cheminformatics and (v) Photochemistry	PO3	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Unit I 1.1 Nomenclature and theories: IUPAC nomenclature; Pauling theory (VBT); Elementary ideas of Crystal Field Theory and its application in splitting of d-orbitals in octahedral field. 1.2 Isomerism: Structural isomerism – Ionization, linkage, ligand and hydrate isomerisms; Optical	12	CO1-CO5	K1 – K5

	and geometrical isomerism of four coordinated complexes. 1.3 Chelates: Definition and examples; Factors affecting stability of chelates.			
II	Unit II 2.1 Crystal systems: Crystal lattice, unit cell and unit cell parameters; Miller indices; Lattice planes in cubic crystals; Crystal systems and Bravais lattices. 2.2 Solid state reactions:Definition and illustrations; Reactivity of solids 2.3 Point defects in crystal structures:Schottky, Frenkel, metal excess and metal deficient defects and Applications of defects	12	CO1- CO5	K1 – K5
III	Unit III **3.1** Introduction to nanochemistry: Significance of nano-sized materials − Size effect properties; types of nanomaterials - Quantum dots (0 D), Nanorods and nanowires (1 D), Nanosheets (2 D) and nanocomposites – Definition only. **3.2** Chemical methods (reduction and Sol-gel) synthesis with examples. 3.3 Scanning Electron Microscopy and Transmission Electron Microscopy – Principle and instrumentation (schematic representation).	12	CO1- CO5	K1 – K5
IV	Unit IV **4.1** Cheminformatics: Introduction; Databases and their types; Online data bases (chemical and biomolecules); Drug designing and Five classic steps in drug development. **4.2** Industrial Chemistry: Fuel gases – Composition, industrial preparation and uses of water gas, producer gas and bio gas; Glass – composition and uses of borosilicate, photochromic and safety glasses; Corrosion – meaning and control of corrosion through galvanization, modification of environment and use of anodic and cathodic inhibitors.	12	CO1- CO5	K1 – K5
V	Unit V **5.1** Electronic transitions in organic molecules:Chromophore, auxochrome, bathochromic shift, hypsochromic shift, hyperchromic shift and hypochromic shift; Different types of electronic transitions and their significance in structural elucidation (concepts only).	12	CO1- CO5	K1 – K5

	5.2 Photochemistry:Grothus – Draper law, Stark – Einstein law and Beer – Lambert law; Quantum yield (simple numerical problems); Photophysicalprocesses (Jablonski diagram);Chemiluminescence.			

Textbooks

1. Principles of physical chemistry by B.R. Puri, L.R. Sharma and M.S. Pathania, Vishal Publishing House Pvt. Ltd., 2008.
2. Textbook of engineering chemistry by R. Gopalan, D. Venkappayya and SoluchanaNagarajan, Vikas Publishing House Pvt. Ltd
3. Principles of nanoscience and nanotechnology, M.A. Shah and Tokeer Ahmad, Alpha Science International, 2010.
4. An introduction to chemoinformatics by A.R. Leach and V.J. Gillet, Springer Science and Business Media, 2003

References

1. Websites:https://www.ccdc.cam.ac.uk/Community/csd-community/freemercury/, http://www.chemspider.com/StructureSearch.aspx, https://www.emolecules.com/
2. Coordination Chemistry by R. Gopalan and V. Ramalingam, Vikas Publishing House Pvt. Ltd., 2001.
3. Solid state chemistry and its applications, A.R. West, Student Ed., Wiley India (P) Ltd., 2003.

B.Sc. Course Articulation Table

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO 2	PO3	PO 4	PO5	PO 6	PO 7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO 8	
CO 1	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K1
CO 2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K2
CO 3	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K3
CO 4	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K4
CO 5	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	K5
Wt. Avg.	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	
Overall Mapping of the Course															PO: 2.5 PSO: -		

ALLIED CHEMISTRY II (for Botany and Zoology students)

Course Code			
Credits	**3**		
Hours / Cycle	**4**		
Category	**Part III**	**Allied**	**Theory**
Semester	**IV**		
Year of Implementation	**From the academic year 2023-34 onwards**		
Course Objectives	1. To get insight of the fundamental concepts and principles of basic inorganic, organic and physical chemistry. 2. To acquire the basic knowledge in chemistry for interdisciplinary research		

CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO1	Recall (i) the basics of coordination and nano chemistry, ii) definition, sources, classification of alkaloids, terpenoids, vitamins enzymes and antibiotics (iii)The fundamental terminologies of chemical kinetics, enzymes and parameters for water analysis (iv) elementary ideas on electronic transitions in organic molecules and photochemistry	PSO1 PSO2	K1
CO2	Understand (i) the theories of coordination chemistry and structure of natural products (ii) instrumentation of SEM (iii) types of nano materials and the importance of size effect properties (iv)the basics of electronic transitions and photochemistry (v) various parameters for water analysis	PSO1 PSO2	K2
CO3	Apply (i) the CFT in d orbital splitting and chelate stability factors (ii) vitamin deficiency symptoms and antimicrobial resistance to understand issues related to health (iii) enzyme inhibition phenomenon to infer enzyme kinetics (iii)Jablonski diagram to interpret photo physical processes	PSO3 PSO4	K3
CO4	Compare and contrast properties/types of coordination compounds, nanomaterials, natural products/drugs, enzymes, kinetic behaviour, electronic transitions, photo physical processes at a basic level.	PSO3 PSO4	K4

CO5	Synthesise the knowledge gained through study of this course to have a comprehensive understanding of the fundamentals of chemistry.	PSO5	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	1.1 Theories of coordination chemistry: IUPAC nomenclature; Pauling theory (VBT); Elementary ideas of Crystal Field Theory and its application in splitting of d-orbitals in octahedral field. 1.2 Isomerism: Structural isomerism – Ionization, linkage, ligand and hydrate isomerism; Optical and geometrical isomerism of four coordinated complexes. 1.3 Chelates: Definition and examples; Factors affecting stability of chelates. 1.4 Bio-coordination Chemistry: Structural features and functions of haemoglobin and chlorophyll	12	CO1-CO5	K1 – K5
II	2.1 Introduction to nano chemistry: Significance of nano-sized materials − Size effect properties; types of nanomaterials - Quantum dots (0 D), Nanorods and nanowires (1 D), Nanosheets (2 D) and nanocomposites – Definition only. 2.2 Green synthesis of Au and Ag nanoparticles and their bio-medical applications. 2.3 Scanning Electron Microscopy– Principle and instrumentation (schematic representation)	12	CO1- CO5	K1 – K5
III	3.1 Alkaloids: Introduction, sources, chemical classification, structure and uses of atropine, quinine and morphine 3.2 Terpenoids: Introduction, sources, isoprene rule, chemical classification, structure and uses of citral, alpha-terpineol and limonene. 3.3 Vitamins: Definition, classification, water soluble vitamins (B1, B2, B3, B6, B12 and C) and fat soluble vitamins (A,D,E and K) – source, deficiency symptoms and daily requirements 3.4 Antibiotics:definition, examples and mode of action of penicillin; antimicrobial resistance	12	CO1- CO5	K1 – K5

IV	4.1 Chemical Kinetics: Order and Molecularity; Zero, first and second order reactions (no derivations); Experimental methods for the determination of order of a reaction; Activation energy – Effect of temperature on reaction rates and Arrhenius equation (simple numerical problems). 4.2 Enzymes: Definition and classification; Factors affecting enzyme reactions; Lock and key model of enzyme activation; Competitive and non-competitive inhibition; Enzyme kinetics: Michaelis-Menton Kinetics (derivation not required) and significance of Km and Vmax; Lineweaver – Burk plot: Determination of Km and Vmax and its application to competitive and non-competitive inhibition.	12	CO1-CO5	K1 – K5
V	5.1 Electronic transitions in organic molecules: Chromophore, auxochrome, bathochromic shift, hypsochromic shift, hyperchromic shift and hypochromic shift; Different types of electronic transitions and their significance in structural elucidation (concepts only). 5.2 Photochemistry:Grothus - Draper law, Stark – Einstein law and Beer – Lambert law(statement only); Quantum yield; Photophysical processes (Jablonski diagram); Bioluminescence; Biochemical fluorophores: Classification and examples; Fluorescence probes – calcium ion probes and green fluorescence proteins (GFP) (elementary ideas only). 5.3 Aqua Chemistry: Parameters in water analysis – Colour, odour, pH, TDS, turbidity and conductivity; Dissolved oxygen, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)	12	CO1- CO5	K1 – K5

Textbooks

1. Coordination Chemistry by R. Gopalan and V. Ramalingam, Vikas Publishing HousePvt. Ltd., 2001.
2. Bioinorganic chemistry by K. Hussain Reddy, New Age International Publication, 2007.
3. Organic chemistry of Natural Products, Volume I by Gurdeep R. Chatwal, Edited by M.Arora, Himalaya Publishing House, 2010.
4. Organic chemistry of Natural Products, Volume II by Gurdeep R. Chatwal, Edited by M.Arora, Himalaya Publishing House, 2011.
5. Textbook of pharmacognosy and phytochemistry by B.N. Shah and A.K. Seth, Elsevier,2010.
6. Principles of nanoscience and nanotechnology, M.A. Shah and Tokeer Ahmad, AlphaScience International, 2010.
7. Principles of Fluorescence Spectroscopy by Joseph R. Lakowicz, 3rd Edition, Springer,2006.
8. Principles of physical chemistry by B.R. Puri, L.R. Sharma and M.S. Pathania, VishalPublishing House Pvt. Ltd., 2008.

. References

1. Biochemistry by L. Stryer, 2nd edition, W.H. Freeman & Co., 1981.
2. Fundamental concepts of Applied Chemistry by Jayashree Gosh, S. Chand, 2006.
3. Bioinorganic chemistry by Asim K Das, Books and Allied Ltd., 2013.

B.Sc. Course Articulation Matrix															
Course Outcomes	Program Outcomes							Program Specific Outcomes							Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	
CO 1	-	3	-	-	-	-	-	2	3	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	2	3	-	-	-	-	-	-	K2
CO 3	-	2	3	-	-	-	-	-	-	2	3	-	-	-	-	K3
CO 4	-	1	3	-	-	-	-	-	-	3	3	-	-	-	-	K4
CO 5	-	-	-	-	3	-	-	-	-	-	-	3	-	-	-	K5
Wt. Avg.	-	2.25	3	-	3	-	-	2	3	2.5	3	3	-	-	-	
Overall Mapping of the Course														PO: 2.75 PSO: 2.7	

COORDINATION CHEMISTRY

Course Code			
Credits	**4**		
Hours / Cycle	**3**		
Category	**Part III**	**Core**	**Theory**
Semester	**V**		
Year of Implementation	**From 2023-24 onwards**		
Course Objectives	To explore the fundamental concepts of coordination complexes, its theories and applications. To Understand organometallic chemistry concepts and to recognize the role of coordination complexes in biology		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall (i) the theories of coordination compounds, (ii) IUPAC nomenclature rules, (iii) fundamental concepts of	PSO1, PSO2	K1

	coordination chemistry & organometallic chemistry and (iv) introductory concepts in bio-inorganic chemistry		
CO2	Understand (i) the theories of coordination compounds, (ii) IUPAC nomenclature rules, (iii) fundamental concepts of coordination chemistry & organometallic chemistry and (iv) introductory concepts in bio-inorganic chemistry	PSO1, PSO2	K2
CO3	Apply (i) the theories of coordination compounds to complexes, (ii) IUPAC nomenclature rules to coordination compounds, (iii) fundamental principles of coordination and organometallic compounds to specific chemical reactions and (iv) fundamental principles of bioinorganic chemistry to specific metals in biology, haemoglobin and myoglobin	PSO3, PSO4	K3
CO4	Compare and comprehend (i) the theories of coordination compounds, (ii) fundamental principles of coordination and organometallic compounds and (iii) fundamental principles of bioinorganic chemistry to specific metals in biology, haemoglobin and myoglobin	PSO3, PSO4	K4
CO5	Explain (i) the theories of coordination compounds, (ii) fundamental principles of coordination and organometallic compounds and (iii) fundamental principles of bioinorganic chemistry to specific metals in biology, haemoglobin and myoglobin	PSO4, PSO5	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**Cos**	**BLOOM'S TAXONOMY LEVEL**
I	1.1 Coordination Chemistry: Early theories – Bloomstrand-Jorgenson's chain theory and Werner's coordination theory; Types of ligands – chelates; Preparation of complexes; Detection of complex formation. Nomenclature − writing formulae and naming of mononuclear complexes. 1.2 Stability of complexes- factors affecting the stability – stepwise and overall formation constants-(determination not required) - effective atomic number rule - explanation and examples.	9	CO1-CO5	K1 – K5
II	2.1 Isomerism in complexes- Structural isomerism and stereoisomerism. 2.2 VB theory- hybridization and shapes of complexes-magnetic properties- spin only magnetic moment- discussion on outer and inner orbital complexes- octahedral, tetrahedral and square planar geometries	9	CO1-CO5	K1 – K5

III	3.1 CF theory- degeneracy of d orbitals – crystal field splitting by octahedral, tetrahedral and square planar arrangement of ligands- spectrochemical series- occupancy of electrons in orbitals- measurement of 10 Dq – factors affecting 10 Dq values. 3.2 Applications of CFT – effect of ligand field on the colour of complexes- Crystal Field Stabilization Energy – Jahn Teller distortion.	9	CO1-CO5	K1 – K5
IV	4.1 Organo-metallic chemistry: Metal carbonyls, Metal – olefin and metal – cylcopentadienyl complexes: Hapticity, 18 electron rule (mono nuclear complexes only) and their synthesis 4.2 Structure of metal carbonyls (back bonding and synergistic effect) and metal – olefincomplexes (DCD model) 4.3 Metal carbonyls in first transition series – examples and structures	9	CO1-CO5	K1 – K5
V	5.1 Applications of coordination complexes in analytical chemistry (qualitative, volumetric and gravimetric analysis) 5.2 Bio-inorganic chemistry: Structure and biological functions of haemoglobin and myoglobin 5.3 Metals in biology: Trace elements and micronutrients – definition and examples; Diseasesdue to deficiency of Fe, Au, I, Zn and Cu – causes and treatment	9	CO1-CO5	K1 – K5

Self study

- Preparation methods for the complexes
- Methods of detection of formation of complexes
- Inert and Labile complexes
- Fluxional isomerism
- Coordination chemistry of Vanadium and Molybdenum on biological systems
- Role of coordination chemistry in fluorescent probes for bioimaging

Textbooks

1. Concise Inorganic Chemistry, J.D. Lee, Chapman and Hall, 1992.
2. Concise Coordination Chemistry, R. Gopalan and V. Ramalingam, Vikas Publishing HousePrivate Limited, 2001
3. Modern Aspects of Inorganic Chemistry, H.J. Emeleus and A.G. Sharpe, Universal BookStall, 1992.
4. Inorganic Chemistry: Principles of Structure and Reactivity, J.E. Huheey, E.A. Keiter and R.I. Keiter, Addison-Wiley, 1993.

References

1. Inorganic Chemistry, D.F. Shriver, P.W. Atkins, C.H. Longford, Oxford

University Press,1996.

2. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson, Wiley Eastern Private Limited 1992

B.Sc. Course Articulation Matrix																	
Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	3	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	2	3	-	-	-	-	-	-	K2
CO 3	-	3	2	-	-	-	-	-	-	-	3	3	-	-	-	-	K3
CO 4	-	3	2	-	-	-	-	-	-	-	3	3	-	-	-	-	K4
CO 5	-	-	2	-	2	-	-	-	-	-	-	3	2	-	-	-	K5
Wt. Avg.	-	3	2	-	2	-	-	-	2.5	3	3	3	2	-	-	-	
Overall Mapping of the Course															PO: 2.33 PSO: 2.70		

ORGANO NITROGEN CHEMISTRY

Course Code			
Credits	**4**		
Hours / Cycle	**3**		
Category	**Part III**	**Core**	**Theory**
Semester	**V**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To gain insights on preparation and reactions of nitrogen containing organic molecules such as nitro compounds, amines, diazo compounds, cyanides, isocyanides etc. • To understand the chemistry of heterocyclic compounds. • To learn the elementary structural features of biomolecules such as amino acids, proteins and nucleic acids.		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall the reactions/structures of Nitrogen containing organic compounds including biomolecules	PSO1, 2	K1

CO2	Understand the reactivity/structures of Nitrogen containing organic compounds including biomolecules	PSO1,2	K2
CO3	Apply fundamental concepts of chemistry to predict the reactivity/structural features of organo nitrogen compounds and biomolecules containing Nitrogen	PSO1,2,3	K3
CO4	(i) Analyse the structural features and propose mechanism for simple reactions including common rearrangements involving organo nitrogen compounds (ii) Analyse the various factors responsible for higher order structures in proteins and nucleic acids	PSO1,2,3,4, 5	K4
CO5	(i) Evaluate the nature of interaction between the functional groups and judge the reaction pathways involving organo nitrogen compounds (ii) Evaluate the stability of higher order structures in proteins and nucleic acids.	PSO1,2,3,4, 5,6	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	1.1 Nitroalkanes: preparation - vapour phase nitration of alkanes, via reaction between alkyl halides and metal nitrites; chemical properties reaction with Br2/NaOH, nitrous acid, condensation with aldehydes. 1.2 Cyano Compounds: Alkyl Cyanides – preparation – from alkyl halides, using RMgX; chemical properties – hydrolysis, addition of Grignard reagents and reduction. 1.3 Alkyl Isocyanides – from alkyl halides and Carbylamine reaction; chemical properties – hydrolysis and reduction. 1.4 Alkyl Isocyanates – synthesis from amines; chemical property–hydrolysis; Preparation of Ethyl Carbonate, Carbamic acid, Urethanes, Urea and Guanidine (reactions not required)	9	CO1-CO5	K1 – K5
II	2.1 Aromatic Nitrocompounds: Preparation – direct nitration and using acetyl nitrate; reduction of nitrobenzene under different conditions 2.2 Amino compounds: Basicity of amines, effects on amine basicity – substitution by alkyl groups, resonance effects and hybridization effect; preparation – reductive amination, reduction of nitro compounds and amides; chemical properties – reaction with alkyl halides and acyl halides, Hofmann elimination, Cope elimination, Hinsberg test for distinguishing 1˚, 2˚ and 3˚ amines.	9	CO1-CO5	K1 – K5

	2.3 Diazo compounds: Diazotisation – mechanism – synthetic applications of aromatic diazonium salts; preparation and chemical properties of diazomethane.			
III	3.1 Molecular rearrangements: Hofmann, Lossen, Curtius, Benzidine, Beckmann and Wolff. 3.2 Heterocyclic compound: synthesis of pyrrole (using acetylene, using furan), thiophene (using acetylene, using n-butane), furan (oxidation and decarbonylation of furfural), indole (Fischer Indole synthesis), pyridine (using acetylene, using β-picoline), quinoline (Skraup synthesis), isoquinoline (Bischler-Napieralski synthesis), chemical properties of pyrrole, thiophene, furan, indole, pyridine, quinoline and isoquinoline.	9	CO1-CO5	K1 – K5
IV	4.1 Amino acids: abbreviation, classification (based on their chemical nature and nutritional requirement); methods of preparation (Gabriel phthalimide, Strecker, amidomalonate), zwitter ionic form, isoelectric point; chemical properties. 4.2 Peptides: N-terminal amino acid analysis (Sanger, Dansyl chloride, Edman degradation and enzymatic method) C-terminal amino acid analysis (hydrozinolysis and enzymatic method), synthesis of dipeptides- liquid phase synthesis and Merrifield solid phase synthesis.	9	CO1-CO5	K1 – K5
V	5.1 Proteins – classification (based on their chemical composition and biological functions), primary, secondary, tertiary and quaternary structures; denaturation, isoelectric point and electrophoresis 5.2 Nucleic acids: Nucleosides and Nucleotides; DNA structure-covalent structure, WatsonCrick double helical model; replication of DNA, types of RNA, Genetic code, transcription and translation (elementary level concepts).	9	CO1-CO5	K1 – K5

Textbooks

1. Advanced organic chemistry, B.S. Bahl and Arun Bahl, 2nd Edition, S. Chand publications, 2010
2. Organic chemistry, 5th edition, John E. McMurry, 7th Edition, Asian Books Private Limited, 2012
3. Organic chemistry, Janice Gorzynski Smith, 2nd Edition, Tata McGraw Hill Education Private Limited, 2008

References

1. Organic chemistry, Leroy G. Wade, 8th Edition, Pearson Education Inc., 2019.
2. Organic Chemistry, Morrison R.T. & R.N. Boyd, Prentice Hall of India Pvt.Ltd., New Delhi. 1995.

Online Resources

1. https://www.sciencedirect.com/topics/chemistry/organonitrogen-compound
2. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Basic_Principles_of_Organic_Chemistry_(Roberts_and_Caserio)/23%3A_Organonitrogen_Compounds_I_-_Amines

Course Outcomes	Programme Outcomes								Programme Specific Outcomes								Cognitive Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	
CO1		3							3	3						-	K1
CO2		3							3	3						-	K2
CO3		3							3	3	3					-	K3
CO4		3	2						3	3	3	2	3			-	K4
CO5				3	3								3	3		-	K5
Wt. Avg.		3	2	3	3				3	3	3	2	3	3		-	-
Overall																	PO: 2.75 PSO: 2.83

CHEMICAL KINETICS AND SURFACE CHEMISTRY

Course Code			
Credits	**4**		
Hours / Cycle	**3**		
Category	**Part**	**Core**	**Theory**
Semester			
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To learn the theories which determine the rate of chemical reactions • To understand concepts on rate of the reaction • To interpret the effect of catalyst in a reaction and its types • To differentiate photo physical process and chemical process • To explain the various adsorption isotherms and process		
CO #	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO 1	Have a basic understanding of the concepts and terminology used in chemical kinetics and surface chemistry	PSO1	K1
CO 2	(i) derive the rate expression for reactions (ii) explain theories of reaction rates (iii) outline the principles of catalysis, photochemistry and adsorption (iv) demonstrate the influence of physical parameters on reaction rates.	PSO1, PSO2	K2

CO 3	Apply rate equations to decipher problems involving rate laws, theories of reaction rates, catalysis, photochemistry and adsorption.	PSO2, PSO3, PSO4	K3
CO 4	Analyse and interpret chemical kinetic behaviour of different systems.	PSO3, PSO4, PSO5	K4
CO 5	Critically evaluate the various kinetic models and predict the kinetic behaviour of simple systems.	PSO3, PSO4, PSO5	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	1.1 Rate of a reaction - Rate equation- Rate constant, Rate determining step, Order and Molecularity - Methods for the determination of order, Factors influencing the rate of the reaction. 1.2 Derivation of kinetic equation for zero, first and second order, parallel, consecutive and opposing reactions.(Problems on rate and order of the reaction). 1.3 Arrhenius law- activation energy. (Problems on Arrhenius law and Activation Energy)	**9**	CO1-CO5	K1 – K5
II	2.1 Collision theory of bimolecular reaction, collision cross section, collision number. 2.2 ARRT- qualitative treatment of equilibrium hypothesis- rate equation- transmission coefficient; Thermodynamic formulation of reaction rate, entropy, enthalpy and volume of activation. 2.3 Unimolecular reactions - steady state treatment - Lindemann hypothesis. 2.4 Effect of solvent and ionic strength on reaction rates (Problems on Ionic strength).	**9**	CO1-CO5	K1 – K5
III	3.1 Homogeneous and Heterogeneous Catalysis: definition –examples and differences - General mechanism of catalysis. 3.2 Enzyme catalysis: Effect of temperature, pH, Concentration (Michaelis - Menten kinetics) on enzyme catalysed reactions	**9**	CO1-CO5	K1 – K5
IV	4.1 Laws of photochemistry: Beer-Lamberts law, Grotthus-Drapper law, Einstein's law of photochemical equivalence, quantum yield.(Problems on Beer Lamberts law) 4.2 Kinetics of photochemical reactions of CH3CHO and H2 - Cl2.	**9**	CO1-CO5	K1 – K5

	4.3 Photophysical processes: Fluorescence and Phosphorescence; Photosensitisation;			
V	5.1Adsorption: Physisorption and Chemisorption – Applications of adsorption − Freundlich Adsorption isotherms -Desorption activation energy - Langmuir Adsorption isotherm; BET equation (no derivation) and its use in surface area determination; Adsorption from solutionGibbs Adsorption Isotherm. 5.2 Colloids-types, stability and electrical double layer, electrophoresis and electro-osmosis - association colloids (micelles) and Critical Micelle Concentration.	**9**	CO1- CO5	K1 – K5

Prescribed Books/Textbooks (1-5 books)

1. Chemical Kinetics, K.J.Laidler, 3rd Edition, Pearson Publication,1987.
2. Fundamentals of Enzyme KineticsbyAthel Cornish-Bowden,4th Edition, Wiley-VCH, 2012
3. Principles of Physical Chemistry, B.R.Puri,L.R.Sharma, Madhan S.,Pathana, 47thEdition,Vishal Publishing Co,2015
4. An Introduction to Physical Chemistry, D.K. Chakrabarthy, Narosa Publishing House, 2001.
5. Fundamentals of Phy. Chemistry,Maron and Lando, illustrated, Macmillan, 1974.

References (3 – 5)

1.Elements of Physical Chemistry, Glasstone and Lewis, 2 ndedition,VanNostrand edition,1962,

2. Elements of Physical Chemistry, Peter Atkins, Julio de Paula, 4th edition, W.H. Freeman & Company,2005

3. Physical Chemistry, Ira N. Levine,5th edition, McGraw-Hill,2001

Suggested Reading

1. Chemical Kinetics - Laidler Published By –Pearson Education India, 1987 ISBN - 8131709728, 9788131709726.
2. Introduction to Surface Chemistry and Catalysis,Gabor A. Somorjai, Yimin Li Edition 2, illustrated Publisher John Wiley & Sons, 2010
3. A. Goel,Applied Colloid and Surface Chemistry Wiley InterScience online books Publisher Discovery Publishing House, 2006 ISBN 8183561500, 9788183561501.

Web Resources

1.http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=13G8VouhmrFfuhs6rkiyTA==
2. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=13G8VouhmrFfuhs6rkiyTA==
3. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=13G8VouhmrFfuhs6rkiyTA==

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	2	2	-	-	-	-	-	-	K2
CO 3	-	3	3	-	-	-	-	-	-	2	2	3	-	-	-	-	K3
CO 4	-	3	3	-	2	-	-	-	-	-	3	3	3	-	-	-	K4
CO 5	-	3	3	-	3	-	-	-	-	-	3	3	3	-	-	-	K5
Wt. Avg.	-	3	3	-	2.5	-	-	-	2.5	2	2.7	3	3	-	-	-	-
													Overall Mapping of the Course		PO: 2.8 PSO: 2.4		

BASIC ANALYTICAL TECHNIQUES IN CHEMISTRY

(75 hours)

Course Code			
Credits	**5**		
Hours / Cycle	**5**		
Category	**Part III**	**Core**	**Theory**
Semester	**V**		
Year of Implementation	**From 2023-24 onwards**		
Course Objectives	• To acquire fundamental ideas on molecular polarization (dipole) and magnetic nature of compounds. • To extend the understanding of molecular polarization and magnetic nature to principle of various spectroscopic techniques. • To apply various spectroscopic techniques to elucidate the structure of simple molecular compounds. • To learn the fundamentals of diffraction studies, chromatographic techniques and mass spectrometry		

CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO1	Recall (i) the fundamental principles of dipole moment and magnetic property of the materials (ii) the fundamental principles of Absorption spectroscopic techniques, NMR and ESR spectroscopy, Mass spectrometry, Diffraction and chromatographic techniques & thermal analysis	PSO1, PSO2	K1
CO2	Understand (i) the principles of dipole moment and magnetic property of the materials (ii) the principles of Absorption spectroscopic techniques, NMR and ESR spectroscopy, Mass spectrometry, Diffraction and chromatographic techniques & thermal analysis	PSO1, PSO2, PSO3	K2
CO3	Apply (i) the principles of dipole moment and magnetic property of the materials to recognize their properties and behaviours, (ii) the principles of Absorption spectroscopic techniques, NMR and ESR spectroscopy and Mass spectrometry to elucidate the structure of a molecule, (iii) the principles of diffraction techniques to derive the structure of crystalline solids and (iv) chromatographic principles for separation of mixture of compounds and (v) thermal analysis to predict the behaviour of compounds at different temperatures,	PSO2, PSO3, PSO4	K3
CO4	(i) Compare the principles of various analytical techniques (ii) Analyze the structure of the compound based on the spectroscopic techniques	PSO2, PSO3, PSO4	K4

CO5	Examine the structure and/property of a compound based on the information from spectroscopic and analytical methods	PSO2, PSO4	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
1	Unit I: Introduction to dipole moment and magnetic nature of compounds 1.1 Dipole moment – molecular polarization – measurement of dipole moment– significance of dipole moment as a vector property. 1.2 Dielectric constant – measurement of dielectric constant. 1.3 Magnetic properties – diamagnetism, paramagnetism, and ferro-magnetism 1.4 Temperature – dependent and independent paramagnetism. 1.5 Magnetic susceptibility determination: Use of Gouy and Faraday balance and applications.	15 hours	CO 1 – CO 5	K1 – K5
2	Unit II: Absorption spectroscopic techniques 2.1 Electromagnetic spectrum – Different regions of the electromagnetic spectrum 2.2 Ultraviolet – Visble Spectroscopy: Electronic transitions - Possible transitions in organic molecules,Beer–Lambert law; Chromophore; Substituent effects; Franck Condon principle, Prediction of λmax for alkene (Woodward-Fieser Rules); Instrumentation – Single beam and double beam - Source (deuterium lamp, tungsten filament), wavelength selector (filters, monochromators), sample container, radiation transducers (Photon transducers), read out devices (photomultiplier tubes, photovoltaic cells). 2.3 Infrared Spectroscopy: Dipole moment changes during rotation and vibration, Types of molecular vibrations, harmonic oscillator model; Instrumentation - Block diagram of an IR spectrometer − IR sources and sample handling. 2.4 Raman Spectroscopy: Theory of Raman spectroscopy, Mechanism of Raman and Rayleigh scattering; Instrumentation – Raman spectrometer (block diagram), sources (laser), sample handling (gas, solid and liquid).	15 hours	CO 1 – CO 5	K1 – K5
3	Unit III: NMR and ESR spectroscopy 3.1 Magnetic properties of nuclei, Gyromagnctic ratio, resonance condition, principle of proton NMR – Larmor frequency - spin lattice and spin-spin relaxation (definitions only); NMR Instrumentation − block diagram; Reference compounds; sample preparation −solvents used in NMR; Difference	15 hours	CO 1 – CO 5	K1 – K5

	between CW-NMR and FT-NMR; chemical shift; shielding and deshielding; factors affecting chemical shift (Electronegativity, Anisotropy and hydrogen bonding); interpretation of NMR Spectra of ethanol. 3.2 ESR spectroscopy: Principle & Instrumentation, block diagram of ESR spectrometer - hyperfine splitting - ESR spectra of methyl radical, benzene anion and p-Nitrobenzoatedianion - Comparison between NMR and ESR (basics only).			
4	Unit IV: Diffraction and chromatographic techniques 4.1 X-ray diffraction: Principle – Bragg's law; Instrumentation: Powder diffraction method (rotating crystal method) 4.2 Electron and Neutron diffraction: Principle; Instrumentation; applications; merits and demerits; Magnetic scattering; Comparison of X-ray and Neutron diffraction techniques. 4.3 Chromatography: Definition, basic principles of adsorption (column) and partition (thin layer) chromatographic techniques; Retention factor (Rf value) and its significance, sample preparation; selection of solvents.	15 hours	CO 1 – CO 5	K1 – K5
5	Unit V: Mass spectrometry and thermal analysis 5.1 Mass Spectrometry: Principle, Ionization methods - Electron impact (EI) method and chemical ionization (CI) method – ratio of mass to charge (m/z) - Instrumentation – description of sample injection system, vaporization and ionization chamber, analyzer tube, detector, amplifier, recorder, mass spectrum. Applications 5.2 Thermogravimetric analysis – principles and applications. 5.3 Differential thermal analysis and differential scanning calorimetry – principles and applications.	15 hours	CO 1 – CO 5	K1 – K5

Self study

- Introduction to anti-ferro, ferri magnetic materials.
- Estimation of metal ions and highly conjugated organic compunds using UV- Visible spectrophtometry.
- Spin-spin splitting of NMR signals and applications of NMR in soil organic matter analysis, enzyme systems, magnetic resonance imaging (MRI)
- Application of ESR in soil chemistry, biochemical and biological systems
- Introduction to fragmentation pattern in mass spectrometry.

Textbooks

1. Instrumental Methods of Chemical Analysis, B.K. Sharma, 24th Edition, Krishna Prakashan Media Pvt Ltd. Meerut, UP, India, 2005.
2. Elements of Analytical Chemistry, R.Gopalan, P.S.Subramanian and K.Rengarajan, 3rd Edition, S. Chand & Sons, 2010
3. Fundamentals of molecular spectroscopy, C.N. Banwell and E.M. McCash, 4th edition, McGraw Hill Eduction Pvt, NewDelhi, 2016
4. Molecular structure and spectroscopy, G. Aruldhas, 5th edition, Prentice-Hall of India Pvt, New Delhi, 2005.

5. Principles of Physical Chemistry, B.R. Puri, L.R. Sharma, M.S. Pathania, 47th edition, Vishal Publishing Co, 2016

Reference

1. Organic Spectroscopy, Kemp W., Macmillan Publishing Co., Inc. New York, 1989.
2. Spectrometric Identification of Organic Compounds, New York, John Wiley & Sons, Inc. Silverstein, Morril Bassler, 1991.

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	3	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	2	2	3	-	-	-	-	-	K2
CO 3	-	3	2	-	-	-	-	-	-	2	3	3	-	-	-	-	K3
CO 4	-	3	2	-	-	-	-	-	-	-	3	3	-	-	-	-	K4
CO 5	-	3	2	-	-	-	-	-	-	2	-	3	-	-	-	-	K5
Wt. Avg.	-	3	2	-	-	-	-	-	2.5	2.25	3	3	-	-	-	-	
Overall Mapping of the Course															PO: 2.88 PSO: 2.69		

PRACTICAL III – ORGANIC ANALYSIS, GRAVIMETRY& PREPARATION

Course Code			
Credits	**6**		
Hours / Cycle	**6**		
Category	**Part III**	**Core**	**Practical**
Semester	**V**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To Systematically analyze, identify the functional group/s in a given organic compound and to synthesize a suitable solid derivative • To synthesis an organic compound and recrystallize the product • Apply the principles of precipitation and develop laboratory skill associated with gravimetric analysis		

CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO1	Recall the general tabulation of qualitative organic analysis and gravimetric analysis Use the methodology to prepare an organic compound	PSO1, PSO2	K1
CO2	Compile the report of the qualitative organic analysis, organic preparation and gravimetric analysis in an organized way	PSO1, PSO2	K2
CO3	Tabulate/present the experimental observations in a systematic manner related to organic qualitative analysis, organic preparation and gravimetric analysis	PSO2, PSO3, PSO4	K3
CO4	In regular classes and ICA i) Interpret the experimental observations to determine the functional group/s present in the organic compound ii) prepare a well crystallized organic compound iii) Calculate the amount of anions/cations through gravimetric analysis	PSO2, PSO4	K4
CO5	In ESE i) Interpret the experimental observations to determine the functional group/s present in the organic compound ii) prepare a well crystallized organic compound iii) Calculate the amount of anions/cations through gravimetric analysis	PSO2, PSO3, PSO4	K5

CONTENT

1. Organic Qualitative Analysis

1.1. Characterisation of organic compounds by their functional groups and confirmation by preparation of derivatives.

1.2. Separation of simple organic mixtures benzoic acid and toluene or glucose and benzoic acid.

2. **Gravimetric analysis**

(use of sintered crucible is recommended wherever possible)

2.1 Determination of the number of water molecules present in a hydrated salt.

2.2 Estimations of lead as Lead chromates or Lead sulphate

2.3 Estimations of Barium as Barium chromates or Barium sulphate

2.4 Estimations of calcium as calcium oxalate monohydrate.

2.5 Estimation of copper as cuprous thiocyanate

2.6 Estimation of zinc as Zinc oxinate or Auminium as Aluminium oxinate.

2.7 Analysis of limestone and brass.

3. Preparations

3.1 Preparation of Five inorganic compounds and determination of boiling and melting points(micro method).

3.2 Preparation of six organic compounds. Determination of boiling and melting points (micro method).

B. Sc. Course Articulation Table

CO	PO1	PO2	PO3	PO4	PO	PO 6	PO7	PO8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	KL
CO1	-	3	-	-	-	-	-	-	3	3	-	-	-	-	-	-	K1
CO2	-	3	-	-	-	-	-	-	3	3	-	-	-	-	-	-	K2
CO3	-	3	2	-	-	-	-	-	-	3	2	2	-	-	-	-	K3
CO4	-	3	2	-	-	-	-	-	-	3	-	3	-	-	-	-	K4
CO5	-	3	3	-	-	-	-	-	-	3	3	3	-	-	-	-	K5
Wt. Avg.	-	3	2.33	-	-	-	-	-	3	3	2.5	2.67	-	-	-	-	
	Overall: PO: 2.665								Overall: PSO: 2.79								

PRACTICAL IV: PHYSICAL CHEMISTRY

Course Code			
Credits	**4**		
Hours / Cycle	**4**		
Category	**Part III**	**Core**	**Practical**
Semester	**V and VI**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	To determine various physical parameters through experiments, thereby understanding the concepts of physical chemistry.		

CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO1	Reminisce the basic physical chemistry concepts through hands-on experiments	PSO1	K1
CO2	Compile the report of the experiments in an organized way.	PSO5	K2
CO3	Tabulate/Record the experimental observations in a systematic manner.	PSO3, PSO7	K3
CO4	Determine various physical parameters for different systems and chemical reactions/ Verify certain laws of physical Chemistry Present the report with systematic procedure during regular laboratory classes.	PSO3, PSO7	K4
CO5	Measure various physical parameters / Verify certain laws of Physical Chemistry while performing the experiment and present the report with systematic procedure during ICA.	PSO3, PSO7	K5

ONTENT

I. Experiments

1. Molecular weight determination by Rast's method.
2. Transition temperature of a salt hydrate.
3. Critical solution temperature of phenol-water system.
4. Effect of electrolytes on the CST of phenol-water system.
5. A study of two component system simple eutectic only.
6. Distribution coefficient of iodine between H2O and CCl4.
7. Determination of equilibrium constant for the reaction: KI + I2 === KI3
8. Determination of heat of neutralization.
9. Kinetics of acid catalyzed hydrolysis of an ester.
10. Kinetics of persulphate iodide reaction.
11. Determination of cell constant.
12. Verification of Onsager equation.
13. A study of weak electrolytes: Ostwald's dilution law.
14. Conductometric titration strong acid vs. strong base.
15. Determination of single electrode potential.
16. Determination of pH.

Textbooks

1. A. Findlay, J.A. Kitchener, Findlay's Practical Chemistry, 8th Edition, Prentice Hall Press, 1954.
2. B. Viswanathan and P.S. Raghavan, Practical Physical Chemistry, Viva Books, 2012.

References

1. R.C. Das and B. Behera, Experimental Physical Chemistry, McGraw-Hill Education, 1984.

Suggested Reading

1. Farrington Daniels, Experimental Physical Chemistry, 7th Edition, McGraw-Hill Inc., US, 1970.

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	K1
CO 2	-	-	-	-	3	-	-	-	-	-	-	-	2	-	-	-	K2
CO 3	-	3	-	-	3	-	-	-	-	-	2	-	-	-	2	-	K3
CO 4	-	3	-	-	3	-	-	-	-	-	3	-	-	-	3	-	K4
CO 5	-	3	-	-	3	-	-	-	-	-	3	-	-	-	3	-	K5
Wt. Avg.	-	3	-	-	3	-	-	-	3	-	2.7	-	2	-	3	-	
Overall Mapping of the Course															PO: 3.0 PSO: 2.67		

COMPUTER AIDED CHEMISTRY

Course Code			
Credits	**3**		
Hours / Cycle	**2**		
Category	**Part IV**	**Skill-Based**	**Theory**
Semester	**V**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To understand the features of programming • To learn the importance of databases • To understand the energetic aspects of computational chemistry • To recognize the basis of protein data bank • To study the types of molecular docking		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall the basics of chemistry and fundamentals of computer programming.	PSO1	K1
CO2	Outline the essentials of programming, cheminformatics, computational chemistry and drug design	PSO2, PSO3, PSO6	K2
CO3	Apply the concept of computer programming to design algorithms for simple calculation, draw and visualize the chemical structures, carry out energy minimization processes and use various online resources to screen drug molecules.	PSO2, PSO3, PSO5, PSO6	K3
CO4	Analyse algorithms, arrive at the relation between structure and energy, examine chemical structures using different online tools and screen for potential drug molecules using molecular docking.	PSO2, PSO3, PSO5, PSO6	K4

CO5	Evaluate algorithmic efficiency and design effective algorithms for chemical structure manipulation and analysis. Appraise the accuracy and limitations of chemical structure drawing and visualization software. Determine the lowest energy conformation of molecules using energy minimization techniques. Critically assess the results of molecular docking simulations to predict ligand-receptor interactions.	PSO2, PSO3, PSO5, PSO6	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	Introduction to programming – basic concepts (Flow charts, Algorithm, Constants, Variable, Control Statements, loops and arrays in programming), MS-Word, MS-Excel and MSPowerPoint. Shortcut keys in MS office.	6	CO1-CO5	K1 – K5
II	Introduction to Cheminformatics - History of Cheminformatics - data storage, retrieval and presentation -Types of Databases - Cambridge structural database - different file formats (SMILES,.cif, .mol, .xyz, .pdb etc.,) - Online property calculators with examples	6	CO1-CO5	K1 – K5
III	Introduction to Computational Chemistry - Coordinate Systems - Z-matrix (H2O and CH4) - Potential Energy Surfaces (Definitions - single point energy, local minima, global minima, saddle point and optimized geometry) - Energy minimization techniques - Molecular Graphics - Software programs used in Computational Chemistry (Gaussian, ORCA, ADF & GAMESS)	6	CO1-CO5	K1 – K5
IV	Introduction to Online resources - online 2D and 3D chemical structure drawing - designing of molecules and demonstrating experiments – Protein data bank - Protein structure visualization tools – RasMol, PyMol, Molegro and Swiss PDB Viewer. (Definitions - PDB id, sequence, homology modeling, Resolution of a PDB, Co-factor)	6	CO1-CO5	K1 – K5
V	Introduction to drug design - Structured-based drug design - Ligand based drug design – difference between drugs and inhibitors - Molecular Docking - Types (Rigid & flexible docking) - Online docking servers. (Definitions only - Pharmacophore, pharmacokinetics, lead molecule, search algorithm & scoring function)	6	CO1-CO5	K1 – K5

Textbooks

1. Molecular Modelling: Principles And Applications, Andrew R. Leach, 2nd edition, Pearson Education; 2nd edition, 2009.
2. Andrew R. Leach & Valerie J. Gillet, An Introduction to Chemoinformatics, 1st Edition, Springer, 2004

References

1. Thomas Engel, Johann Gasteiger, Applied Chemoinformatics: Achievements and Future Opportunities, 1st Edition, Wiley Publication, 2018.

Suggested Reading

1. Jürgen Bajorath, Chemoinformatics for Drug Discovery, Wiley, 1st Edition, 20013.

Online Resources

1. www.molinspiration.com
2. http://molcalc.org
3. www.rcsb.org
4. http://www.swissdock.ch/
5. https://bioinfo3d.cs.tau.ac.il/PatchDock/php.php
6. https://ochem.eu/home/show.do
7. http://cheminf.cmbi.ru.nl/services.shtml
8. http://www.cheminfo.org/

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	KL
CO 1	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	KL1
CO 2	-	3	-	2	-	-	-	-	-	3	2	-	-	-	3	-	KL2
CO 3	-	3	-	3	3	-	-	-	-	3	2	-	2	-	3	-	KL3
CO 4	-	3	-	3	3	-	-	-	-	3	3	-	2	-	3	-	KL4
CO 5	-	3	-	3	3	-	-	-	-	3	3	-	3	-	3	-	KL5
Wt. Avg.	-	3	-	2.75	3	-	-	-	3	3	2.5	-	2.3	-	3	-	
Overall Mapping of the Course															PO: 2.92 PSO: 2.76		

ENVIRONMENTAL CHEMISTRY

Course Code			
Credits	**3**		
Hours / Cycle	**4**		
Category	**Part IV**	**General Elective**	**Theory**
Semester	**VI**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	To impart a sense of responsibility about environment and a personal commitment to protect and preserve the environment To create awareness among students about the pollutants and their adverse impact on environment. To promote the collaboration with other organizations and associations to solve local environmental problems To develop pro-environmental attitudes among students to be effective advocate of environment		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall (i) the structure of the atmosphere (ii) different types of pollutants and pollution. iii) definition of quantification of pollutants (iv) consequences of pollution	PSO1, 2	K1
CO2	Understand (i) the structure of the atmosphere(ii) the reason for various pollution and their pollutants (ii) the adverse effect of pollution on the environment	PSO1,2	K2
CO3	Apply the fundamental concepts related to various pollution and quantification of pollutants for minimizing the pollution level.	PSO1,2,3	K3
CO4	Analyze (i) the various reasons and sources of various pollutants responsible for different types of pollutions. (ii) the remediation techniques for the minimization of pollution.	PSO1,2,3,4, 5	K4
CO5	(i) Assess the root causes for various types of pollutions (ii) Evaluate the quantification of pollutants for measuring the pollution level and to minimize it and save the environment.	PSO1,2,3,4, 5	K5

SYLLABUS

UNIT	CONTENT	HOURS	COs	BLOOM'S TAXONOMY LEVEL
I	Atmospheric pollution: Structure of the atmosphere - sources of air pollution - primary pollutants - CO, hydrocarbons, particulate matter, SO2, NO, Secondary pollutants-smog, acid rain, ozone destruction-CFCs - Green house effect - global warming.	12	CO1-CO5	K1 – K5
II	Water Pollution: Quantification of pollutants-BOD, COD, DO in natural waters wastewater treatment - aerobic AS, TF process anaerobic process-nitrification-denitrification - thermal pollution.	12	CO1-CO5	K1 – K5
III	Fertilizer: N and P fertilizers used in crop production-nitrate pollution and phosphorus pollution of water-Eutophication Pesticides-Pest control using chemicals-pollution due to organo chlorine-organo phosphorus, insecticides,herbicides,PCB,PAH-Biomagnification	12	CO1-CO5	K1 – K5
IV	Heavy metal pollution: Toxicity-bioaccumulation-Mercury-methyl formation-toxic effect of lead in the environment-lead additives of petrol; cadmium, chromium and Arsenic	12	CO1-CO5	K1 – K5
V	Noise Pollution: measurement of noise level, noise pollution hazards and control Pollution due to radioactive waste-health and environment effect-management of nuclear waste	12	CO1-CO5	K1 – K5

Self-study

- Finding out how long it takes for bioplastic to degrade
- Finding out how much microplastics in waters
- Bioplastic making, natural dye extraction
- Biobased soap, toothpaste etc., making
- Techniques for removal of heavy metals.

Books: 1. Environmental Chemistry A.K.De 3rd Edition

References:

1. Environmental Chemistry, P.S.Sindu, 2nd Edition, 2010, New Age International Pvt Ltd.

Web resources

1. https://moef.gov.in/en
2. https://www.undp.org
3. https://www.fauna-flora.org
4. https://www.worldwildlife.org
5. https://www.unep.org
6. https://www.oecd.org

B.Sc.Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	3	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	2	3	3	-	-	-	-	-	K2
CO 3	-	3	3	-	-	-	-	-	3	3	3		-	-	-	-	K3
CO 4	-	3	3	-	-	-	-	-	3	3	3	3	2	-	-	-	K4
CO 5	-	3	2	-	2	-	-	-	3	3	3	3	2	-	-	-	K5
Wt. Avg.	-	3	2.66		2				2.8	3	3	3	2	-	-	-	
Overall Mapping of the Course															PO: 2.55 PSO: 2.76		

CHEMISTRY OF METALS AND NUCLEAR CHEMISTRY

Course Code			
Credits	**5**		
Hours / Cycle	**5**		
Category	**Part III**	**Core**	**Theory**
Semester	**VI**		
Year of Implementation	**From 2023-24 onwards**		
Course Objectives	• To learn the principles of metallurgy and applying them to the extraction of few metals • To understand the trend and anomalies in the characteristics of d-block elements • To gain knowledge on the inner transition elements • To explore the nuclear chemistry by knowing the nuclear processes, theories, stability and isotopes		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall (i) the fundamental principles of metallurgy, (ii) the fundamental chemistry of transition and inner transition elements and (ii) fundamental concepts of nuclear chemistry	PSO1, PSO2	K1
CO2	Understand (i) the fundamental principles of metallurgy, (ii) the fundamental chemistry of transition and inner transition elements and (ii) fundamental concepts of nuclear chemistry	PSO1, PSO2	K2
CO3	(i) Apply the principles of metallurgy to the extraction of metals from their ores, (ii) Apply the fundamental concepts of transition and inner transition elements and compounds to understand their reactivity, (iii) Apply the fundamental concepts of nuclear chemistry to recognize the structure of nucleus and (iv) Apply the fundamental concepts of nuclear chemistry to recognize the properties and reactivity of nucleus	PSO3, PSO4	K3
CO4	(i) Compare the various metallurgical process involved in the extraction of a metal from its ore, (ii) compare the periodic and chemical properties among transition and inner transition elements and (iii) compare the properties and reactivity of the nucleus	PSO3, PSO4	K4
CO5	Justify (i) the extraction and reactivities of the transition and inner transition elements based on chemical principles and	PSO4, PSO5	K5

	(ii) the properties and application of nucleus based on the principles of nuclear chemistry		

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	1. 1. General principles of metallurgy: Ores and minerals; Concentration of the ores; Extraction of the metals – Ellingham's diagram & Electrochemical series; Different types of chemical processes involved in extraction of metals; Purification of metals. 1.2 Extraction and uses of the following metals - Al (Alumino thermite process), Na and Ca (Dow's process), Ti (Kroll process), Fe (Blast furnace and Bessemer Converter) V (extraction from vanadinite and carnotite), Pb (Extraction from Galena) and noble metals (Pt and Pd).	15	CO1-CO5	K1 – K5
II	2.1 General characteristics of d-block elements: metallic character and reactivity, variable oxidation states, standard electrode potentials and reducing behaviour; colour and magnetic properties, catalytic properties & tendency to form complexes. 2.2. Important compounds of transition metals: Potassium permanganate, potassium dichromate, osmium tetraoxide, titanium dioxide, cis-platin, vaska's complex, ruthenium bipyridyl complex – synthesis and reactions. 2.3 Polyacids: Iso and hetero polyacids of Cr, Mo and W – Formation and structure.	15	CO1-CO5	K1 – K5
III	3.1Chemistry of inner transition elements; position in the periodic table - occurrence, oxidation states of lanthanides and lanthanide contraction & its consequences; Colour, spectral and magnetic properties of lanthanides compounds. 3.2 Extraction of mixture of lanthanides from monazite sand; Separation of lanthanides by the following methods: Solvent extraction and ion exchange. 3.3 Actinides: Occurrence, position in the periodic table, comparison between lanthanides and actinides, Extraction of Th and U.	15	CO1-CO5	K1 – K5
IV	4.1 Fundamental particles: quarks, leptons and force carriers – Hadron (definition and classification).	15	CO1-CO5	K1 – K5

	4.2 Natural radioactivity: Laws of radioactive disintegration, radioactive equilibrium, radioactive series. 4.3Nuclear properties: theories of nuclear structure (shell model and liquid drop model);n/p ratio: binding energy, mass defect and packing fraction, nuclear stability. 4.4 Isotopes: Principles and methods of separation of isotopes; uses in analytical chemistry, reaction mechanisms, industries and medicine; radiocarbon dating; radiation induced reactions; nuclear isomerism; neutron activation analysis.			
V	5.1 Artificial radioactivity: Methods of nuclear transmutation – Bohr's theory, types of transmutation with projectiles, orbital electron capture. 5.2 Fission theory: Types of nuclear reactors, construction and working of nuclear reactors, particle accelarators – synchrotron and betatron. 5.3 Fusion: Principle and examples; Stellar energy. 5.4 Environmental and ethical aspects of nuclear technology, nuclear waste management.	15	CO1- CO5	K1 – K5

Self-study

- Types of furnaces; extraction of Li, Cu, Ir and Os
- Iron triads and Platinum group elements – their position in the periodic table
- Preparation of transuranic elements
- Different units of radioactivity
- Safe handing radio-isotopes, A brief history of nuclear power plants accidents
- Atomic energy programmes in India, applications of nuclear chemistry in electricity generation, medicine, industry, agriculture

Textbooks

1. Principles of Inorganic Chemistry, Puri B.R, Sharma L.R &Kalia K.C., Milestone Publishers and Distributors,New Delhi, 2008.
2. Concise Inorganic Chemistry, Lee, J.D., 5th Edition, New Delhi, Oxford University Press, 2008.
3. Elements of Nuclear chemistry by Arnikar, New Age Publication,1995.

References

1. Wahid U Malik, G.D.Tuli, R.D.Madan Selected Topics in Inorganic Chemistry. New Delhi. S Chand & Co. 2009.
2. Advanced Inorganic Chemistry, Wiley Indian Pvt. Ltd. Cotton F.A. and G.Wilkinson 2008.

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	3	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	2	3	-	-	-	-	-	-	K2
CO 3	-	3	2	-	-	-	-	-	-	-	3	3	-	-	-	-	K3
CO 4	-	3	2	-	-	-	-	-	-	-	3	3	-	-	-	-	K4
CO 5	-	-	2	-	2	-	-	-	-	-	-	3	2	-	-	-	K5
Wt. Avg.	-	3	2	-	2	-	-	-	2.5	3	3	3	2	-	-	-	
Overall Mapping of the Course															PO: 2.33 PSO: 2.70		

NATURAL PRODUCTS, PHARMACEUTICALS AND SPECTROSCOPY

Course Code			
Credits	**5**		
Hours / Cycle	**5**		
Category	**Part III**	**Core**	**Theory**
Semester	**VI**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To learn the classification and structural features of natural products, the clinical uses of drugs, the use of spectral data in structure identification • To utilize the knowledge of various reactions in the structural elucidation of natural products • To utilize the knowledge of various spectral techniques in identification of structure of organic compounds		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall i) definition, classification, isolation, structure and reactions of alkaloids, terpenoids, carbohydrates, vitamins and drugs ii) basic concepts and spectral data of FTIR, NMR and Mass	PSO1 PSO2	K1
CO2	Understand (i) the fundamental reactions and structural features of natural products (ii) the clinical uses of certain pharmaceuticals (iii) the concepts and spectral data of FTIR, NMR and Mass	PSO2 PSO3	K2

CO3	Apply i) the fundamental reactions in the structural elucidation of natural products and synthesis of certain pharmaceuticals ii) the concepts and spectral data for structural predictions	PSO1 PSO2 PSO5	K3
CO4	Analyse i) the utility of various reactions in the structural elucidation of natural products ii) the SAR of certain pharmaceuticals iii) the various influencing factors of spectroscopic techniques in determining the structure of organic compounds ii) Analyze the functional groups of organic compounds using FT-IR, ^{1}H-NMR, ^{13}C-NMR techniques	PSO2 PSO3 PSO4	K4
CO5	Evaluate the structure through a complete synthesis of natural products and drugs Interpret the structure of simple organic molecules from the spectral data of FTIR, NMR and Mass	PSO5 PSO6	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	1.1 Alkaloids: Definition, classification, isolation, purification; structural elucidation of piperine, nicotine and coniine. 1.2 Terpenoids: Definition, classification, isolation, isoprene rule, special isoprene rule; structural elucidation of geraniol, dipentene and alpha terpineol. Vitamins: Definition, classification, structural elucidation of vitamin A.	15	CO1-CO5	K1 – K5
II	2.1 Carbohydrates: Definition, nomenclature, classification; Haworth and Fischer projections; structural elucidation of glucose and fructose; conversion of glucose to fructose and vice versa; mutarotation and epimerization (definition only); Kiliani synthesis (pentose to hexose) and Wohl's method (hexose to pentose); sucrose and maltose (structure and chemical properties); starch and cellulose (structure and uses only). 2.2 Organometallic therapeutic agents: Sb compounds – Tartar emetic, anthiomaline, Hg compounds – Salyrgan, Thiomersal, Au compounds – Solganal, Krysolgan.	15	CO1- CO5	K1 – K5

III	3.1 Analgesics - synthesis and uses of aspirin, acetaminophen - nalorphin, methadone pethidine and morphine and its SAR, Antibiotics: clinical uses of Chloramphenicol, penicillin, tetracyclines and streptomycin, SAR of chloramphenicol and penicillin, Sedatives and hypnotics - synthesis and uses of phenobarbitone, cyclobarbitone and thiobarbitone. 3.2 Antimalarials - quinine and chloroquine (synthesis and structural elucidation not required). Antileprosy drugs – Dapsones (Synthesis & Clinical uses only) 3.3 Antidiabetic agents (oral): Tolbutamide, Glibenclamide (Synthesis and clinical uses), Antithyroid drugs: methimazole&Carbimazole (Synthesis & Clinical uses only), Parkinson's disease and its treatment: Levodopa, carbidopa, amantadine (Synthesis and clinical uses).	15	CO1- CO5	K1 – K5
IV	4.1 FT-IR spectroscopy: Principle, modes of vibrations in molecules; factors influencing vibrational frequencies; FT-IR spectrum (functional group region & finger print region), assignment of values in terms of wave number for various bonds (alkane, alkene, alkyne & aromatic C-H, aliphatic & aromatic C=C, C≡C, alcoholic, phenolic & carboxylic acid O–H, ether C-O, organo halogen C-X, aldehyde, ketone, carboxylic acid, ester, & amide C=O, amine C-N & N-H and nitro C-N & N=O). 4.2 1H-NMR Spectroscopy: Principle, chemical shift, factors affecting chemical shift, shielding and deshielding, Features of 1H NMR spectrum and associated structural feature of organic compound – Number of signals – position of the signals – intensity of the signals – spin-spin splitting of signals, chemical shift of common type of protons.	15	CO1- CO5	K1 – K5
V	5.1 ^{13}C-NMR Spectroscopy: Principle, proton coupled and decoupled 13C-NMR spectrum; assignment of values for various carbon atoms (alkanes, alkenes, alkynes, alkyl halides, ethers, aldehydes, ketones, carboxylic acids, esters, amines and amides). 5.2 Mass spectrometry: principle, base peak, molecular ion peak, isotope peak, metastable peak and their uses – nitrogen rule; McLafferty rearrangement; fragmentation pattern of organic compounds (2-ethylbutane, propyl chloride, tertiary butyl alcohol, acetaldehyde, acetone, ethyl amine, phenol, propionic	15	CO1- CO5	K1 – K5

	acid, ethyl acetate, propanamide), m/e of some common fragments. 5.3 Elementary combined spectral problems (carbon containing C1 to C5 alcohol, ester and mono substituted aromatic system).			

Self-study

- Chemical reactions of Glucose, Fructose, Sucrose and Maltose
- Salient features of FT-IR, ^{1}H-NMR, ^{13}C-NMR spectroscopic techniques
- Uses of Mass spectrometry in structural prediction of simple molecules
- Compare various anti-diabetic drugs for better clinical uses with minimum side effects
- Enumerate various anti-thyroid drugs based on their efficacy

Textbooks

1. Organic Chemistry, Vol. 1, I. L. Finar, 6th edition, Pearson publications, 2002
2. Organic Chemistry, Volume 2: Stereochemistry and the Chemistry Natural Products, I. L. Finar, 5th edition, Pearson publications, 2002.
3. A Textbook of Pharmaceutical Chemistry Paperback, Ghosh Jayshree, 3rd Edition, S. Chand publications, 2010
4. Synthetic Drugs, Gurdeep R. Chatwal, 2nd Edition, Himalaya Publishing House, 2009
5. Medicinal Chemistry, Ashutosh Kar, 4th Edition, New Age International Pvt Ltd., 2009

References

1. Organic chemistry, Leroy G. Wade, 8th Edition, Pearson Education Inc., 2019
2. Organic chemistry, Janice Gorzynski Smith, 2nd edition, Tata McGraw Hill Education Private Limited, 2008

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	1	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	-	2	3	-	-	-	-	-	K2
CO 3	-	3	-	-	2	-	-	-	3	2	-	-	3	-	-	-	K3
CO 4	-	3	2	-	-	-	-	-	-	3	3	2	-	-	-	-	K4
CO 5	-	-	-	3	2	-	-	-	-	-	-	-	3	2	-	-	K5
Wt. Avg.	-	3	2	3	2	-	-	-	3	2	3	2	3	2	-	-	
Overall Mapping of the Course															PO: 2.5 PSO: 2.5		

PHASE RULE AND ELECTROCHEMISTRY

Course Code			
Credits	**4**		
Hours / Cycle	**3**		
Category	**Part III**	**Core**	**Theory**
Semester	**VI**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	To comprehend the impact of pressure and temperature on phase equilibrium, understand the inter-conversion of chemical and electrical energy linking thermodynamics with electrochemistry, and apply theoretical and foundational principles to electrochemical phenomena in electrochemical systems.		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall the basic principles and fundamental laws of states of the system and electrochemistry	PSO1	K1
CO2	Understand and explain the physical behaviour of ions, electrode – electrolyte, solids, liquids and gases and their changes with various factors.	PSO4, PSO5	K2
CO3	Apply the knowledge of phase rule and electrochemistry to understand the behaviour of phases and interconversion of electrical and chemical energy	PSO3, PSO5	K3
CO4	Analyze various factors influencing the state of the system, electrode-electrolyte interface and the behaviour of ions in solutions.	PSO3, PSO4, PSO5	K4
CO5	Use the laws of phase rule and electrochemistry to compare, comprehend and evaluate the behaviour of states of the systems, electrolytes and emf measurements for various applications	PSO3, PSO4, PSO5	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	1.1Statement and explanation of the terms with examples for phase (P), component (C) and degree offreedom (F), criteria of phase equilibrium. Definition and significance of Gibbs phase rule. Derivation of Gibbs phase rule.	15	CO1-CO5	K1 – K5

	1.2 Derivation of Clausius-Clapeyron equation and its importance to equilibria in phase transitions (solid-liquid, liquid-vapour and solid-vapour).Application of phase rule to one component systems-water, CO2 and sulphur. 1.3 Reduced phase rule- Two component system: (i) Simple Eutectic: Lead-Silver system (ii) Formation of Compounds with Congruent melting points: Ferric chloride-water system. (iii) Formation of Compounds with Incongruent melting points: Sodium chloride-water system.			
II	2.1 Binary solutions: Fractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, lever rule. 2.2 Solubility of binary partially miscible liquids, (CST-UCST and LCST). Phenol-water system, nicotine-water system, Effect of addition of solute on CST of phenol. 2.3 Distillation of Immiscible Liquids. Solubility of gases in liquids; Henry's law and its relationship with Raoult's law. 2.4 Nernst distribution law: Thermodynamic derivation; limitation of the law, application in studying association, dissociation and solvent extraction. Study of formation of complex ions.	15	CO1- CO5	K1 – K5
III	3.1 Electrode potential: Single and standard electrode potentials. Reference electrodes: (i) Primary reference electrode: Standard hydrogen electrode (ii) Secondary reference electrode: Saturated calomel electrode. Determination of standard electrode potentials of zinc and copper electrodes; Calculation of cell EMF from single electrode potentials; Definition and applications of electromotive series. 3.2 Different types of electrodes: (i) Metal-Metal ion electrodes (ii) Amalgam electrodes (iii) Gas electrodes (iv) Metal insoluble salt electrodes (v) Oxidation –reduction electrodes (definition and derivation of EMF for each electrode). 3.3 Electromotive force Definition; Measurements using potentiometer; Construction and working of Weston saturated and unsaturated standard cells; Conventions regarding sign of EMF.	15	CO1- CO5	K1 – K5
IV	4.1 Thermodynamics of electrochemical reactions: Derivation of Nernst equation and its use in calculating EMF of cells at different activities of the individual electrodes. Relationship between EMF and	15	CO1-CO5	K1 – K5

	(i) free energy changes (ii) enthalpies changes (iii) entropy changes occurring in electrochemical reactions; 4.2 Classification of electrochemical cells: Chemical cells and concentration cells with and without transference; Definition and derivation of EMF for each cell-liquid junction potential. 4.3 Applications of EMF: Calculation of (i) Valency of ions in doubtful cases(ii) free energy, enthalpy and entropy changes in electrochemical reactions, (iii)solubility product of sparingly soluble salt pH and its determination using hydrogen, quinhydrone and glass electrodes; Potentiometric acid-base, redox and precipitation titrations.			
V	5.1 Faraday's laws of electrolysis; Electrolysis of aqueous NaCl and CuSO4 solutions using the corresponding metal or inert electrodes; Properties of electrolytes: Colligative properties -Vant Hoff factor. 5.2 Electrolytic conductance: Determination - variation of conductance with concentration. Equivalent conductance at infinite dilution; Transport numbers: Determination using Hittorf's method and moving boundary method. Applications of conductance measurements - determination of Ka and Ksp. 5.3. Concepts of activities, activity coefficients and ionic strength of strong electrolytes. (simple numerical problems) Kohlrausch's law of independent migration of ions, degree of dissociation - Oswald's dilution law for weak electrolytes; Conductometric titrations.	15	CO1- CO5	K1 – K5

Selfstudy

- Gibbs-Duhem-Margules equation, its derivation and its applications, Aniline-hexane system.
- Simple eutectic: Water -Potassium iodide system, freezing mixtures.
- Applications of conductance in water quality testing (TDS)
- Commercial cells: Dry cell, lead storage, and H_2-O_2 fuel cells
- Arrhenius theory of electrolytic dissociation, Conductometric titrations
- Concept of electrical double layer and stability of colloids

Textbooks

1. Elements of Physical Chemistry, Puri, Sharma and Pathania, 4th Edition, Vishal Publishing Co., 2013
2. An Introduction to Electrochemistry, S. Glasstone, East-West edition, D. Van Nostrand Company, Incorporated, 1942
3. Elements of Physical Chemistry, S. Glasstone and D. Lewis, Palgrave Macmillan; 2ndRevised edition, 1963.
4. Fundamentals of Physical Chemistry, Maron and Lando, Collier Macmillan internat. editions, Macmillan, 1974

References
1. Physical chemistry, P.W. Atkins, 8th edition, Oxford university press, 2006
2. Physical chemistry, Keith J. Laidler and John H. Meiser, CBS Publishers, 2nd Indian edn., 2006.

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	K1
CO 2	-	-	3	-	3	-	-	-	-	-	-	3	3	-	-	-	K2
CO 3	-	3	-	-	3	-	-	-	-	-	3	-	3	-	-	-	K3
CO 4	-	3	3	-	3	-	-	-	-	-	3	3	3	-	-	-	K4
CO 5	-	3	3	-	3	-	-	-	-	-	3	3	3	-	-	-	K5
Wt. Avg.	-	3	3	-	3	-	-	-	3	-	3	3	-	-	-	-	
Overall Mapping of the Course															PO: 3 PSO: 3		

ENTREPRENEURSHIP SKILL FOR CHEMIST

Course Code			
Credits	**3**		
Hours / Cycle	**3**		
Category	**Part III**	**Elective**	**Theory**
Semester	**VI**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To understand the basics of business concept and entrepreneurship • To learn the fundamentals of intellectual property rights • To identify entrepreneurial opportunities that exist		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall the fundamental concepts and principles of business, Intellectual Property (IP), Chemical industries and entrepreneurship	PSO8	K1
CO2	(i) Understand the fundamental concepts and principles of (a) business & business plan, (b) entrepreneurship, (ii) Understand the challenges and opportunities in chemical industry and (iii) Understand government schemes for promoting entrepreneurship	PSO4, PSO8	K2

CO3	Apply the fundamental concepts and principles of business, ethics and entrepreneurship	PSO8	K3
CO4	Analyse and Comprehend the fundamental concepts and principles of business, the misconception in IP, role of chemical industries in India, entrepreneurship skill and the case studies	PSO8	K4
CO5	Compare and evaluate (i) the business environment, challenges opportunities in entrepreneurship in general and chemical industries in specific and (ii) schemes for innovation and entrepreneurship	PSO8	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	**Business Basics** Introduction, nature of business, understanding the business environment, business ethics, forms of business ownership, key business concepts: Business plans, market need, project management and routes to market	9	CO1-CO5	K1 – K5
II	**Chemistry in Industry** Current challenges and opportunities for the chemistry-using industries – supply of raw materials, energy, climate change, waste management and environmental impact, role of chemistry in India and global economies; Drivers of innovation.	9	CO1- CO5	K1 – K5
III	**Intellectual Property Rights** Intellectual Property – fundamentals, concepts, importance of IP, Types of Intellectual property - Trademarks, Copyrights, Patents and trade secrets – Definition, protectable, duration of protection, ten most common misconception in IP, IP Intellectual Property Protection (IPR); Different international agreements – WTO and Paris convention.	9	CO1- CO5	K1 – K5
IV	**Entrepreneurship** Enterprise, Entrepreneur and Entrepreneurship - Definition; types of entrepreneurship and enterprises; concept of entrepreneurship, attributes, roles and responsibilities of an entrepreneur, advantages, key entrepreneurial skills; Case studies (Alternative Chemistry Careers: Mark D. Frishberg, Eastman Kodak/Eastman Chemical Company, Patent Assets	9	CO1-CO5	K1 – K5

	for High Technology Commercial Innovation - James L. Chao)			
V	**Entrepreneurship Challenges and Opportunities** Global challenges and cooperation's; Entrepreneurship and Environment; Women as Entrepreneurs, Sources of assistance - government and other schemes and programmes on start-up and entrepreneurship- Promoting Innovations in Individuals, Start-ups and MSMEs (PRISM), Sustainable Finance Scheme-Small Industries Development Bank of India (SIDBI), Small Business Innovation Research Initiative (SBIRI), Trade Related Entrepreneurship Assistance and Development (TREAD) Scheme for Women, Department for Promotion of Industry and Internal Trade (DPIIT) Recognition.	9	CO1- CO5	K1 – K5

Textbooks

1 1. H. N. Cheng, Sadiq Shah, Marinda Li Wu - Vision 2025_ How To Succeed in the Global Chemistry Enterprise- Chapter 8 (ACS Symposium Series 1157) American Chemical Society (2014).

2. A. K. Yetisen, L. R. Volpatti, A. F. Coskun, S. Cho, E. Kamrani, H. Butt, A. Khademhosseini and S. H. Yun, Entrepreneurship, Lab Chip, 2015, 15, 3638. (DOI: 10.1039/C5LC00577A).

3. Chemistry - Developing Solutions in a Changing World; The European Association for Chemical and Molecular Sciences (EuCheMS): Brussels, Belgium, 2011.

References

1. The Oxford Handbook of Creativity, Innovation, and Entrepreneurship Edited by Christina E. Shalley, Michael A. Hitt, and Jing Zhou, Oxford University Press, 2005.

2. W.R. Cornish, Intellectual Property, Sweet & Maxwell, London, 2000.

Suggested Reading

1. Chemistry Entrepreneurship Edited by (García-Martínez, Javier, Li, Kunhao), Wiley, 2022

Online Resources (accessed on 28 June 2022)

1. https://edu.rsc.org/resources/tutor-course-resources-business-skills-for-chemists/4012886.article
2. https://pubs.acs.org/doi/10.1021/acs.inorgchem.1c03288
3. https://ce.ioc.kit.edu/downloads/Chem_Entrepreneurship_Paper_en.pdf
4. https://ipindia.gov.in/resources.htm
5. https://www.startupindia.gov.in/content/sih/en/government-schemes.html
6. https://openstax.org/books/entrepreneurship/pages/4-2-creativity-innovation-and-invention-how-they-differ

B.Sc. Course Articulation Matrix																	
Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	3	K1
CO 2	-	-	2	-	-	-	3	-	-	-	-	2	-	-	-	3	K2
CO 3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	3	K3
CO 4	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	3	K4
CO 5	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	3	K5
Wt. Avg.	-	-	2	-	-	-	3	-	-	-	-	2	-	-	-	3	
												Overall Mapping of the Course			PO: 2.5 PSO: 2.5		

ADVANCED CHEMISTRY

Course Code	**EC05**		
Credits	**3**		
Hours / Cycle	**3**		
Category	**Part** **NA**	**Elective**	**Theory**
Semester	**VI**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To expose the students to advanced level concepts to enhance their competency skills • To gain insight on some advanced organic rearrangements and name reactions and understand the basics of pericyclic reaction through FMO approach • To gain knowledge on the electronic spectra of the inorganic complexes, reaction mechanism and kinetics of the complexes, IR spectroscopic tool to study metal carbonyls and few more metalloenzymes. • To learn group theory and to solve numerical problems in basic concepts in physical chemistry		

CO#	**Course Outcome(s)**	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K5)**
On completing the course successfully, the student will be able to			
CO1	Recall the fundamentals of organic, inorganic and physical chemistry	PSO1	K1
CO2	Explain (i) nature of reactive intermediates in organic reactions, rearrangement reactions, pericyclic reactions and optical isomerism in specific organic compounds (ii) Electronic spectra and reactions of coordination compounds, nature of organometallic compounds and metallo enzymes (iii) The basic principles of group theory, quantum mechanics, Chemical kinetics, Chemical equilibrium, Classical thermodynamics, electrochemistry and photochemistry	PSO2, PSO4,	K2

CO3	Identify (i) the formation and stability of reactive intermediates (ii) mechanism of rearrangement and pericyclic reactions (iii) stereochemistry of compounds with chiral axis (iv) possible electronic spectra and reactions of complexes (v) types of bonding in organometallics and metallo enzymes. Solve numerical problems in basic concepts of physical chemistry	PSO2, PSO3	K3
CO4	Analyze the (i) structure & stability of reactive intermediates (ii) mechanism of rearrangement and pericyclic reactions (iii) stereochemistry of compounds with chiral axis (iv) possible electronic spectra and reactions of complexes (v) types of bonding in organometallics and metallo enzymes (vi) relation between various physical quantities.	PSO3, PSO4	K4
CO5	Analyse and interpret data to identify patterns, trends and relationships and to synthesize knowledge from multiple sources.	PSO3, PSO4	K5

SYLLABUS				
UNIT	**CONTENT**	**HOURS**	**COs**	**BLOOM'S TAXONOMY LEVEL**
I	1.1 Reactive intermediates in organic synthesis: Carbocations, carbanions, free radicals, carbenes, arynes, and nitrenes.Generation, detection, stability and reactivity. 1.2 Molecular rearrangement:Favorskii, benzilic acid and dienone-phenol.	9	CO1 - CO5	K1 – K5
II	2.1 Optical isomerism: due to chiral axis - allenes, biphenyls and spiranes with appropriate substituent – R & S notations; due to chiral plane in hexahelicene and transcyclooctene 2.2 Pericyclic reaction: Electrocyclic reaction (butadiene-cyclobutene system), cyclo-addition (2+ 2 and 4+2 systems) and sigmatropic reaction – [1,2], [1,3] and cope (definition, example, FMO treatment only) 2.3 Name reactions: Simmons-Smith, Robinson annulation, Darzens, and McMurry	9	CO1 - CO5	K1 – K5
III	**3.1** Electronic spectra of inorganic complexes: Ground state term symbols for d^n configurations and their splitting in excited state (elementary treatment only), Orgel diagram and assignment of electronic transitions in complexes; Racah parameters, nephlaxeutic effect and calculation of B value. **3.2** Kinetics and mechanism of substitution reactions in octahedral complexes: Acid hydrolysis, base hydrolysis, water replacement reaction, SN1CB. **3.3** Substitution reactions in square planar complexes: Trans effect, trans effect series and theories of trans effect	9	CO1 - CO5	K1 – K5

IV	4.1 Organometallic chemistry: 18 electron rule and calculation of M-M bond, IR spectroscopy as a tool to understand the backbonding in carbonyl complexes – effect of other ligands on backbonding in carbonyls. 4.2 Metallo enzymes: Redox and non-redox enzymes – definition, types and examples; Structure and functions of carboxy peptidase, carbonic anhydrase, xanthine oxidase and superoxide dismutase	9	CO1 - CO5	K1 – K5
V	**5.1** Advanced topics in physical chemistry 5.1 Group Theory: Symmetry and group theory - symmetry elements and symmetry operations - point groups - simple examples. **5.2** Quantum mechanics: Eigen function and Eigen values (problems) - quantum mechanical operators - Angular momentum, kinetic energy and potential energy (derivations only) **5.3** Numerical problems on Chemical kinetics (first, second and third order reactions), Chemical equilibrium, Classical thermodynamics (first and second law only) electrochemistry (specific and equivalent conductance, ionic strength, activity and mean ionic activity coefficient), photochemistry (quantum yield, lambert-Beer's law)	9	CO1 - CO5	K1 – K5

Textbooks

1. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, 7th Edition, 2015, Wiley Publications.
2. Advanced Organic Chemistry, Organic Reaction Mechanisms, V.K.Aluwalia& R.K. Parashar, 2002, Narosa Publishing House, New Delhi, India
3. Stereochemistry Conformation and Mechanism, P.S. Kalsi, 7th Edition, 2012, New age International Publishers, New Delhi India
4. Inorganic Chemistry: Principles of structure and reactivity, J.E. Huheey, E.A. Keiter, R.L. Keiter and O.K. Medhi, 4th Edition, Pearson Publication, New Delhi, 2014.
5. Symmetry and spectroscopy of molecules, K, Veera Reddy, New Age International (P) Ltd, Second edition (April 15, 2009)
6. Principles of Physical Chemistry B.R. Puri, L. R. Sharma and M. S Pathania, Vishal Publishing Co.; 47th edition edition (2017)

References

1. Organic Chemistry, Jonathan Clayden, Nick Greeves and Stuart Warren, 2nd Edition, 2018, Oxford University Press, India.
2. Inorganic Chemistry, G.L. Meissler and D.A. Taarr, 3rd Edition, Pearson Education in South Asia, New Delhi, 2009.
3. Chemical applications of group theory, F.A. Cotton, 3rd Edition, Wiley India Publicaiton, 2008.
4. Physical Chemistry – A molecular approach, D.A. McQuarrie, University Science books, 2011.

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	3	-	-	-	-	-	-	K1
CO 2	-	3	2	-	-	-	-	-	2	3	2	-	-	-	-	-	K2
CO 3	-	3	3	-	-	-	-	-	-	3	3	3	-	-	-	-	K3
CO 4	-	3	3	-	-	-	-	-	-	3	3	3	-	-	-	-	K4
CO 5	-	3	2	-	-	-	-	-	-	3	3	3	-	-	-	-	K5
Wt. Avg.	-	3	2.5	-	-	-	-	-	2.5	3	2.75	3	-	-	-	-	
Overall Mapping of the Course															PO: 2.75 PSO: 2.81		

PROJECT BASED LEARNING

Course Code			
Credits	**32**		
Hours / Cycle	**2**		
Category	**Part IV**	**Elective**	**Theory**
Semester	**VI**		
Year of Implementation	**From the academic year 2023-24 onwards**		
Course Objectives	• To construct knowledge on their own through facilitation by mentors • To acquire 21st century skills such as critical, creative thinking, collaboration and communication as well as bench skills • To gain skills in generating and interpreting data through designing experiments • To impart critical reading and scientific writing skills through reading chemical education journals for synthesizing information		

CO#	Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K5)
On completing the course successfully, the student will be able to			
CO1	Recall the fundamentals of organic, inorganic and physical chemistry	PSO1	K1
CO2	Use domain specific technological research tools to analyze and interpret data	PSO1 & PSO3	K2
CO3	Apply the basic concepts to explain the research findings	PSO3	K3
CO4	Critically analyze literature to identify the knowledge gap in the research problem and present the results as a systematic scientific report in written and verbal	PSO5 & PSO8	K4
CO5	Generate hypothesis, design and carry out the experiments to validate the hypothesis.	PSO7 & PSO8	K5

Course content

- It is a skill development course
- Students will be undertaking any 4 group micro projects, each of 3 cycles long.
- The students will be carrying out the micro projects in groups
- The students will read Chemical education research articles and synthesize information, draft mini research proposal for micro project including hypothesis and design experiments based on the themes provided:

Broad domains for Micro research projects

1. Designing Green synthetic protocol for organic / inorganic compounds and materials
2. Designing protocol /SOP for Complex preparation, qualitative and quantitative analyses
3. Determination of nutrient in the food samples
4. Computational chemistry: Writing algorithms for predicting the outcome of chemical reactions
5. Extraction of compounds from natural sources by optimizing parameters
6. Computing physical parameters and constructing isotherms: Chemical kinetics, adsorption and catalysis studies
7. Developing novel materials for sensing

Evaluation

The outcome of the course will be evaluated through the submission of project report based on the following rubric:

Statement of hypothesis (5), designing/optimizing methodology (5) through critical and creative thinking, peer collaboration (5) and Scientific writing (10) (Title, abstract, keywords, introduction, methodology, results and discussion and conclusion)

References

- Chemistry Education Research and Practice https://www.rsc.org/journals-books-databases/about-journals/chemistry-education-research-practice/
- Journal pf Chemical Education, American Chemical Society, https://pubs.acs.org/journal/jceda8
- *Education in Chemistry, Royal Society of Chemistry,* https://eic.rsc.org/
- African Journal of Chemical Education, https://www.ajol.info/index.php/ajce
- The Chemical Educator, http://chemeducator.org/
- Chemistry Teacher International, https://www.degruyter.com/view/j/cti

B.Sc. Course Articulation Matrix

Course Outcomes	Program Outcomes								Program Specific Outcomes								KL
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO 1	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	K1
CO 2	-	3	-	-	-	-	-	-	3	-	3	-	-	-	-	-	K2
CO 3	-	3	-	-	-	-	-	-	-	-	3	-	-	-	-	-	K3
CO 4	-	-	-	-	3	-	-	2	-	-	-	-	3	-	-	2	K4
CO 5	-	-	-	-	3	-	-	2	-	-	-	-	-	-	2	3	K5
Wt. Avg.	-	3	-	-	3	-	-	2	3	-	3	-	3	-	2	2.5	
													Overall Mapping of the Course		PO: 2.67 PSO: 2.7		